IN ASSOCIATION WITH abbvie

2018 Sligo Engineering Expo

Knocknarea Arena - IT Sligo
Thursday 3rd May 2018

Event Catalogue

IT Sligo
An Institiúid Teicneolaíochta, Sligeach

Welcome from the President of IT Sligo

Engineering is the heartbeat of Irish Industry and it is central to the contribution that IT Sligo is making to the growth of the economy here in the North-West. Throughout its 48-year history, engineering has been an integral part of the Institute's education offering. We are deeply proud of that heritage and are fiercely ambitious to grow and develop the role that IT Sligo can play in the engineering sector, both educationally and as a collaborative partner with industry.

This special event is a collaboration between industry, educators and innovators, bringing together some of the best talent and expertise across Ireland. The Expo reflects the close working relationship between IT Sligo and employers in all aspects of engineering across the region and provides a real opportunity for forthcoming graduates to meet, discuss and engage with their future employers.

Engineering is a creative enterprise, one that requires intense imagination and taps into our everyday curiosity about how the world works. You'll get a sense of that when you browse the truly diverse range of exhibits featuring some of Ireland's leading engineering companies alongside innovative projects developed by students and graduates from IT Sligo's School of Engineering & Design.

You will also get to see the range of engineering programmes on offer by the Institute, provided on campus and online, which might stimulate you to continue your studies in Engineering.

On behalf of the Institute of Technology, Sligo, I am delighted to welcome you to the Engineering Expo 2018 at the Knocknarea Arena.

As a qualified engineer myself, I am passionate about helping others to develop their engineering careers through education, which is why I fervently hope that this Engineering Expo at IT Sligo is a source of inspiration and motivation for the future generations of engineers.

For students and jobseekers, the Engineering Expo provides a good insight into what a career in Engineering is really like. It is particularly gratifying to see so many employers from the North-West at the Expo, all of whom wanting to employ our graduates – we are seeing employment opportunities for engineering graduates in the North-West at a very high level this year.

Discover and enjoy.

Dr Brendan McCormack President IT Sligo.

Welcome from the Head of the School of Engineering & Design

Welcome to our 4th Engineering Expo.

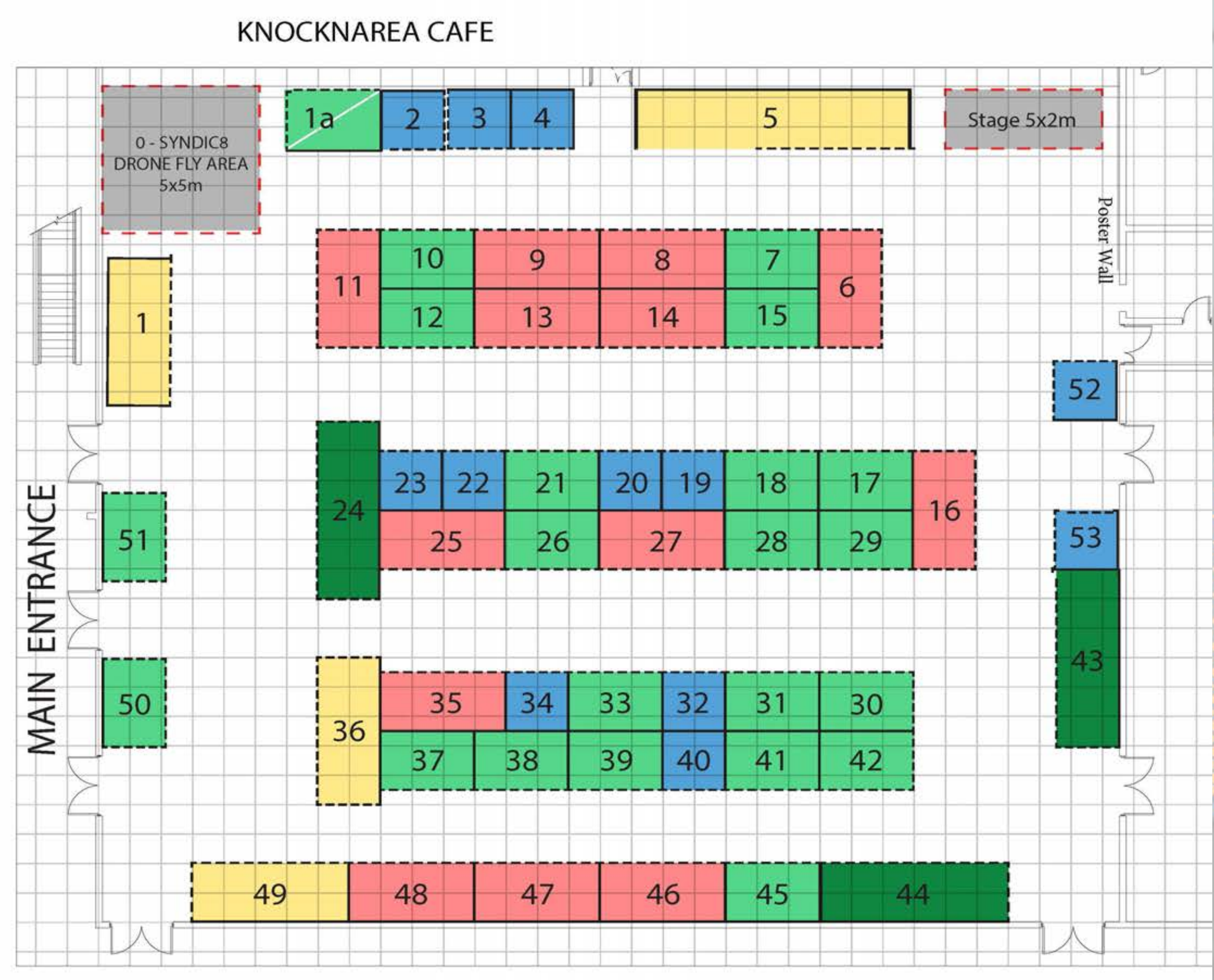
At the Engineering Expo you will see an extensive range of activities on show that include student projects, industry exhibits and guest speakers and – all aimed to inspire future engineers, showcase our graduates, promote engineering in the Northwest and to open up engineering conversations and connections.
Over fifty of our final year students will showcase their projects that are the culmination of their education in IT Sligo. We are proud that we educate students that satisfy the needs of industry across a broad range of programmes including; civil engineering, mechanical engineering, precision engineering & design, mechatronics, electronic & computer engineering and a broad variety computing programmes. Many of our graduates have gone on to leadership positions in some of the top companies in Ireland and around the globe.

We have 38 great companies showcasing the leading edge in engineering and technology, many with jobs on offer. Prospective job hunters and those interested about roles in engineering are invited to attend. We hope that primary and secondary students along with the teachers and parents will come along and be inspired about the potential of a career in engineering.
We are also promoting all our fulltime, online and apprenticeships courses we offer for the manufacturing, technology and construction industry sectors – that include engineering, computing and science programmes.
An event like this would not happen without a great team of people on board. I would like to thank everyone who contributed across many organisations and within IT Sligo. A special thank you to the industry steering group, our academic and technical staff who supported the student projects, our core IT Sligo organising team, our event manager Oli Melia, logistical partner Ocean FM (led by Daniel Brown) and our key industry sponsor AbbVie.

I hope you enjoy Engineering Expo 2018.

Una Parsons, Chartered Engineer, FIEI
Head of School of Engineering & Design IT Sligo

Event Plan & Exhibitor List



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Catalogue Entries

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Together with its wholly-owned subsidiary, Pharmacyclics, the company employs more than 29,000 people worldwide and markets medicines in more than 170 countries. In Ireland, AbbVie employs almost 600 people at five different manufacturing and commercial sites across the country. The company's commercial headquarters is based at Citywest in Dublin with a separate international manufacturing and engineering services centre also located in the capital at Santry. AbbVie has two manufacturing plants in Sligo, one of which is a global centre of excellence for medical devices. The company also has a third manufacturing centre in Cork.

AbbVie is committed to developing and manufacturing the cutting-edge therapies and innovations that hold the potential to improve health care worldwide. Meeting these ambitious health goals involves combining advanced science with deep knowledge of diseases and Ireland plays a central role across all stages across this process.

AbbVie harnesses and supports Irish expertise in complex chemical and biological R&D. The company tests discoveries through clinical trials involving Irish patients, doctors and centres. It supports the manufacturing of many of the medicines and delivery devices involved here in Ireland. In this way, Ireland contributes to every part of the medicine discovery process.

This platform then provides AbbVie's commercial team with the opportunity to make these new treatments rapidly accessible to Irish patients.

AbbVie believes strong local partnerships are crucial to achieving the best outcomes for patients as we seek to make a remarkable impact on people's lives.

In the company's core areas of immunology, cancer, neurology and virology, AbbVie works with patient groups, caregivers, health providers and policymakers. This community focus is what drives AbbVie to deliver new best-in-class therapies with life-changing impact for people in Ireland and beyond and the company aspires to do this in a way that is sustainable for society.

AbbVie's Ballytivnan site in Sligo was recently awarded the world-renowned Shingo Prize for enterprise excellence.

In 2018, AbbVie was named as Ireland's No.1 large workplace. The company's first place finish ensures it remains the highest placed employer in the pharmaceutical/pharmaceutical industry.

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Sylvester hails from Castlebar and has a wealth of experience in the Irish recruitment industry, particularly in the Connaught region.

During the last number of years we have succeeded in forging solid relationships with companies throughout Ireland, establishing ourselves as a market leader in the recruitment industry.
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LotusWorks are engineering and technical experts who work with the world's leading companies and household names around the world. With 29 years' experience at the cutting-edge of various industries, our 470 staff gain exposure to the very latest technologies and innovations. Our people are at the heart of our business and we care about investing in them, their health and making sure they are happy as part of the LotusWorks team.

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Specialists in Calibration, Commissioning, Contract Staffing, Operations & Maintenance and Automation, our ability to tailor and deliver "best fit" expert technical and engineering services to our clients, allows our clients to focus on their core activity.

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First Polymer Training Skillnet

Polymer Technology Ireland Ibec

FIRST POLYMER TRAINING SKILLNET

First Polymer Training (FPT) Skillnet operates as a training network for Irish Industry and is funded by Skillnet Ireland. While they specialise in specific polymer programmes for the plastics and medtech industry, many programmes are aimed at the wider manufacturing sector, including a wide range of practical maintenance programmes.

Initiated and promoted by Polymer Technology Ireland (Ibec) since 1999; First Polymer Trainings objective is to provide subsidised technical training to industry, both at their technical training centre in Athlone or in-company as required. The centre in Athlone is a state of the art facility with 4 injection moulding machines, an extruder, a thermoformer and purpose built maintenance training boards.

FPT is a QQI validated provider for a number of technical programmes and has developed a series of polymer processing and design awards since 1999. A range of free e-learning programmes are also available, which are used to complement existing programmes.

FPT initiated an online polymer engineering degree with Sligo and Athlone Institutes of Technology back in 2009 – **B. Eng. Level 7(Ord) Degree in Polymer Processing**. The seventh cohort graduated in 2017 and the programme is strongly subscribed each year. A new **Level 6 Certificate in Polymer Technology** was also recently developed as a means of entry to the degree or for those who already worked in industry and wanted to gain a formal technical polymer qualification.

Please contact FPT or visit www.firstpolymer.com for more details on all programmes.

www.firstpolymer.com Tel: 090 6471223 email: info@firstpolymer.com

Polymer Technology Apprenticeship Ibec

Manufacturing Apprenticeship Ibec

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Polymer

Industry-led Polymer Apprenticeship

Award: Bachelor of Science in Polymer Processing Technology (Level7)

Developed by Plastics Ireland, an Ibec network, along with a strong industry consortium, First Polymer Training and Athlone Institute of Technology as the lead provider this polymer apprenticeship is suitable for any company producing polymer technologies/plastic products.

Programme:

Duration: 3 years

70% of the time will be spent on the job and the remaining 30% in Athlone Institute of Technology (15 weeks/yr).

"Getting involved in the polymer apprenticeship for us was a no brainer. Ireland's polymer industry is incredibly diverse with more than 6,500 people working across more than 200 businesses with companies specialising in key manufacturing areas such as medtech, biopharma, aerospace as well as food and drink. As a contract manufacturer, we need the right people who understand how to work with the latest technology and can apply technical knowledge in order to meet the demands of these growing sectors. These news apprenticeship schemes will equip people better than any other programme of its kind in Ireland."

Aisling Nolan

Mergon International General Manager

www.polymertechnologyapprenticeships.ie

Manufacturing

Developed by the Irish Medtech Association, an Ibec sector, along with a strong industry consortium and Galway Mayo Institute of Technology as the lead provider these manufacturing apprenticeships are suitable for a hugely diverse manufacturing environment, e.g. Medical Technology, Plastics, Pharma, Food, Machinery, ICT etc.

Programme:

Manufacturing Technician Apprenticeship Level 6 – 2 years (H. Cert.)

Manufacturing Engineer Apprenticeship Level 7 – 3 years (B. Eng.)

"We came together with one goal in mind, to create career paths that would deliver, technical, knowledge based, challenging, interesting and sustainable jobs across the country. We could see the benefits of the Apprenticeships from the outset, not only for those people in our companies who want to upskill, but also as a career path for school leavers and others. I believe the 'process of experiencing, reflecting, learning and doing' is the best way to turn out the highest quality Technicians and Engineers. We look forward to making these Apprenticeships a success for everyone involved"

Barry Comerford

CEO Cambus Medical, Chairman of the Apprenticeship Consortium, Ex-Army Apprentice, Naas, 27th Pln.

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Lindal's relationship with Sligo commenced in 2000, when a wholly owned subsidiary of **Litec Moulding Ltd** was created as the center of excellence for the LINDAL Group's injection moulded technical components. By creating high value return for our customers, through the generation of innovative, technically advanced solutions

Litec Moulding has continually grown year on year for every one of its' 18 years to become a global producer of thin wall, high precision and fast cycle time products. The company now operates on a 24/7 basis, employing 70 staff, producing 5 Billion parts per year.

This success has been made possible by **Litec Mouldings'** highly skilled specialist team dedicated to exceeding customer expectations from design concept to customer dock in an environment focused on achieving Zero defect. The company philosophy is to seek excellence through continuous improvement of all our activities, products and services. This is encouraged through employee engagement, involvement,

empowerment and a process of lifelong learning. The company actively support and encourage personal development and educational advancement. **Litec** provides undergraduate placement opportunities and a graduate development programme. The company is actively involved locally with Sligo IT and also further afield with University of Limerick, NUI Galway and Ulster University.

Lindal groups' confidence in the diverse team based in Sligo has been expressed in investment of over €11m over the last 5 years and further planned investment in 2018 in State of the art processes and equipment to meet the demands of today and tomorrow.

Litec Moulding part of Lindal Group is constantly on the lookout for new talent to become part of the team to ensure the continuing future success of the company both in Sligo and globally with opportunities for significant career development and progression.

If you are interested in a position with Litec Moulding please send a Cover Letter and Curriculum Vitae to G_LIE-humanresources@lindalgroup.com

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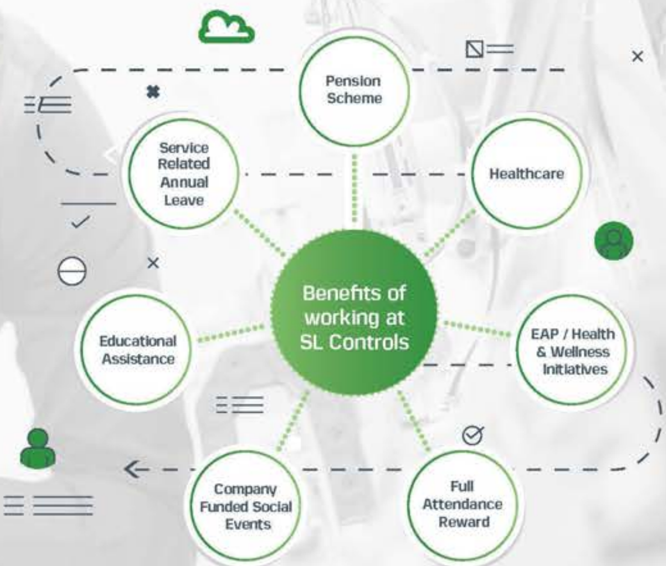

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We are proud that our head-office resides in Tuam, Co. Galway, Ireland, within the grass-roots of the Community that we started in. We have a further 6 operations spread across the UK, the Netherlands, Poland and South Africa.

Across all our teams, we offer exciting opportunities to develop and market advanced solutions that address and exceed our customer base across Agriculture, Equestrian, Civils/Construction, Marine and Material Handling divisions. We believe in what we can deliver. Indeed, many of our sites are currently supporting a range of new product introductions.

The JFC Experience

We are ambitious and lead with focus, drive and passion. JFC employees work every day to discover and address new ways to the way that we work. We are always looking for talented people to join our team and, when we find them, we make it our business to treat them well.

What we expect is that you give your best every day through delivering on our core competencies of leadership, business acumen, customer focus, achievement and collaboration. In doing so, you will help shape JFC's strategic goals in achieving our 2020 Vision.

What You Will Do Here

Whether it's in our engineering design lab, at exhibitions promoting our products to our customers, in the office or on the production floor, everyone's work at JFC starts with commitment to what we do. As JFC employee, you'll have exciting opportunities to innovate, collaborate and demonstrate your passion towards excellence every day.

We offer numerous career paths to help you succeed in our many businesses and functions, including Research & Development, Sales Marketing, Technology, Finance, Operations, Procurement & Logistics, Purchasing, Human Resources and more.

Get In Touch

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Phone: +353 93 24066

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OPHARDT hygiene

BREAKING THE CHAIN OF INFECTION

About GSK in Sligo

- The company originated over 150 years ago, and was bought by GSK in 2009
- Sligo site first opened in 1975
- Site Size is 31,500 m^2
- 175 Employees onsite
- Currently serves c. 70 markets
- Sligo produces c.40 formulations
- Produces c.450 SKUs
- Manufactures both prescription and over the counter medicines and cosmetics
- Topical dermatological products - creams, lotions, gels and liquids.
- Main Markets are UK, Germany, France, Korea, Poland

Core Product Family for Sligo

Dry Skin Eczema treatments

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Other Examples of our Products


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Mayo, Sligo and Leitrim
Education and Training Board

Mayo Sligo & Leitrim Education and Training Board (MSLETB) Provision; FET Sector: Summary of our Services

Apprenticeships typically consists of 3 off-the-job training phases and 4 on-the-job phases. Apprenticeships Phase 1, 3, 5 and 7 are on the Job phases (placement) of 3 – 4 years. To undergo the Apprenticeship programme individuals must first be registered by an employer. MSLETB also register apprentices for the new Generation Apprenticeships. These cover engineering, Finance, Hospitality and ICT.

Traineeships provide job-specific training which combines direct training and a significant workplace training element (Work Based Learning, WBL element) with an employer. All programmes lead to QQI Major awards at levels 4 to 6 on the NFQ. Traineeships take nine - eighteen months to complete (up to 50% of which could be in the work place). Examples of Traineeships: Hospitality Engineering, Childhood Care & Education, Healthcare Support, Hairdressing and Beauty Therapy. Traineeships have significant Work based Learning (WBL) requiring sponsor/placement periods throughout the 6 – 18 month programme (Block and Day release combinations).

Specific Skills Training (SST) courses are typically around 6 months to complete and are designed to meet the needs of industry across a range of sectors. QQI accreditation is at Levels 4-6 on the National Framework of Qualifications (NFQ) and/or industry specific qualifications. Examples of SST courses include, Computer Applications and Office Skills, eBusiness, MySQL, Retail Skills, Health and Beauty, Business Administration, Construction Skills, Professional Cookery, Hospitality, Business Process Improvement, Manual and Computerised Payroll, Precision Engineering, Software Development.

Skills for Work is a programme aimed at providing opportunities to help employees upskill to meet demands of the workplace. Programmes are 35 hours duration delivered and designed in a flexible way to meet the needs of employer and employee.

Part-time Evening courses of typically 30 hours duration over 10 weeks provide short up-skilling modules for both unemployed and employed persons. Examples of courses include Welding TIG, Interior Design, ECDL, CAD, Door Security, Supervisory Management, and Start Your Own Business. Courses generally lead to accreditation at levels 4-6 on the NFQ or certification from an Industry accrediting body.

Post Leaving Certificate(PLC) provides courses in a combination of general studies, vocational skills and opportunities for work experience so students can enter or re-enter skilled employment in the labour market. Courses generally lead to major awards at NFQ Levels 5 and 6. Typically courses are one full academic year.

Other Programme Areas

ecollege is the leading online learning institution in Ireland delivering online and distance training courses in business, project management, SQL, Cisco, graphic design, web design, digital marketing, software development and basic computer literacy. These courses are available to both employed and unemployed people who wish to update their skills. See www.ecollege.ie

Community Training provided through Community Training Centres, Local Training Initiatives and Specialist Training Providers (for people with disabilities).

Youthreach is a 2-year full-time programme for early school leavers aged between 15-20 years of age. Programmes can include QQI certification, Junior Certificate, and Leaving Certificate Programmes.

Vocational Training Opportunities Scheme (VTOS) provides a range of courses to meet the education and training needs of people who are unemployed. It gives participants opportunities to improve their general level of education, get a certificate, develop their skills and prepare for employment and further education and training. They are usually delivered over two academic years on a full-time basis of 30 hours per week.

Back to Educational Initiative (BTEI) provides part-time Further Education programmes for young people and adults. Courses lead to a range of accreditation at levels 1-6 on the NFQ. **Adult Literacy Programmes** are provided to people inside and outside of the labour force who want to improve their communication skills, i.e. reading, writing, and numeracy and information technology. They also provide English for Speakers of Other Languages (ESOL).

Support Services:

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NWCAM

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The North West Centre for Advanced Manufacturing (NWCAM) links the academic capabilities of Northern Ireland, Republic Of Ireland and Scotland (in collaboration with Ulster University, University Of Glasgow, Institute of Technology Sligo and Letterkenny Institute of Technology) to develop and deliver, in partnership with industry partners, 15 world leading research projects within the Life and Health Science sector.

The collaborative research projects have the potential to deliver global products and processes that can be licensed throughout the world. NWCAM is a new trans-regional centre for the research and development of innovative solutions and is funded by the EU's INTERREG VA Programmes (total EU funding €8.5m) which is managed by the SEUPB. Catalyst Inc is the lead partner in the delivery of the project.

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Contact: Linzi Ryan, PEM Business Development Engineer.
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ALCOHOL DETECTION DEVICE

Charles Traboue

Introduction:

Alcohol Detection Device is designed to incorporate vehicle for safety purpose. It has a alcohol or gas sensor that measures the driver breath. In the event of presence of alcohol in the breath it will shut down the system to prevent from driving . If alcohol is not detected, it makes the car available for driving.

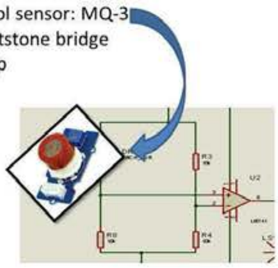
Objectives:

Objective 1: draw awareness that, reducing road accident caused by Drink Driving can be easily done by equipping vehicles with this device.
Objective 2: demonstrate skills and knowledge acquired during Electronic Engineering course.

Methodology:

Wheatstone bridge:

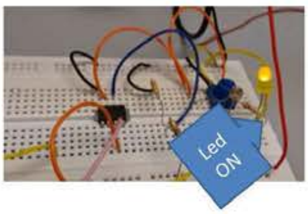
1. Alcohol sensor: MQ-3
2. Wheatstone bridge
3. opamp



Wheatstone bridge

Opamp configured as comparator.

Signal conditioning



Yellow LED is ON (HIGH) when alcohol is absent

Yellow LED is OFF (LOW) when alcohol is detected.

Signal (alcohol) is captured and converted into one or zero, High or low. This analogue to digital conversion is fed into microcontroller.

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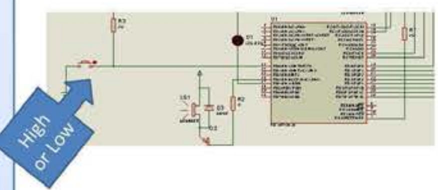
Methodology (Continued):



The project Schematic Design

The switch seen on the left hand side corresponds to the previous circuitry.

The core of the project

PIC18F45K20

It has 40 pins. 1 timer (8bits) and 3 timers (16 bits),and many more features.

Results:

LCD

LCD displays "system ON" when alcohol is not detected and "system OFF" when alcohol is detected.

No alcohol detected

Motor and green led
Are ON in absence of
alcohol

Charles Traboue,
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Results:

Alcohol detected

Buzzer and red led are ON when alcohol is detected
Led flashes 20 times during that time.

Conclusions:

This a work of nearly a year of intensive research, tests. Sometimes with positive results, sometimes with failures.
But when everything seems to collapse, there is the feeling deep inside that keeps giving an extra energy to go extra miles. And now, the work done the energy put in the achievement of the project pays off.. It is rewarding even if it is for an EXPO event duration.
With the hope that people will start equipping their vehicles with this device to increase road safety in this country

NB: The code for this project was written in C language.

References:

Drink Driving in Ireland is a significant factor of road accident and road death every year.
According to:
alcoholireland.ie:
Alcohol consumption is a significant road safety issue in Ireland and is a factor in 38% of all deaths on Irish roads, as well as many other collisions resulting in injuries.

Drink Driving is an offence.
According to:
https://businessandlegal.ie/drunken-driving-in-ireland
The concentration of alcohol required to prove this offence is an excess of alcohol in the blood of 80 milligrammes of alcohol.

Photos from the electronic components provider:

https://ie.rs-online.com/

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Fingerprint and Bluetooth Access Control.

Introduction

The purpose of this project is to fulfil a need for control of access to property. It can be applied to many roles including domestic, commercial and industrial needs. The user interface will rely on two separate technologies:

- An android application which controls the gates via Bluetooth.
- A fingerprint scanner containing a database of user registered authorised fingerprints.

Objectives

- The result of this project should be a working access control system comprising of a control module and a working model of a gate system.
- To develop an understanding of the challenges posed by the process of designing a system both in terms of hardware and software requirements.
- Design a system schematic using the software package Proteus and test the project in a virtual environment prior to a physical build using code developed in MPLabX.
- Develop a test plan and apply it to a prototype build using breadboard.

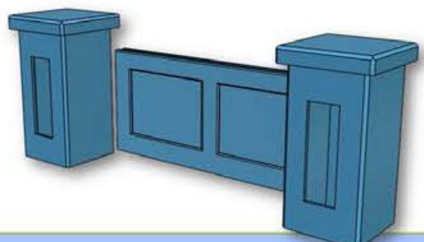
Methodology

Research.

- As the project comprises both electrical and mechanical components the safety aspects of the project were researched resulting in inclusion of IR Break-Beam sensors and an Emergency Stop button.
- Research into the regulatory and legal requirements of a full-size example of the controlled gate was also undertaken.

Designing/Planning.

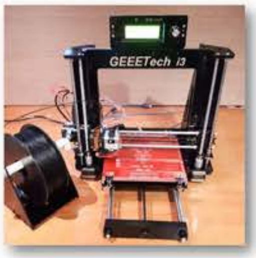
- Initial design started in October 17.
- Component research was undertaken to find parts which would best suit the application.
- A circuit diagram was completed using Labcenter Electronics Proteus software.
- A software flowchart was developed using Microsoft PowerPoint.
- A Gantt chart was developed using Project Libre software to ensure all aspects of the project were completed on time.
- A hardware block diagram was completed using Microsoft Excel.



- A test plan was developed to ensure correct operation of each aspect of the project.
- Consideration was given to the physical construction method and a decision to use 3D printing technology was taken.
- A 3D software model of the project was completed using Autodesk 123D Design software.

Construction.

- The physical structure of the project required research into 3D printing options.
- A Geeetech Prusa i3 pro B was used to print the required parts using PLA 1.75mm filament, Autodesk 123D Design and Repetier software.



- The electronic module was built on single sided Perfboard and based around a pair of Pic 16 series microcontrollers which communicated serially with a H05 Bluetooth module and a GT-511C3 fingerprint scanner.

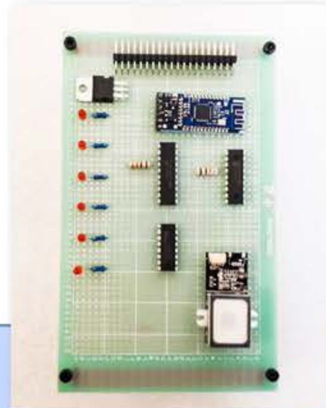
- Code for the individual modules of the project was developed using MPLABX .
- These modules were prototyped separately using breadboard before being integrated with the system as a whole.
- An Android App was developed using Android Studio.

Testing.

- At each stage of construction, the individual modules were tested in accordance with the test plan.
- When all modules were operating within design parameters, the system was assembled in its entirety and underwent functional testing.
- The safety features of the project were of key importance at this stage.

Results.

- During the testing stage several changes were made to the initial design.
- The originally selected motor was replaced due to electrical noise considerations as it was interfering with operation of the microcontroller.
- A current sensing feature was omitted from the final design as it was found to be too demanding in terms of processor time and a work around was unfeasible in the time available.
- The above issue resulted in a redesign of the gate operation from a swinging type to a sliding type. This was due to the difficulty in detecting obstructions in the larger area covered during the opening/closing of the swinging gate. Break-Beam sensors provide adequate obstruction detection for the linear nature of a sliding gate.



Conclusion.

- This project was selected as it was felt to have potential to bring together many of the skills learned during completion of the Electronic Engineering Degree, including design and programming skills.
- The key objectives have been met and several other unanticipated skills have been acquired.
- The 3D printing element of the build involved quite a steep learning curve to both design in 3D and learn how to achieve the required quality of output.
- Production of a short video required the use of OBS studio and Lightworks software, further reinforcing the ability to gain a working knowledge of proprietary software in a relatively short time period.

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Android controlled robotic Arm

Introduction:

The idea for this project came about after coming across a process inefficiency in work. Product inspection is carried out every few hundred cycles to ensure product quality. This can be time consuming and can lead to increased downtime. The aim was to completely automate this process taking away the need for human intervention. The design aim was to try to keep it as simple , efficient and cost effective as possible while carrying out the task.

Aims of Study:

To demonstrate the theoretical knowledge gained during the course and apply it to a project .This project will also show how an inexpensive microcontroller can offer solutions to Industrial process control issues.

Methodology:

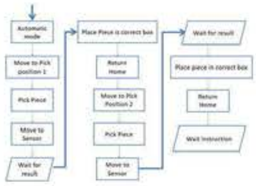
Research:
Research began by creating a flow chart of the manual process, then breaking it down to find cost effective solutions to automating these steps in the most efficient way possible.

This process was broken into three main sections:

1. Product handling
2. Product inspection
3. Quality control verification.

Design/Planning:
The design process involved:

- Selecting an appropriate microcontroller
- Selecting an appropriate handling unit and inspection sensor.
- Initial Schematic design.
- Initial PCB layout.
- Software Flow chart.
- Android application research and programming.
- Bluetooth Module selection.
- Researching components.
- Power supply specification research.
- Sourcing suppliers and costing.



Assembly:

- The Microcontroller and other components are mounted on a solderless breadboard for the project purposes.
- The Handling unit is a kit designed by Lynxmotion which was assembled and mounted on a solid Perspex sheet.
- The inspection sensor is the Keyence IV-G300CA which comes with it own amplifier and software to program the inputs ,outputs and results signals.
- An android Device will be used as the HMI.

Methodology (Continued):

Control:

- The microcontroller is the brain of the operation
- It handles the Serial communication for the Servo sequencer board .
- It also handles the digital I/O signals to and from the Keyence control amplifier.
- The appropriate microcontroller would need to have the peripheral modules for the PWM output and the Serial communication.

Quality check/HMI:

- Quality check is handled by the vision sensor and is processed through its own control software and the signal is sent via it amplifier.
- The quality parameters are set in the IV-navigator control program.
- The microcontroller then processes this result signal via optocouplers and issues the result to the handling unit and the Android device which acts as a HMI.
- The Android device then informs the user of the result and retains the results.

Safety:
Safety is a principle design feature in the project. The project includes an emergency stop and the handling units speed is set to the lowest acceptable limits.

Results:

Design/Planning:
After reviewing several concepts of design, a final concept was developed and components were chosen for the project. It comprised of programming the following steps using MPLABX and the MIT app inventor Software:

- Wait for start signal from user
- Pick the workpiece at position 1
- Move to the Test position.
- Trigger the inspection sensor.
- Await a result from the inspection sensor
- Process the result and place the workpiece in the appropriate box.
- Move to the next workpiece at position 2.

Results (Continued):

Microcontrollers

- A PIC18F45K22 microcontroller is used to control the project.
- An ECCP (Enhanced Capture Compare PWM) was initially to be used but the desired resolution and sequencing could not be achieved by the ECCP module . An SSC-32U servo sequencer module which offers 10bit resolution is used to reach the desired output.
- 2 UART communication modules are used. One for the Bluetooth and the serial connection the for SSC-32U PCB.

Quality check/HMI:

- The inspection sensor returned a result successfully to the Microcontroller and the Android device.
- The signals had to be conditioned by an Optocoupler due to the high voltage output of the amplifier.

Assembly:

- For demonstration purposes the project was assembled in such away it can fit on a desk
- The Robot was assembled to the manufacturers specifications
- The breadboards were first simulated and designed using Proteus 8 PCB design software to identify possible component issues. This helped reduce the build time of the final breadboards.
- An Electrical junction box was used to house the power supply for the SSC-32U control PCB and the inspection sensor power supply.

Conclusions:

- This project provided a great opportunity to utilize the skills , knowledge gained from the course in a practical way. Overall the project was a success and was an excellent learning and personal development experience.
- The objective to automate the manual process was achieved
- The project schedule ran according to plan

The limiting factors of the project Included:

- Time as the amount of programming and research used more time that expected
- The resolution of the PIC microcontrollers PWM not being as expected.
- The MIT App inventor software limited the way in which commands could be sent to the user.

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DIY 3D Printer

By Ross Monaghan

Introduction:

My desire to pursue this project arose from this increasing prevalence of 3D Printing in industry and its constant coverage in media. It has been something I have followed closely since it first came to my attention several years ago and I felt it would be an exciting and topical project to attempt this year.

It has the ability to cause great disruption and innovation within manufacturing industries. Particularly in areas such as prototyping.

Aims of Study:

To create a working 3D printer using knowledge and experience gained over the duration of my study in Electronic Engineering.

.

Approach:

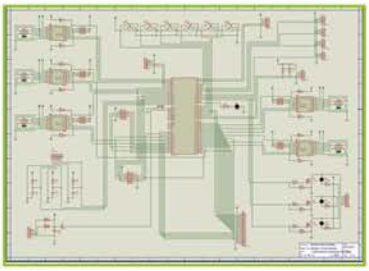
The approach taken for the project can be divided into four main stages:

1. Research.
2. Design/Planning.
3. Build.
4. Completion.

Research:
Research had to be carried out into choices which had to be made with regards to the design and build of the 3D Printer.

Some of these choices included:

- What type of printer would be most suitable for the project.
- What materials would be used in its construction.
- What electronic parts would be used in it.



Design/Planning:
A plan had to be made which would detail the path to be taken over the course of the project. This meant making a Gantt Chart which included each phase of the project and its projected duration.

The design of the printer involved three main stages:

- Design of the structure – In which drawings and a Solidworks model of the 3D printer were made.
- Design of the circuit – Which meant creating detailed schematics and PCB designs in Proteus.
- Design of the software – Where a detailed software flowchart had to be made.

Approach (Continued):

Build:
The build was comprised of the completion of all software and hardware aspects of the printer.

- Software – The software of the printer was to be composed of code on the Arduino Mega 2560 and PIC 18f4520. The compiler used for the Arduino was the Arduino IDE. The pic was compiled using MPLABX.

- Hardware – The hardware build would involve the building of the body and mechanical parts of the printer. I chose to use plywood, steel rods, and plastic parts for its construction. Given that my project was to create a 3D Printer, I thought it would be a good idea to use 3D printed parts for my project. These parts are coloured green and can be throughout the printer.

Finalisation:
This stage involved the final tasks which had to be completed once the 3D Printer was finished. These tasks included:

- Finalising the project report detailing the entire process of planning, designing and building.
- Creating a promotional video of the project.
- Showcasing the Printer at the Engineering Expo.

Results:

The results for each stage are as follows.

Research:
The research stage came to the following conclusions:

- Printer Type – Cartesian.
- Printer Materials – Combination of Plywood, Steel and Plastics.
- Printer Main Board – Ramps 1.4 & Arduino Mega 2560.

Design/Planning:
The Gantt chart made in the planning stage was followed as closely as possible in order to complete the necessary tasks.

- A solidworks model of the Printer was made which aided in the construction of the body of the printer.

- The necessary circuit schematics were completed. These helped while assembling the electronics in the Printer.
- The software flowchart was completed which eased the process of writing the code of the Printer.

Results (Continued):

Build:
Software:

- The software for the Arduino was created by modifying open source code which was obtained online.
- For the PIC the code was written up from scratch.

Hardware:

- The body was assembled using plywood as a frame.
- Several key parts that had been printed connected the steel rails, motors and other mechanical parts.
- The main board and components were contained in a custom housing in the printer.

Completion:

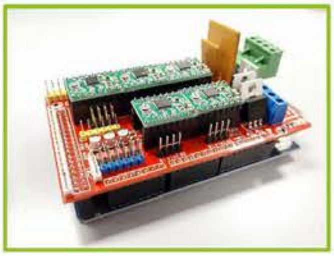
- The report was completed.
- A promotional video was made which served as a quick overview of the process of completing the project.
- The project was ready to be showcased at expo day.

Conclusions:

Were the goals achieved?

Yes:

- The printer was successfully completed with all intended functionality.
- The process provided a valuable platform to learn and display knowledge acquired during the course.



The main limiting factors of the project Included:

- Time – The time taken for the ordered parts to arrive was a big limiting factor in that the project build could not begin until they had arrived.
- Resources – The presence of a dedicated 3D Printing room which was available to enter at will would have been welcome.

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An Institiúid Teicneolaíochta, Sligeach

Function Generator

Introduction:

The purpose of Function Generator Is to create different types of electrical waveforms over different frequencies, these frequencies can be used in the development, testing and to repair electronic equipment.
I chose this project as it closely associated with some of the other modules I studied this year, such as Digital signal processing and Embedded systems.
It was my aim to keep the circuit design as simple as possible, however to also integrate as many different waveform types.

Aim of Study:

To apply the studies over the last two years to a practical project that can be used for applications in the real world, highlighting the

Methodology:

Research:

The research process started with the help of my lecturer Fergal, whom suggested a project which had close relation to other modules I have studied over the last year.

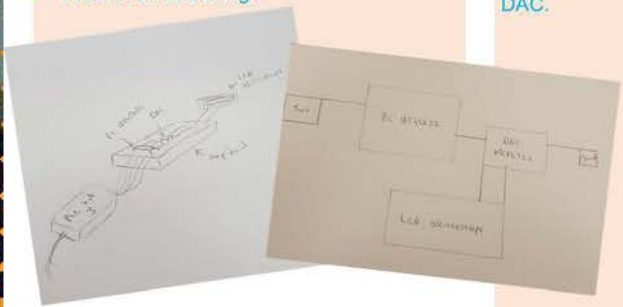
I decided on a function generator as I felt it was something which could be created relatively easily, however would also provide a good practical use for certain applications.

I spent some time looking at other function generator projects to give myself a good idea of what direction to take.

Design/Planning:

The design and planning process involved:

- Develop project schedule
- Developing initial concepts
- Researching similar projects
- Project Sketches and drafts
- Understanding SPI bus
- Source code
- Proteus Circuit design



Building:

The components I chose to use for the circuit were:

- Microcontroller PIC18F45K22;
- Digital to analogue converter: MCP4921

Both components run on a power supply of 3.3v – 5v, which can be sourced using the PIC KIT 3.

A standard breadboard was used for developing the prototype before being transferred on a strip board, and standard jumper wires were also using for connections.

Proteus was used for the Circuit design phase of development, whilst MPLAB X was used to write the source code.

Source code:

The Serial Peripheral Interface (SPI) bus was used in the source code to communicate between the microcontroller and the Digital to Analogue converter (DAC).

"Serial Peripheral Interface (SPI) is a synchronous serial data protocol used by microcontrollers for communicating with one or more peripheral devices quickly over short distances. It can also be used for communication between two microcontrollers.

With an SPI connection there is always one master device (usually a microcontroller) which controls the peripheral devices." *(https://www.arduino.cc/en/Reference/SPI)*

In this case the master was the PIC microcontroller and the slave was the DAC.

Results:

Design/planning

- I was able to create a function generator capable of creating sawtooth waveforms, as well as other waveforms.
- The LCD oscilloscope was a great addition to the project, it allowed for the project to become independent of other devices. And to be able to run and display itself.

Building

- The final construction from the prototype to the stripboard made for a better quality finish with the project.
- The components I used in the project were all high quality electronic components capable of strenuous wear and tear.

Conclusions

- This project provided me with an opportunity to apply skills learned over the last two years to develop a device which has a real life application.
- It was a very useful exercise in terms of practical experience using electronic components and developing a program to apply to a task
- It provided some difficult steps, such as developing the Proteus simulation circuit and the code on MPLAB X.
- **The main limiting factor of the project:**

Timeframe

Understanding and developing the code.

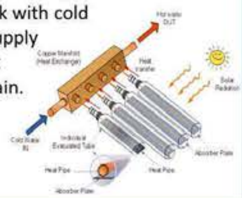
Understanding and using the SPI Bus.

An Institiúid Teicneolaíochta, Sligeach

Automated Solar Panel Protection System

Introduction:

The need for this project arose when it was noticed that the main method for preventing stagnation in solar panels on hot days is to replace the hot water in the tank with cold water from the mains supply by dumping hot water it into the waste water drain.



Aims of Study:

To demonstrate the theoretical knowledge gained over the course of my study in a practical, real world application.

Methodology:

Research:
Research began by thinking of how the process of heating the water works. Simplifying it helped develop a procedure to interrupt the process. These were:

1. The suns rays heat the glycol
2. Heat is transferred from the glycol to the water
3. Stop the UV rays from heating the glycol

Design/Planning:
The design process involved:

- Selecting technology
- Develop project schedule
- Develop initial concepts
- Create multiple small tasks
- These tasks involve taking a temperature reading, driving a motor, changing the direction and stopping the motor using sensors.
- Circuit designed using proteus

Fabrication:

- All of the parts were thoroughly researched and purchased
- A combination of components selected to utilise various functions of microcontrollers
- Blind mechanism built with a lead screw, linear rails and bearings

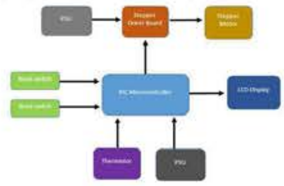
Hardware/Software:

- PIC18F45K20 microcontroller
- 10KΩ NTC thermistor
- 10KΩ potentiometer
- Magnetic reed switch
- Bipolar stepper motor
- 16x2 LCD display
- 8mm Leadscrew
- Linear rail system
- Power supply module
- Write code in MPLABx
- Compile with XC8
- Build simulation model in Proteus
- Test program/Trouble Shoot

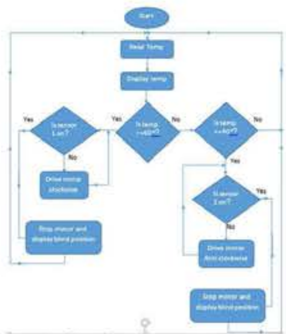
Methodology (Continued):

Process/Control:

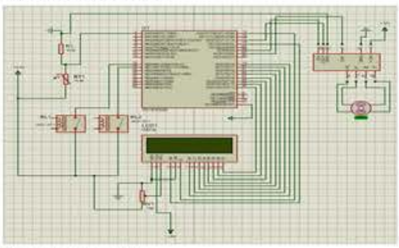
- Take temperature reading
- If temperature is >60°C extend blind
- Stop when fully extended
- If temperature is <35°C retract blind
- Stop when fully retracted
- Display temperature and position on LCD



- Hardware Block diagram



- Software Flow chart



- Circuit schematic

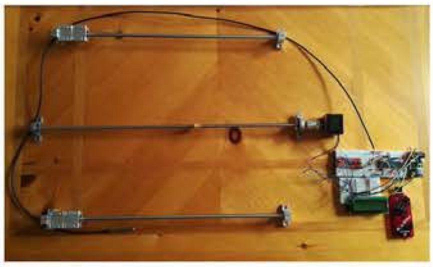
Assembly:

- Connections made through solderless breadboard
- Inputs and outputs connected with hook-up wire
- LCD display direct to breadboard using soldered header pins
- Stepper coils connected with header pins
- Final mounting on laminated pressboard for display

Testing:

- Testing was carried out on each element of the project using both hardware and software simulation techniques.
- To simulate a working thermistor in the early stages a potentiometer was used to simulate voltage changes.
- Proteus simulations were used to develop a working LCD header file
- Debugging features in MPLABx made it possible to step through segments of the program and a multi-meter was used to test voltages and signals on each PIC pin
- Multi-meters were used to test continuity between sensors, power supplies and stepper motor coils.

Results:



Design/Planning:

- Power supplied by power module that takes 12V input and outputs 3.3V and 5V on each rail
- Take analogue voltage from NTC thermistor
- Convert to digital reading using ADC module
- Convert digital reading to temperature using beta calculation
- Display temperature
- Display Cooling/Heating status of system on LCD
- Select motor direction based on temperature
- Use Pulse Width Modulation to drive motor
- Stop blind in fully extended position or fully retracted position when magnetic sensor triggers an external interrupt
- Update system status and temperature on display

Issues encountered:

- LCD not initialising properly
- PIC not accepting a +5V Vref for ADC
- Integer division and floating point arithmetic
- Beta calculation for temperature conversion
- ADC registers not configured properly
- Stepper motor missing steps when driven
- Blind not moving if started when closed and temperature lower than lower limit

Conclusions:

- It is expected that this system will be an effective and efficient means of cooling solar panels
- Introduce a reduction in water consumption by negating the reliance on mains water to cool over heating panels
- Provided positive personal development through focus and determination to overcome obstacles and set backs
- Exposure to a variety of electronic components was extremely interesting and beneficial
- This project provided an opportunity to display skills and knowledge gained from the course in a practical way. Overall the project was a success and was an excellent learning experience.
- Completing the HPRD module improved my soft skills

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Wireless serial communication

Introduction:

A very common thing in electronics is the need for two devices to communicate with each other. This project will look into the serial communication between two non-related microcontrollers, the Arduino AVR and the PIC 18F45K20 microcontroller. In fact they have the same types of hardware modules and some of them follow the exact same protocols for communication. For the purpose of this project the wireless XBee modules, were used for transmitting the date from the pic into the Arduino.

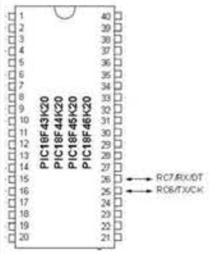
Aim of study:

The goal of this study is to explain, design and build a wireless serial communication transmitter and receiver, using the theoretical and practical knowledge from the course

Methodology:

Research:

It began by looking into serial module Tx,Rx in hardware in each of the Arduino and PIC. Also, understanding the theory of RS232 serial communication by looking into the signals being transmitted. A standard single transmission of RS232 serial communication will contain a start bit, 8 bits of information and a stop bit. Since there's only 8 bits of information, a system was invented called **ASCII** which is short for **The American Standard Code for Information Interchange**.

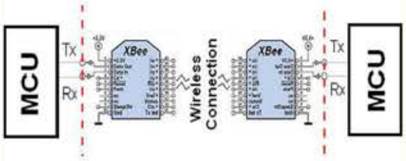


Design/Planning:

1. Selecting project concept.
2. Developing project schematic for transmitter and receiver.
3. Reviewing all parts calculation.
4. Reviewing coding sources.
5. Components required.
6. Develop a hardware plans for each of the transmitter and receiver.

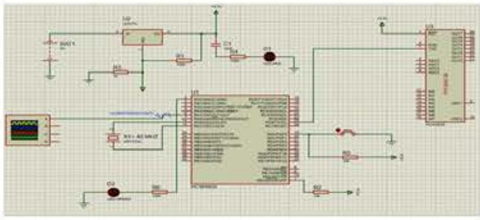
Schematics:

- Main part; There's quite a few component for this project and so XBee wireless modules which will transfer 9600 baud serial communication from transmitter to receiver.



Methodology (Continue):

- Transmitter circuit:



Power Supply

+9v battery .The circuit require +3.3v power supply, so a LM317 with 2 resistors producing the output voltage.

PIC18F45k20

It's connected to +3.3v power and ground. Also, a 40 MHz crystal is added giving it a 10 MHz instruction frequency.

XBee Module

It's used for transmitting the command from the PIC to the receiver system. XBee require +3.3v.

SPST Push Button

A button with a pull-up resistor is used. When the switch isn't pressed the RD0 input sees +3.3v or logic 1, when the switch is pressed, the RD0 input sees +0v or logic 0.

- Receiver circuit:

Arduino UNO

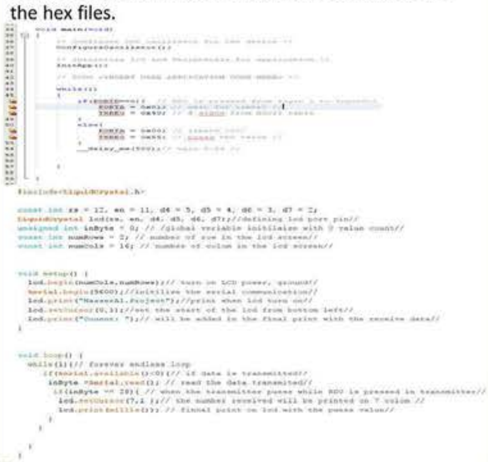
The Arduino Uno is connected to +9v battery then it takes care of its voltage regulation to +5v and +3.3v for the XBee module.

16x2 LCD Display

It will be used to display the output. It require +5v

- **Code for both circuit:**

The frame code for each device is different because the is two compilers are used to build the downloadable the hex files.



Result:

Will After programming the code onto your Arduino UNO and PIC 18F45k20

Conclusion:

The purpose of this project was to build a wireless transmitter/receiver system with two non-related microcontrollers; an Arduino and PIC 18F45K20. For our aim of this project. It was successful to prove the capability of using using a common communication protocol like serial communication makes it less complicated for two devices to communicate with each other, particularly if the devices have their own dedicated hardware serial modules.

- **Links for video demonstration:**

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Automatic Guitar Tuner

Aidan Gilmartin

Introduction

Tuning a musical instrument to specific pitches has been around for hundreds of years. Originally instruments were tuned to a reference point i.e. The 20th century brought great advancements in technology. New methods such as electronic tuners offered precise tuning accuracy and multiple possible tunings on stringed instruments such as the guitar. Automatic tuning has been touted as the next step

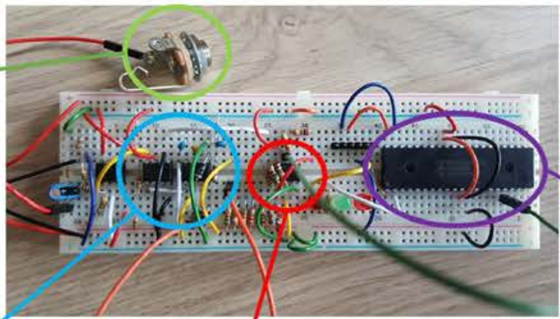
The guitar

When the guitar signal comes in it is a combination of multiple waves all adding together to create the sound or 'tone'. These waves are all octaves (higher pitched iterations) of the root note. The problem is that the pure guitar signal can be difficult to interpret.

So this will need to be conditioned and interpreted.

The Input

This is where the guitar will be plugged it. It will use a ¼ inch jack as is standard across all guitar related equipment

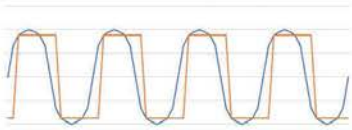


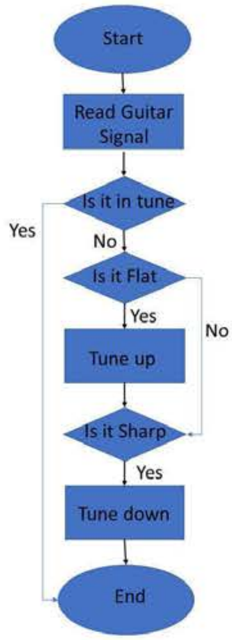
The Low-Pass Filter

So the first thing to do is to take the octaves out of the incoming guitar signal. This is achieved by using a Low-pass filter to attenuate the higher frequencies, so that only a wave consisting of the root note remains.

Schmitt Trigger

To turn the analogue signal into the signal is ran through a Schmitt Trigger. Basically threshold levels are set so when it hits the high threshold level it will stay high until it hits the low threshold level and stays low. So essentially you get square waves with this approach. Below is a sample signal.



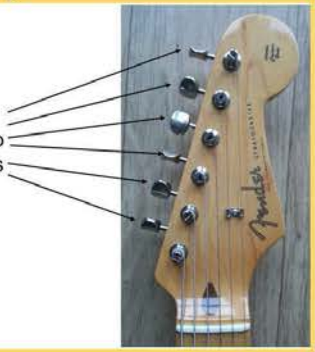


Microcontroller

This interprets all the information. Above is how the software decides how to tune the guitar. If it is flat it will tune up. If it is sharp it will tune down. If it is in tune it wont change the tuning and the next string can be tuned.

Servo Motor

A servo will turn the tuners to get the guitar string to it's desired pitch



Conclusion

Automatic Tuning of a guitar can be achieved using a combination of the listed physical components and software. Other iterations of automatic tuning are possible via various techniques

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Robotic Predictive Maintenance

Utilising Condition Based Monitoring and the Internet of Things

Introduction:

It is forecasted that by 2022 an additional 2.4 million industrial robots will be commissioned. This will bring the total number installed worldwide to over 3.6 million.

As production tools such as precision robots degrade, quality decreases and associated maintenance costs increase. Spending on robotic service related items will top $200 billion by 2022.

Predictive maintenance is not only the most cost-effective maintenance model, but also minimises risk of secondary damage from robotic failures, i.e. producing defective or worse still dangerous products.

Aims of the Study:

Robotic systems generate vast amounts of useful real-time data in relation to their current operating condition, environmental variables, time elapsed and distance traversed since last maintenance activity.

Up until now the data was analysed using motion sensing equipment along with supporting mathematical models. This technology struggles to comprehend the inter dependencies between axis motion, acceleration, contact stress and hand-offs from one robotic system to another. There is a compelling need for a low-cost alternative that can accurately model and predict in real-time when maintenance is required.

This project will concentrate on the implementation of a predictive maintenance system for robotic systems; sensors utilised, the sampling and data acquisition techniques used, analysis of the data to predict failure and finally a cost benefits model for a robotic predictive maintenance program.

Methodology:

In order to collect the data a number of robotic arms were created, various sensors were attached, the data was collected locally and streamed to a cloud server via an Internet Gateway. A workflow was created to implement this data collection system.

Methodology (Continued):

Workflow:

1. Robotic Arms 3D printed
2. Servo deploy and Cortex M3 based MCU connect
3. Ubuntu BLE Node-Red config
4. WiFi IoT Gateway functional
5. Azure resources and streaming analytics created, IoT hub deployed
6. Condition Based Monitoring and Predictive Analytics operational

Four robotic arms (3D printer to the right) streaming data to Azure cloud

Data Acquisition via BLE:

The system utilised a Texas Instruments Cortex Arm M3 based CC2650 MCU to collect sensor data. A TI-RTOS (very similar to the Keil CMSIS-RTOS) controlled and transmitted data from 10 MEMS sensors via BLE.

Four Pololu controlled servos were attached to each robotic arm. Identical movement scripts were repeatedly executed. Electrical features, gyroscopic, accelerometer and magnetometer x, y and z axis data as well as environmental information such as lux, humidity and ambient temperature were streamed from the robotic arms and to the Azure cloud.

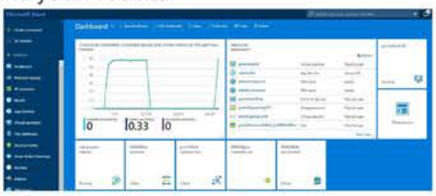
An event processor called RoboticPdM job runs on Azure. The event processor takes the average x,y,z sensor values for a completed Robotic cycle. It passes the values to an API.

The API is exposed by to a Machine Learning workspace that is provisioned as part of Microsoft Azure IoT solution.

Results :

Analysing data to identify meaningful patterns:

This involved developing a set of models using a subset of the acquired data. The analysis needed an hypothesis. The hypothesis chosen was Borgi's Power based conditional monitoring. This gave a baseline against which to evaluate the analytical results.



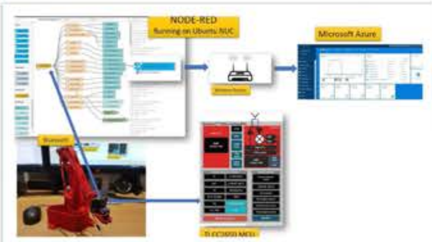
While it is still in its early stages, the experimental results demonstrated the existence of a correlation between a set of electrical features and robotic repeatability values.

Validating the model:

To run this IoT-enabled predictive maintenance system the robotic arms need to be connected, operational and sending the real-time data to the Azure cloud. This is currently happening. The live data flow is what the model analyses to detect problem signs and trigger the pre-programmed alerts.

Conclusions:

This project provided an opportunity to display skills and knowledge gained from the course in a practical an innovative way. The predictive maintenance IoT system created is robust and scalable. The bill of material was less than €100 for each robotic arm.



The objective to stream real time telemetry data from the device to the cloud was achieved. The objective to analysis the data was achieved. The ability to predict failure is still a work in progress. Overall I believe the project was a success.

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Detection & Recognition of Traffic Signs with Computer Vision and Machine Learning

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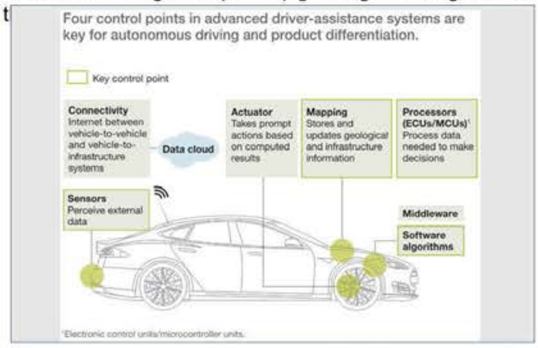
Introduction

The future of driving looks increasingly more attractive as advanced driver assistance system (ADAS) technologies gain traction in the main stream automobile consumer market. While ADAS technologies such as automatic cruise control, lane departure warning and automatic braking were once only seen in higher end models, they have now filtered down to the less expensive – more affordable market. Even the European New Car assessment Programs (NCAP) give higher ratings to cars t



With Python used as the prototyping language and an open source computer vision library called OpenCV, the aim was to examine both detection and classification through established machine learning algorithms: Haar Cascades and K Nearest Neighbours. For example developing a system that either notified the driver of the current speed limit or alternatively an automated speed reduction system would be important from a road safety aspect.

Methodology - Haar

This project is based around a classic object detection method, first introduced by Paul Viola and Michael Jones (2001) **[2]**. Haar feature based classifiers and a supervised machine learning adaptive boosting (Adaboost) algorithm are used to achieve detection. Four main stages are employed:

1. Haar Features: E.g.→
Important features are extracted from both positive and negative image sets using Haar features. Feature values are calculated from the difference of the summation of pixel values under the bl… from the summation of pixel values under the w…

2. Integral Image: [3]
Computational efficiency for image sub-region pixel value summations is achieved through an integral image methodology. Calcul… on involving only 4 pixel

1	2	2	4	1
3	4	1	5	2
2	3	3	2	4
4	1	5	4	6
6	3	2	1	3

input image

0	0	0	0	0	0
0	1	3	5	9	10
0	4	10	13	22	25
0	6	15	21	32	39
0	10	20	31	46	59
0	16	29	42	58	74

integral image

Methodology – Haar (Contd.)

3. Adaptive Boosting Algorithm (Adaboost):
Adaboost selects the most appropriate features (aka weak classifiers) from the total possible feature set.

4. Cascade of Classifiers:
Adaboost splits up the selected features into a number of stages. The features are then applied to sub-windows in the input image. If a window passes a stage, the next stage of features is applied and so on. If all stages are passed by the sub-window, then that region is classified as a positive object.

Methodology - k-NN

Optical character recognition is achieved by a K-Nearest Neighbour (k-NN) algorithm. KNN is a non-parametric, supervised algorithm used for optical character recognition. It is termed a "Lazy Learner" as it delays the process of modelling the training data until it is needed to classify the test objects. New objects are classified based on a similarity measure (e.g. distance function).
The image first undergoes thresholding followed by contour extraction. Sub regions of interest contain the digits that help classify the speed limit.

Procedure

Step 1	Step 2	Step 3	Step 4	Step 5
Collect thousands of negative images.	Create positive sample set.	Train cascade and create cascade xml file.	Multiscale object detection algorithm	Resolve Digits with KNN

Results

Preliminary results allow for Real Time detection rates between 10 – 30 frames per second:

Conclusion

This project highlights the combined capabilities of OpenCV and Python even running on modest hardware resources. The objective of Real Time detection was achieved along with sub classification of speed limit signs via optical character (/digit) recognition. Further improvements are envisaged with respect to computational efficiency by using C++ and a GPU.

References

[1] McKinsey & Company: https://www.mckinsey.com
[2] Viola, Paul and Michael J. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features", Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2001. Volume: 1, pp.511–518.
[3] https://uk.mathworks.com/help/vision/ref/integralimage.html

Automated individual Livestock Feeder

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Introduction

On average it cost around 300 euro a year to maintain a single cow, approximately two thirds of that is the cost of feeding.

Feeding cattle without an automated feeding mechanism will require around a quarter of the total working time available to the farmer.

With this project I hope to improve feeding so much that a farmer can leave in the morning to go to work and return in the evening with the feeding done.

We will look to improve the economic outlook with regards grain feeding cattle.

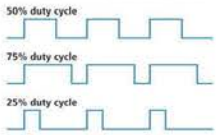
Individual Feeding station

Objectives

- To research the pros and cons between automated feeding and manual feeding.
- To design a mechanism that automatically releases feed to an animal based on its needs.
- To design the device to have as little interaction with the farmer as possible.
- Record data from the device, e.g. weight and amount of feed released.

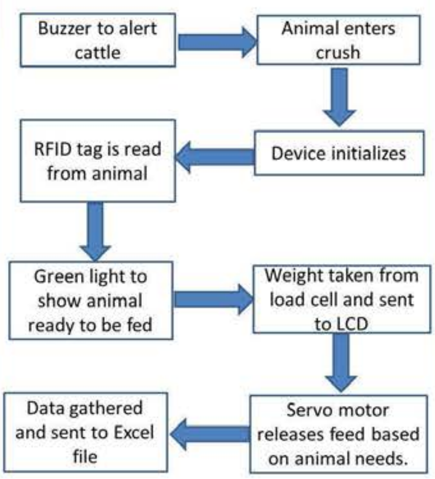
Methodology

- A buzzer will be used to alert the animals of feeding time and to call them to the shed, preventing farmers from gathering the cattle in the morning.
- UFID tags to track animals intake and when to alert the mechanism to begin working.
- A light to show if this animal has already been fed and has reached its max allowance for the 24 hours.
- Pulse Width Modulation to control a servo motor to release feed to the animal.



- Red light to show animal is under weight
- Gather data when animal is fed, print to excel file

Flow chart



Conclusions

A working device will show if an animal is sick, an under weight animal not showing signs of weigh gain, even with extra feed and nutrients means there is a deeper medical issue.

A successful project will also lead to a more streamlined method of grain feeding animals to max weight target before being sent to factory.

This will lead to less hands on work for farmers creating less injuries, more time for 9-5 job and more time for other farming jobs that need more attention.

Future Features for development

Future improvements could include performing other tests on animal including height and take bloods while animal is eating at station.

Using solar energy to power the device saving money on electricity.

Components

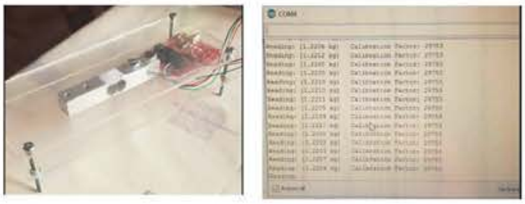


Figure 1 Testing load cell

Figure 2. An example of how the animal wold look.

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Object Recognition using Convolutional Neural Network

Nathan Reilly
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Introduction

The need for object recognition has become a necessity in this modern day of engineering from security and safety to manufacturing and production. This project was aimed at seeing what methods are being used for object recognition and what works best at the moment. They're lots of different applications for deep learning but this project only looks at object detection within images or a continuous video feed.

Defining Deep Learning

Deep learning is in essence teaching a computer to solve on its own, by telling it the right answer to a similar problem many times over. For example if I took 100 images of cars each with different backgrounds, colours, lighting and angles and then label each of the images with the answer 'car' as its object in the image then the code can learn these patterns, through its activated filters, and therefore could recognise a car in a image from a new image it has never seen before.

Human	Computer
Hey computer heres 100 images with ants in them	Oh so that's what ants look like I'll recognise them in future
Human	**Computer**
What is in this new image computer? 	It is highly probable that an ant is in the image

Research

When it came to research three main methods kept showing up for image recognition using deep learning:

- ConvNets or 'Convolutional Neural Networks'
- Viola-jones algorithm
- Image segmentation

Through research on these it was found that they were designed for recognising different types of objects in images for example the viola-jones algorithm is used specifically for detecting faces from photos. Image segmentation was found more in industry type places like production plants to ensure product quality. ConvNets were found to be used mostly in tech companies, they were also found to be the most effective method for object recognition in deep learning, they can be designed to target any objects in an image. An interesting point to make about ConvNets is that they make a specific assumption that the input data is from an image. For this project I will make a ConvNet targeted at recognising 'ants' in images.

Method

- ConvNets are made through connected layers.
- Commonly there are 5 types of layers, An Input layer, Convolution layer, ReLU layer, Pooling layer and a Fully connected layer.
- The first input layer would contain a series of input data ie raw pixels values from an image.
- Convolution layer performs a dot product on the pixel data.
- The numbers multiplied by the pixel values are from filter values.
- Filters are designed to find certain patterns in images.
- A series of positive matches of filters in an image will help determine what object is present in the image.
- The final fully connected layer will give a probability score on what it thinks is in the images based on its lcassifiers

Supervised Learning

To train a ConvNet to be able to recognise ants it must be shown a series of images that have a label with them telling the network what is in the image. The more images with labels that are available to the network the better it is at recognising that specific object. If we wanted to build a ConvNet to be able to recognise every object in the world we would need 1000s of images with labels of each object. Not only this but we would need 1000's more of the same object for validation on the training data to validate how well the network works. This would be an incomprehensible amount of computation not to mention memory required. This is why it does not exist.

Alexnet

A famous ConvNet that has been made is called alexnet which is made up of 25 layers. It contains 5 convolution layers. It was trained to recognise 1000 possible classes, these classes were trained on over 1 million images with labels and it took over a week using GPU's along with CPU's. This is a very large ConvNet which puts into perspective the scale of how much computation was involved. For this project I will take this existing network and modify it to classify only one class 'Ants' this is done through Matlab.

MATLAB R2017b

Conclusions

- Deep learning is possible to replicate.
- The more image you have for training the better your network will be at classification.
- Matlab is a good platform for deep learning.
- Only in the latest release of matlab has there been newly developed functions to make the training of a network easier.
- ConvNets are the best networks for image classification.

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Pedestrian Detection with Head-Up Display

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Introduction

As road use continues to increase, accidents and death rates are also increasing. Worldwide pedestrian road deaths account for approximately one fifth of all road fatalities.
Vehicle manufacturers are increasingly implementing driving aids to improve driver's road awareness and reduce driver distractions.
This project looks at one approach in pedestrian detection and the means of displaying the relevant information.

Figure 1. Blind spot example [1]

Aims of Study

To demonstrate what can be achieved with stare of the art Convolutional Neural Networks by implementing it into a practical and applicable demonstration of real-time object detection and display methods within the motor industry.

Methodology

Research :

A literature review was undertaken in the evolution of computer vision from its origins to modern day Convolutional Neural Networks. In depth research was carried out on object detection and classification. YOLO (You Only Look Once) was chosen for its detection accuracy and real-time operating speed. On the display aspect of the project, the best option for a driver display was to use a Head-Up Display to present the detection data in the field of view of the driver thus increasing safety by keeping the drivers attention on the road ahead.

Design:

This involved:

- Ethics and safety design.
- Component selection.
- System design and layout.

Build:

- Coding and system building.
- Real world testing.
- Fault finding and acceptance testing.
- Project report and presentation.

Methodology (Continued)

Concept:

The YOLO real-time object detection system monitors both driver's nearside and offside blind spots and when a pedestrian or cyclist enters either, a video image and caution message of the situation are displayed on the windscreen. This message is displayed within the field of view of the driver through the the medium of a Head-Up Display. Along with being an extra set of eyes on the road, the system has the benefit of keeping the driver's attention on the situation ahead.

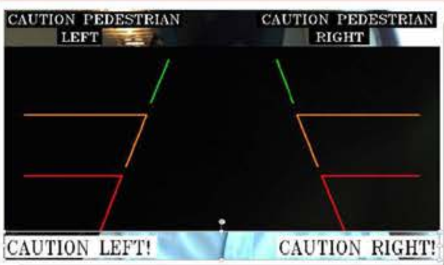
Software:

The system was programmed in Python using the Pycharm IDE, TensorFlow, OpenCv and Microsoft Visual Studio. Processing was performed using a 2GB Nvidia GPU.

Hardware :

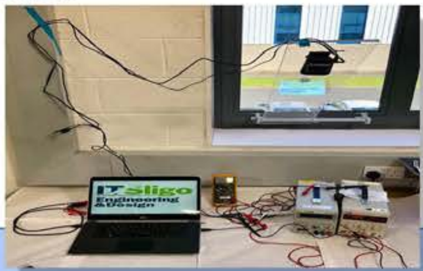
The system utilises a 2MP wide angle camera as an input. A retrofit Head-up Display was used as it proved to be compatible and cost effective. Hudly projects images at a res. of 480x240.

Results



Testing and Results:

The system was fitted to a standard car with the camera pointed rearwards and the Head-Up display fixed at just below the driver's line of sight. It was then extensively tested in a large variety of real world situations.



Results (Continued)

Detection:

The network used was called Tiny YOLO and detected at a rate of 6.5 frames per second. This worked accurately under most conditions. Degradation of detection was experienced under low light conditions and night time.

Display:

A Head-Up display provided a safe and convenient means to indicate the detection information. The main advantages in this display type is how it presents the image in the field of view of the driver without having to re-adjust their focus or head posture. On successful detection of a pedestrian on either the nearside or offside blind spot of the motor vehicle, the display will activate and show the blind spot activity. At all other times the display remains inactive.

End Result:

After following the test plan as set out in the design phase the end result was a robust human detection system that performed as desired and which displayed the information without the driver having to take their eyes off the road to observe the situation of somebody entering their blind spot. The system was trained to detect 80 different objects and although action was only taken on humans, the system could easily be reworked to detect any or all of the other 79 objects.

Conclusions

- The project successfully met the research objectives outlined in the methodology.
- It provided a system that can accurately detect and classify pedestrians within the driver's blind spots and display them via a Head-Up display.
- This system distinguished between right and left at a wide range of distances thereby presenting the relevant data required to increase driver safety.
- The use of multiple camera inputs stitched together and better night-time capabilities would help to refine pedestrian detection and overall performance.

Reference
[1] Silicon Valley Bicycle Coalition (2018). "bike-truck-blindspot"[online]. Available at: https://bikesiliconvalley.org/2018/03/large-vehicles-bicycles-interacting-safely/bike-truck-blindspot/ [Accessed 13 April 2018].

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Guitar pickup using a Linear Sensor Array

Introduction

Most electric guitars use magnetic pickups. Magnetic pickups tend to have a core of permanent magnet which is wrapped with a copper coil for each string.

As the string vibrates, the magnetic field created by the permanent magnet is disrupted, inducing electric current which can then be amplified as sound. The main disadvantage of this type of pickup is that it cannot be used directly with instruments whose strings are not ferrous. Unlike traditional pickups, optical pickups can be applied to all strings, including non-ferrous ones.

Aims of Study

The aim of this study is to develop an optical pick up using the skills and knowledge acquired during the course.

Methodology

Research
Research began with the study of similar works related to the problem. Suitable hardware to over come the problem was investigated

Design
The main priority of the design element was to find a suitable linear sensor array that was

- small enough
- fast enough.
- High pixel density

The TSL1401CL from AMS was chosen for these reasons. It has a max clock speed of 8Mhz and ~130 clock cycles per frame to give a theoretical max of (8000000/130) 60,000fps

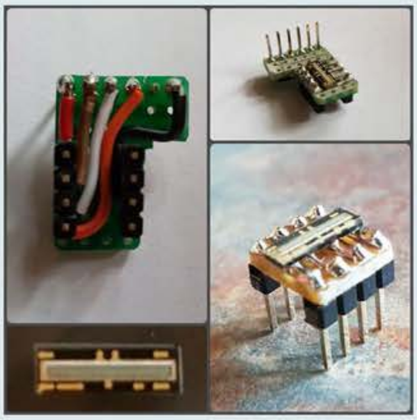
Methodology (continued)

Prototype
The TSL1401CL is only available in an SMD *surface mount device) package

This package is ideal for manufacturing but not ideal for experimentation as it is not breadboard compatible.

So a break out board had to be developed.

The prototype pick up design is driven by an STM32 evaluation board that has STM32F100RB

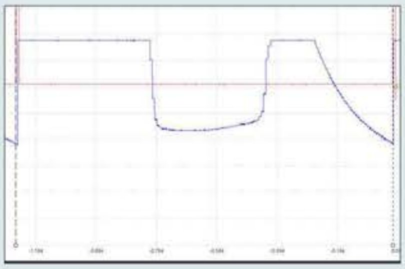


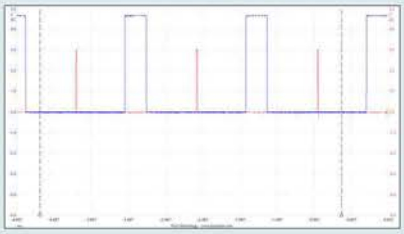
Software development
The tool chain used to develop the project was keil µvision.

Testing
Testing was performed by placing the pickup under the lower E string.

Results

At this present time (project not fully finished) we can see from the scope that at a modest clock speed of 100khz a frame rate of 800fps can be achieved which is enough to sample all open string of the guitar.





Conclusion

Overall this project proves that its is definitely possible to use a linear sensor array to capture the sting vibrations of an instrument

The results obtained in this project indicate that this optical pickup design is definitely an avenue worth exploring.

Limitations
The main limitation at present is technology. With only a maximum of 128 levels detected by the linear sensor this leaves us in the region of 6-bit ADC which is a far cry from 24bit studio quality.

References

C. Willcox, "willcoxguitars.com," Willcox Guitars, 2017 11 2017. [Online]. Available: https://www.willcoxguitars.com. [Accessed 20 11 2017].

https://www.researchgate.net/publication/234034228_Acoustics_and_Modeling_of_Pickups

P. Daniel A. Russell, "Physics of Guitar Pickups," 01 January 2012. [Online]. Available: http://www.acs.psu.edu/drussell/guitars/pickups.html. [Accessed 20 11 2017].

Smart Alarm System

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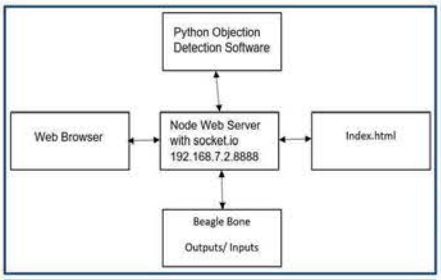
Introduction

The proposed project; a smart real-time object detection video surveillance alert system achieves this goal by utilizing machine learning technology which is at the heart of the smart video surveillance market. The goal is for an alarm to be triggered when a "person" is detected and do nothing if a cat or dog or any other object passes by.
Video surveillance is an industry experiencing rapid growth and being constantly pushed to meet new cutting-edge technology demands. The research carried out shows how the Internet of Things (IoT) combined with advancements in machine learning is greatly enhancing video surveillance systems. It also highlights the fact that a monitored video surveillance alarm system is proven to be a deterrent for burglars. By combining deep learning with the Internet of Things (IoT) technologies, people have the capabilities to monitor the relevant information of their own video surveillance data, rather than the system merely being a mass recording device. Deep learning has not only improved the reliability of object classification but has also made it possible to analyse and process large amounts of video footage in a fraction of the time it took preceding analytic technologies.

Methodology

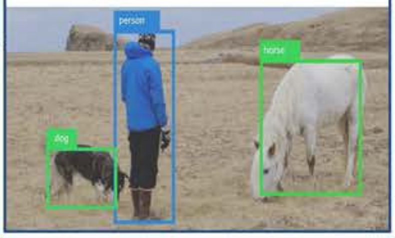


Machine Learning [3]

Machine learning is a subfield of Artificial Intelligence (AI). A.I is a field of computer science that provides computers and systems with the ability to learn without being explicitly programmed.

YOLO [2]

YOLO is a real time object detection neural network. Artificial neural networks are computer simulations of biological neurons and are used to extract patterns and rules from sets of data. Image classification is the task of taking an input image and outputting a probability of classes that best describes the image. Humans learn this skill from an early age. The classifier gives a probability score that the classified object is something from a pre-trained dataset

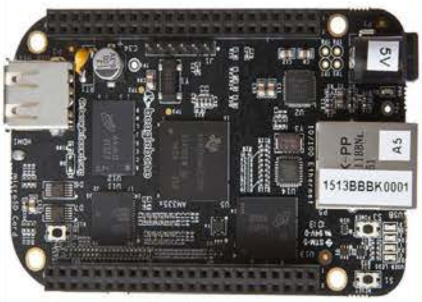


Objectives

- To develop a smart alarm system that will alert the end user when a person is detected and not trigger when any other object is present.
- To install and manipulate object detection machine learning software.
- To set up a dedicated server.
- To create and develop a HTML webpage which uses CSS.
- The website alerts the end user with a message when a person has been detected.
- Email end user when alarm is triggered..
- Develop these processes using Javascript, Pyhon, HTML and BoneScript coding languages.

Website

BEAGLE BONE BLACK [1]



The Beagle Bone Black

The Beaglebone Black (BBB) is a Single Board Computer (SBC). It has 2 x 46 pin headers. It contains onboard flash memory and default Linux installation. The BBB uses its own Integrated Development Environment (IDE) called Cloud9. Using this platform, the board is capable of running Ruby or Python programming languages. JavaScript is also available using node.js in the browser. The node.js capability of the BBB makes it a good option for client/server communication

References

1] www.beaglebone.org
2] Reddie.P.J (2017). "PASCAL VOC Dataset mirror". [Online] Available at: https://pjreddie.com/projects/pascal-voc-dataset-mirror/ [Accessed on 27 December 2017]
3] Chakravorty.T (2016). "How machine Learning Works: An Overview". [Online] Available at: https://thenewstack.io/how-machine-learning-works-an-overview/ [Accessed on: 05 December 2017]

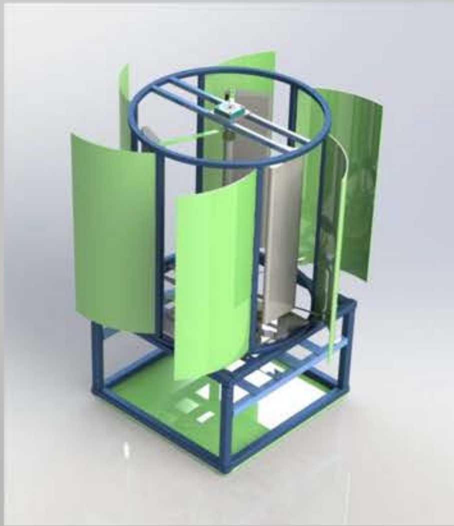
Conclusions & Results

The alarm was triggered successfully when a person was detected.
The project had some limited functionality due to the website not being hosted live.
Not running tensorflow on a dedicated GPU generated a slow program output hich would have benefited greatly from the the processing power of a dedicated GPU.

Vertical Axis Wind Turbine with PLC Control

Introduction:

The purpose of this project was to eliminate the need for a braking system in a Vertical Axis Wind Turbine as well as controlling the airflow that reaches the blades. This was achieved by adding a outer cage to the turbine that had diffusers added that could open allowing air to flow freely or could close ultimately shutting off air and working as a braking mechanism.



Objective:

- Design and fabricate a vertical axis wind turbine
- To eliminate the conventional mechanical braking system in typical vertical wind-axis turbines
- Improve start up speed of the turbine so can operate in lower wind speeds.
- Research, design and analyse a number of prototype diffuser concepts.
- Optimise the most efficient and effective blade design to suit.

Methodology:

Research:

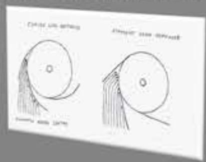
Research was conducted by gathering information online and through testing carried out on the prototype. By creating a prototype the team could collect required data and analyse the results recorded. A 6 Door diffuser system Was chosen over the 3 Door system.

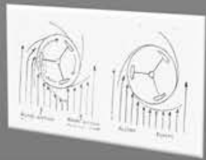
Methodology (Continued):

Design Phase:

In the design phase the team had to design and research in the following areas:

- Wind energy
- Current braking
- technology
- Diffuser linkage
- mechanism
- Blade design
- Plc program to
- control the diffusers
- Prototype design
- and testing
- Final design CAD
- model and drafting.





Build Phase:
Various components from a Previous turbine build were Recycled and reused.

- Linkage mechanism was manufactured using the CNC.
- The base was constructed from 35x35mm box steel and the outer cage 25x25mm.
- Spindle and generator were recycled from previous build.
- Barth STG600 PLC was used. The software use to create the program was miCon-L
- Blades were design using a timer structure to make the process more workable. NACA 2421 aerofoil design was used.

Results:

Design Phase:

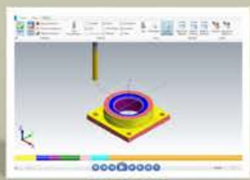
- A prototype was designed and analysed using the wind tunnel at IT Sligo.
- The main design was then modified to implement the new findings recorded.
- The test showed that that cage was at optimal performance when opened 50%.
- A variable pitch was added to the bladed to give more control under different weather conditions.

Results (Continued):

Manufacturing:

- The frame and cage were fully manufacturing and assembled on schedule.

- The Linkage Hub for the bearing was manufactured using the CNC



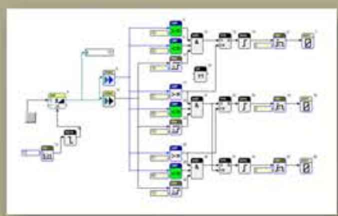
PLC Control:

Using the program miCon-L the turbine was programmed to open and close and different time intervals depending on the speed of the spindle. Ideal RPM (200):

100 -150 – Opening (100%)

150 -190 - Opening (50%)

210 - Max - Opening (0%)



Conclusion:

The purpose of this project was to eliminate the need for a braking system in a Vertical Axis Wind Turbine as well as controlling the airflow that reaches the blades. This was achieved by adding a outer cage to the turbine that had diffusers added that could open allowing air to flow freely or could close ultimately shutting off air and working as a braking mechanism.

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Automated Tin Whistle

Introduction

This project was chosen in order to create a combination of technology and music. The aim was to take an instrument and create a device that would allow it to be played remotely and even automatically. An Irish Tin Whistle was chosen as the instrument for the project.

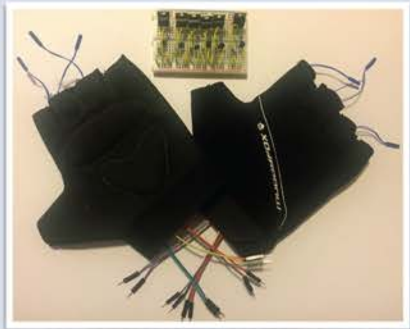
Aim of Study

To apply the theoretical and practical knowledge learned throughout the school year to a project that represents multiple passions.

Methodology

✦ **Definition:**

The defining of the project began by establishing the required elements of playing the tin whistle. There are three major



elements which are represented by the body parts used to play the instrument:

- Mouth [Air to generate tones]
- Fingers [To cover the holes]
- Brain [To decide which notes to play]

✦ **Design and Planning:** The design process consisted of:

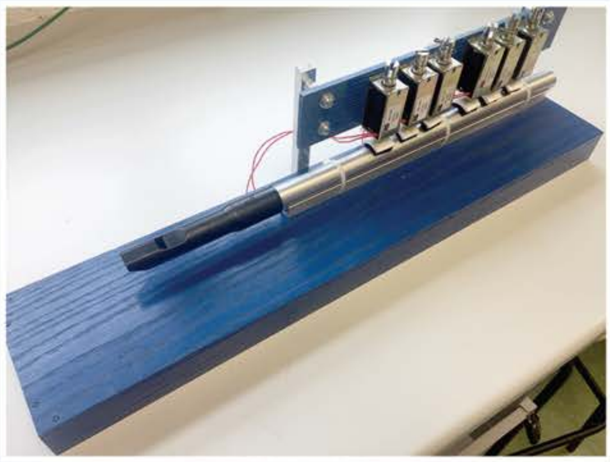
- Sketching the initial design
- Developing a work breakdown structure
- Determining resource requirements
- Prioritizing project tasks
- Developing a schedule for the project
- Creating a design model in Inventor

✦ **Assembly:**

- The majority of the project was created and assembled at home
- The assembly consists of wood with stainless steel fastenings and supports for the whistle and the solenoids
- Materials were sourced from suppliers in Canada and the non-fabricated parts were from the IT Sligo storeroom
- Fabricated parts include the base, whistle cradle, solenoid rack, and solenoid pads

Methodology, cont.

✦ **Control:** The whistle was to be controlled either manually and automatically. The following were created to accommodate both:



- LabVIEW program for automatic control
- Gloves with sensors built in to allow for manual remote input
- Master list of glove inputs with corresponding commands
- BUZ11 circuits for the LabVIEW outputs

✦ **HMI:** Since the project uses LabVIEW for its programming it made sense to use LabVIEW as the HMI as well. The HMI displays a digital version of the whistle to indicate which holes are being covered and displays the note being played next to it. An indicator shows whether the whistle is set to automatic or manual control.

Results

✦ **Design and Planning:**

- The design went through multiple iterations before the design was finalized
- The majority of the components and circuitry are housed inside the base of the project
- The design of the solenoid pads allows for small adjustments to be made as necessary to ensure that the solenoids actuate to their fullest extent
- The control gloves used to manually control the instrument can be easily removed from the project instead of removing them from the hands every time the user moves away from the device

✦ **LabVIEW Programming:**

- Two National Instruments DAQ boards were used for input and output with 12 digital I/O points each
- BUZ11 transistors are used on the outputs to control the individual solenoids and reed switches are used as the manual inputs

Results, cont.

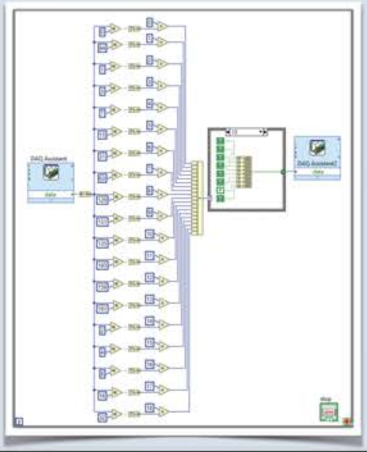
- 18 different states are available using a case structure that chooses a case based on which switches are triggered

•The reed switches input into the LabVIEW program as a binary value. That input is then compared to the values that correspond to the various solenoid combinations. If the values match, then the comparator signals the case structure to activate the corresponding frame. Each frame has a set of true and false values that are outputted to trigger the corresponding solenoids

✦**HMI:**

•The HMI was created using the front panel of LabVIEW
•Each frame in the case structure outputs a string value to an indicator on the front panel that displays which note is being played

- A model of the tin whistle displays a real time representation of which solenoids are being triggered
- There are also indicators to show whether the system is in automatic or manual mode



Conclusion

✦ **Conclusions:**

- This project was an opportunity to demonstrate both skills learned throughout the program and a passion for music
- The aim of creating an automated instrument was achieved and contained all elements from the original plans

✦ **Limiting factors for this project:**

- The biggest limiting factor was time, specifically balancing the time used to work on the project outside the lab with other school work

Canada

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Automated Pick and Place Gantry Bot

Introduction

We came up the idea when we both wanted to do a project with vision system incorporated with a pick and place. After brainstorming and research, we initially decided to create a robot to solve a puzzle as it was an interesting idea. We believe that a gantry arm of some description would be suitable. We wanted our design to be simple and effective while still capable of performing the tasks that we hoped for.

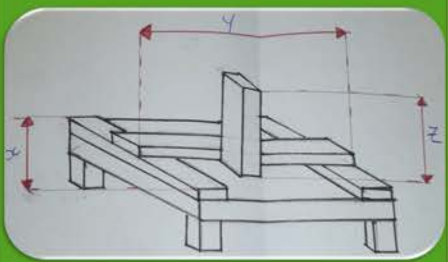
Aims of Study

To highlight the skills that we have learned our the course of our college experience in Mechatronics Engineering.

Methodology

Research :

We began by researching other projects and machines that used both vision systems and pick and place. We found that different visions systems used different methods of detection; such as colour, size, shape, edges and motion.



Design and Planning:

We wanted a gantry bot that utilised X,Y and Z planes. We designed a small gantry bot that we deemed suitable by referring to the previous research. We stared by creating rough sketches and CAD designs.

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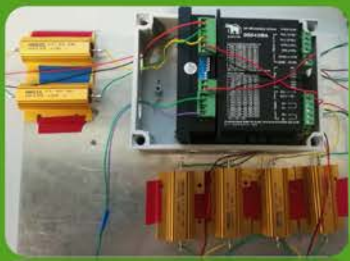
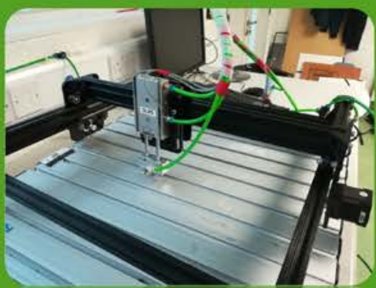
Methodology

Fabrication :

We found a gantry robotic arm system on Openbuild online. Originally it was intended to be used as a laser burning machine. After researching modified versions of this ACRO systems and learned that it is versatile. We decided to order this system. It is belt driven with stepper motors as the source of power.



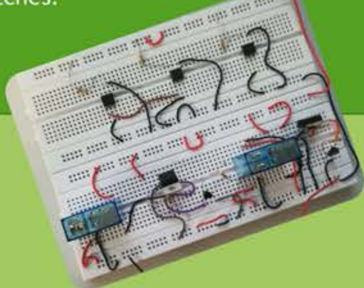
Unfortunately, this bot did not have a Z Axis. To overcome this, we decided to fabricate a plate that would hold a pneumatic cylinder with a suction cup that will be used.



After this, we fabricated pneumatic system that would extend and retract the cylinder and activate the vacuum generator

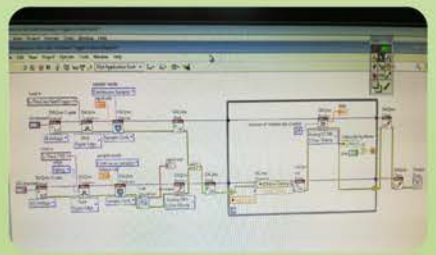
Control:

We are using LabVIEW with a DAQ card to control the project. LabVIEW is controlling the pneumatics, stepper motors, relays, reed switches and limit switches.



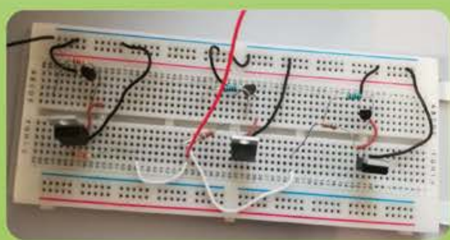
Results

After we had assembled our project we began on the wiring for the relays, limit switches and the other components. Once that was all completed we just had the program to complete.



Conclusion

This project allowed us to show of our skills and abilities even thou we didn't get it finished to the standard we originally wanted. The main factor in our way was time. Given more time we would of done more with our vision system.



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Pick and place with vision recognition

Name: Nigel Cronnolly
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Introduction and objectives

The purpose of this project is to pick up an object of the same shape and size and place that object in a designated position depending on the contours of an image that is on the object.

The objects were chosen to be cubes and the images on the cubes were chosen to be letters. The pick and place motion is achieved by using two stepper motors on linear C-beam rails for the X and Y axis and a pneumatic double acting cylinder with a vacuum suction for the Z axis .

The objective of this project is to implement both control and data acquisition. A human machine interface display is also to be created.

Methodology:

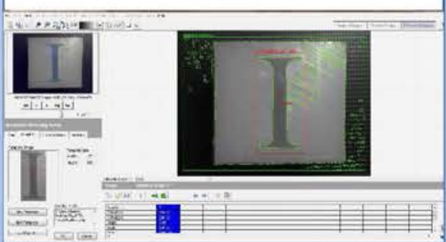
The project was broken down into three main sections:

- **Research**
- **Build and Programming**
- **Testing**

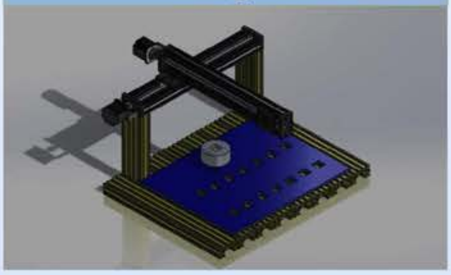
Research
This involved researching datasheets and user manuals of electronic components and to find the most suitable hardware and software to help me achieve my objectives.

Build and Programming
The chosen design was drawn in solidworks to get greater detail of the dimensions needed for each part. A case machine was used for the LabVIEW program to ensure an operator can stop the project safely at any time.

Testing
This involved testing the motors at different speeds and stepping rates to ensure the cubes where placed in accurate positions and eliminating any bugs in the LabVIEW program.



Design:



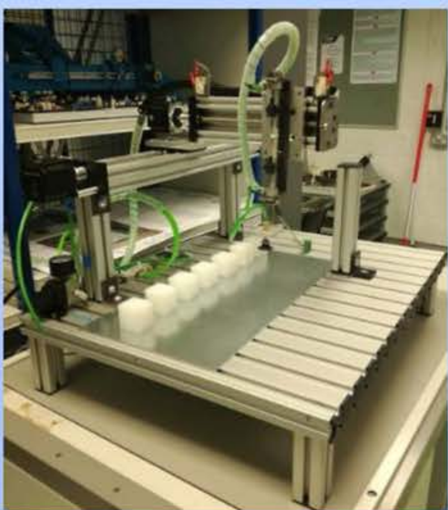
Hardware & Software:

Two Nema 17 12 volt stepper motors are used for movement along the X and Y axis, the MID 6402 was used to drive the motors. The X, Y movement was achieved by the turning of the lead screw which moves a platform guided by a linear C-beam rail in both forward and reverse directions.

A non rotational double acting cylinder is used to pick and drop the cubes and a 5/2 directional control valve is used to control the extension and retraction of the cylinder. At the tip of the pneumatic cylinder is a suction cup used to pick up the cubes.

NI motion assistant was used to build the program in LabVIEW for driving the motors and NI vision assistant was used to develop the program for distinguishing contours of the letters on the cubes.

All brackets and cubes were manufactured in the general engineering workshop using the milling machine and the lathe.



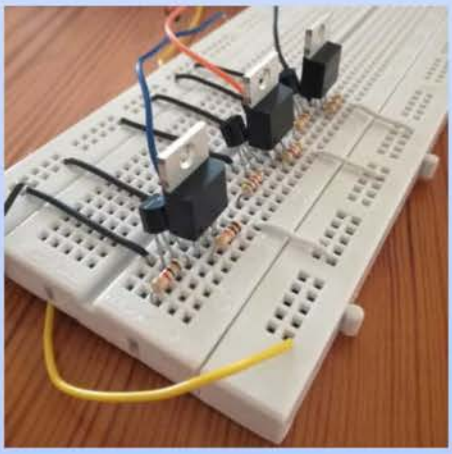
Interfacing:

The SCB-68 interface card along with the PCI-6221 data acquisition board is used to output and receive digital signals to and from my electronic circuit.

A circuit was built using three buz11 mosfets and three NPN transistors to enable the switching of the of the solenoids on the directional control valves.

The SCB-68 can only output and receive signals of no higher than 5 volts. The NPN transistor was used to receive the 5 volt output from the SCB-68. Sending a logic 1 level to the NPN transistor switches the mosfets logic state, in turn switching on the solenoid of the 5/2 directional control valve.

Sending the SCB-68 a higher voltage than 5 volts can damage the SCB-68 interface card therefore voltage regulators where used to step down the 24 volt signal from the reed limit switches that were attached to the double acting cylinder to 5 volt signals.



Conclusion

On completion of the project the cubes can be picked up successfully and dropped to there allocated locations. The LabVIEW program created is used to control the stepper motors and solenoids. The acquired data from the limit switches tells the LabVIEW program to move onto its next step. The front panel of the program acts as the human interface display therefore all my projects objectives have been achieved.

Distribution, Testing & Sorting Stations

Introduction:

Automating distribution, testing and sorting processes are crucial in many industries as it is considered more efficient than doing them manually.
In this project, Festo rigs were used to produce an automated system that consist of three stations. The stations purpose is to distribute workpieces from a magazine module, test the workpieces and sort them.

Aims of Study:

To demonstrate the abstract knowledge acquired over the course of our study in a practical, real life application.

Research

Before the project has been started it had to be planned, Therefore quite a few things had to be researched. Below is a list of the main factors that had to be researched:

- PLC Programming
- State-Transition Diagrams
- AS-I Bus Modules
- Peripheral Addressing
- Handheld Programmer
- Sensors
- Pneumatics

Methodology:

Design/Planning:
The design & planning processes involved:

- Selecting technology
- Develop project schedule
- Develop initial concepts
- Reviewing available resources
- Assign deadlines for tasks
- Develop detailed plans for three main sections
- Sketching initial concepts.

Fabrication:

- Most of the parts were fabricated in the GEW.
- Profiles for various rig modules to be mounted on were modified to desired size.
- Brackets were modified in order to fit nicely.
- Materials sourced from GEW.
- Fabricated parts include the chute, brackets, profiles, etc.

PLC/Control:

- Connecting all inputs and outputs of the rigs to either I/O Modules or AS-I Bus modules.
- Addressing AS-I Modules using Handheld Programmer.
- Configuration of the hardware in S7 300.
- Using peripheral addressing to access inputs and outputs of the AS-I Modules.
- Creating state transition diagrams and symbolic tables for both PLCs.
- Write PLC codes in Simatic Manager.
- Test program/Trouble Shoot.

Methodology (Continued):

Safety:
Safety was vital in the design of the project. The project includes two emergency stop buttons that are used to shut the outputs.

Results:

Design/Planning:
After reviewing what is available in the store, it was decided to avail the exciting sensors and actuators to complete the sorting station. Also initial created concept was modified and used to create the sorting station. It comprised of the following steps using electro pneumatic PLC system:

- Distribute workpieces using magazine module
- Transport workpieces to the testing station via swing arm module.
- Testing the workpiece and sorting it to one of two chutes.
- The black workpieces will be carried to the following station where it will be sorted again based on the colour of its top side.
- If the colour of the top is black it will be rejected.
- If the colour of the top is bright colour it will continue to the next station.

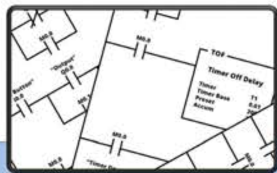
Results (Continued):

PLC/Control:

- Siemens S7-300 had 16 DI and 16 DO connections
- Two PLCs were used to control the stations
- The first PLC has AS-I technology installed in it.
- The second PLC only uses I/O modules.
- Three AS-I Modules were used to control the third station
- Each AS-I Module has four inputs and four outputs
- The first and second stations are controlled with I/O modules
- Code was written in Simatic Manager using ladder logic. FC1 included main code of process cycle. OB1 executed by the PLC called up FC1.

Fabrication:

- Some parts were fabricated in the GEW
- Some parts were taken from the store
- Mainly Festo Pneumatic components used
- Emergency stop disables all outputs



Conclusions:

- This project provided a chance to show skills and knowledge gained from the course in a practical way. Overall the project was a success and was a great learning experience.
- The objective to automate the manual process was achieved
- The project schedule had to be modified at some stages in order to fully utilize time

FESTO

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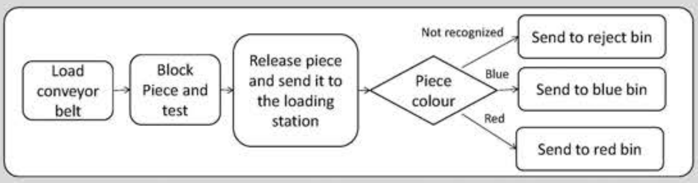
Automatic Sorting Station

Introduction

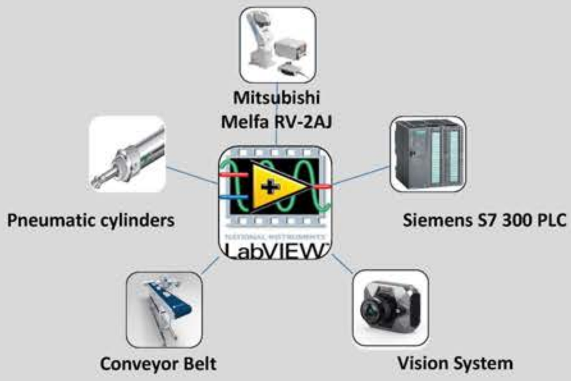
The Automatic Sorting Station was designed aiming at industrial applications, by using modern technology such as vision systems and robotics. The project consists of two main phases, analysis and transport. The first is responsible for analysing the piece on a conveyor belt using a camera that overlooks the belt, as the part is being transported, a cylinder blocks the part from moving and the vision system checks the part, releasing it to the next phase when the data is collected. The conveyor system continues to move the part down to the loading area. At this point, depending on the colour of the piece, there are three different locations it can be transported to, if the piece is faulty (e.g. colour not recognized) a rejection piston will send the part to the reject bin, if the piece is good, the robotic arm will pick and place the part on one of two bins. This system will be monitored by an HMI system on LabView.



Methodology

There are two main parts to the automatic sorting station. The physical build and software.

- The stations were put in place using various brackets and bolts.
- Two double acting cylinders are used to help guide the part into the loading place and to reject any faulty parts.
- 'CIROS Studio' was used to program a position list into the robotic arm and also to download programs.
- An OPC Server was set up to create a link between LabVIEW and the plc. This allows the LabVIEW program to call on the plc inputs and perform duties.
- The Mitsubishi Robotics add-on was used inside LabView to run the programs and change variables inside the robot controller.
- The LabVIEW program was created, tested and trouble-shooted to carry out the correct sequence of picking and placing parts.

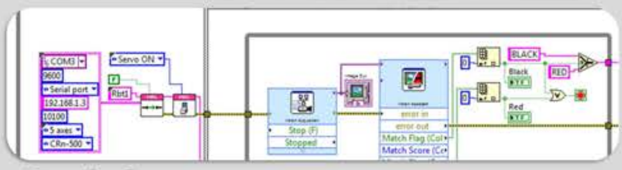


Loading Station

Conveyor Station

Results

The result was a success although we experienced many obstacles. The LabVIEW program was the main control of the system and allowed the robot to pick and place parts in the correct locations. The LabVIEW program was set out to monitor the components of the system and the status of the bins. The project was a success and we were pleased with the outcome.



Conclusion

The project had a very positive outcome since we were able to familiarize ourselves with the technology employed on it.
We overcame most of the barriers related to learning the new skills for programming the robotic arm.
The troubleshooting was for sure the most important part of the project development since we had various different systems to integrate.
We were also able to get a great understanding of LabVIEW programming and PLC programming, all important aspects of mechatronics engineering which will stand by us for our future in the industry.

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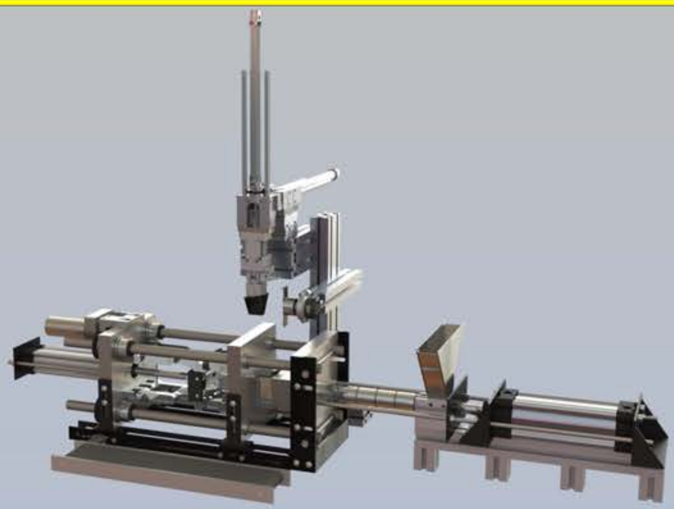
AIIMM

AUTONOMOUS INTELLIGENT INJECTION MOULDING MACHINE



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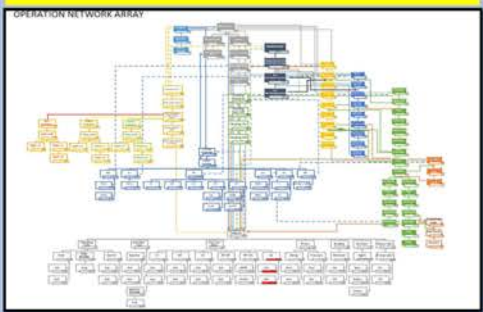
INTRODUCTION

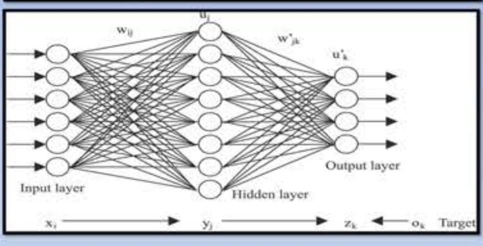
AIIMM is an autonomous injection molding machine with machine learning capability which is in line with the vision of industry 4.0. AIIMM is designed to reduce operation cost and maximize efficiency by calibrating and optimizing the entire injection molding processes autonomously, ensuring the final product achieved the desired quality. Sensors located in strategic location gives AIIMM its situational awareness, therefore allowing AIIMM to respond appropriately to certain stimuli. The machine will be design on the principle of simplicity and adaptability.

OBJECTIVES

This project aims to create an autonomous injection molding machine with machine learning capability which allow the integration into an evolving neural network to reduce manufacturing cost while increase machine efficiency and performance.

SYSTEM ARCHITECTURE





METHODOLOGY

Research

Studies done on injection molding have shown increase in demands across all ranges of polymeric products. Latest machine has smart systems to check for part defects and compensate for pressure loss and changes in heat flux to limit the amount of rejected product while maintaining a high-speed operation with high level of automation involved. Recent development in machine learning and artificial intelligence also promotes the development of next generation machine which have self-correcting capability while being able to communicate and exchange data within an evolving neural network that is constructed around artificial intelligence technology.

This technology allows for complete automation of processes from raw material extraction to the final product which will greatly reduce the cost of each individual product while increasing the overall product quality. It also eliminates the risk involves in certain processes during the making of certain products. This smart technology can be implemented over a plethora of machine platform to form a neural network where operations data can be analyzed by an artificial intelligence to relay appropriate decision which streamline the operation of all the machines within the network to accomplish a given set of objectives.

Design

- Scalable and adaptable.
- Cost effective and efficient construction.
- Operate autonomously most of the time.
- Respond autonomously in critical situation.
- Can be integrated into a network of machines.
- Encompass ISO 45001 operational safety standards.

Fabrication

- Prototyping machine via additive manufacturing.
- Secondary Manufacturing Processes were used.
- CNC Machining, Laser cutting, surface grinding, turning.
- Manufacture adaptive components to integrate Festo pneumatic equipment.

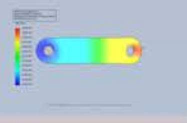
Testing

1. Periodic dry run to ensure all system's nominal.
2. Add raw material and initiate production run.
3. Check and record all operation status for future reference.

ANALYSIS

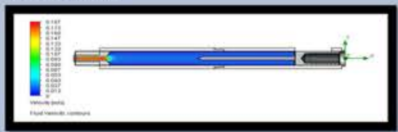
Mechanical Stress

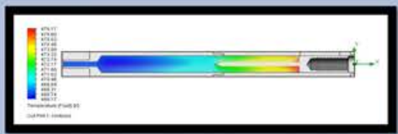
Displacement



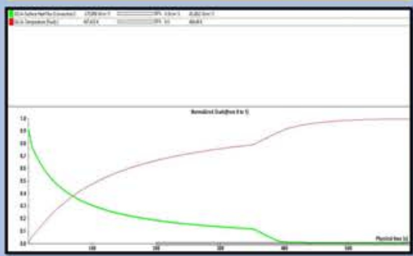
Stress Concentration

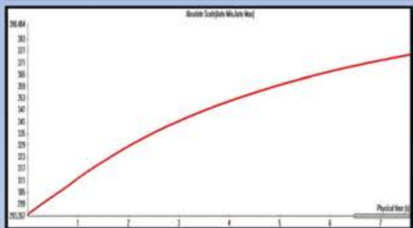
Fluid Flow





RESULTS





CONCLUSION

- The system have been tested and proven to be working as designed.
- Entire process is flexible and scalable for any required situation.
- Machine is operating as predicted by software simulation analysis.

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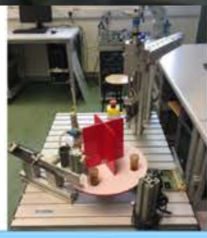
Automated Vial Processing & Quality Inspection



Introduction:

The purpose of this project was to develop a practical working knowledge of production stations in industry. This included the study of robotics, vision systems & material conveyance. The production station is capable of processing and quality assuring a product automatically before it is let out to the customer. Ideas for this project were inspired from different industries in the Sligo region.

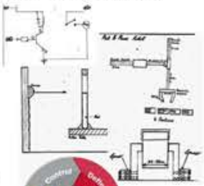
Aims of Study:

To demonstrate the theoretical knowledge gained throughout the course of our study in a practical, real world application.

Methodology

Research:
Research began by observing similar processes in industry, then breaking it down to the simplest steps and automating these steps in the most efficient way possible. This process was broken into four main stations:

1. Loading/Unloading
2. Vial Filling
3. Vial Capping
4. Quality Control



Design/Planning:
The design process involved

- Selecting Equipment
- Develop project schedule
- Develop different ideas
- Reviewing and selecting best solutions
- Assign tasks among project members
- Develop detailed plans and drawings for the 4 stations mentioned above
- Model design in Solidworks
- Tools associated with the DMAIC methodology were used during the life cycle of this project

Fabrication:

- Parts were both fabricated in the GEW and in workshops off campus due to time constraints
- Materials used included Mild Steel for its strength, Aluminium for its light weight and Nylon for its ability to be easily machined.
- Materials were sourced from the GEW and local suppliers in the town of Sligo.
- Fabricated parts include Connecting Plates for the Festo Electric Drive to the Guided Pneumatic Cylinder and from the Cylinder to the Pneumatic Grippers, the Index table, Dividers, Bracket for the Festo electric Drive, a nozzle machined to fill the vials, a guide and push mechanism fully fabricated with a magazine for cueing the caps for the vials.

Operation:
Station 1: The electric drive, pneumatic cylinder and grippers are used to pick and place a vial on the index table. The index table rotates through 90° to the second station.

Methodology (Continued):

Station 2: The windscreen wash pump in conjunction with my fabricated nozzle and top--plate are all installed in station 3. Master program will wait for station 1 complete signal and will then fill the vial for approximately 1.5 seconds then index table will switch to station 3.

Station 3: A lot of work went into this station fabrication wise and also to build my program and the overall program around this set up. Good decision making in the programming standards left the complexity of this program as efficient as possible and the technique applied was great design intent. Here a double acting 100mm stroke cylinder with a nylon block on its end pushed one cap at a time from the magazine to the top of the vial and a second Festo short stroke cylinder then pushed the cap down onto the vial to seal it.

Station 4: A UV light positioned under the index table illuminates the fluorescent additive in the liquid. This enables the vision system to easily distinguish the level of medicine in the vial and make a PASS/FAIL selection accordingly. The result is displayed to the user through the HMI and a record kept.

Quality check/HMI:

- Quality check based on the level of medicine in the vials.
- Vision system takes in an image of the level of medicine in the vial.
- NI myDAQ transmits the image from the camera to LabVIEW VI which decides whether the vial is a Pass or Fail.
- HMI displays bag weight and alerts user if bag is accepted/rejected and also alerts user to fill hopper when empty.

Safety:
Safety was a key consideration during the design of this project. Any parts that were fabricated in the GEW were given a good finish and any sharp edges were deburred. The Station also includes an emergency stop button and is fully enclosed to prevent moving parts from coming into contact with a person.

ZERO INCIDENTS
Conceive It. Believe It. Achieve It.

Results:

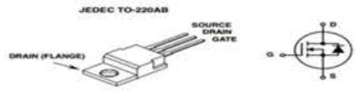
Festo Electric Drive:
The Festo Electric Drive can be operated using an I/O interface through a bus cable connected to its controller.

Positions are programmed by the user onto the controller. These position are then selected by sending I/O signals to 5 wires of the bus cable from the NI myDAQ to the drive. This binary configuration allows for a total of 32 positions.

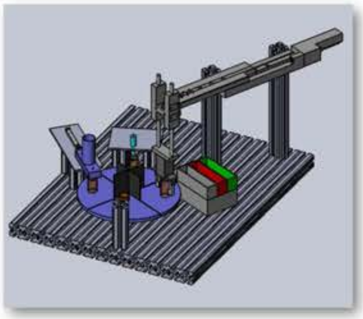
Results (Continued):

Stepper Motor
A Driver Board is used for control, the output pins are connected to the motor and the input pins are connected to the NI myDAQ card. An opto-isolator circuit is used to switch the 5V output from the DAQ card up to 12V to control the motor.

Water pump / filling station
Here we used an old VW windscreen spray pump as our filling system. In order to operate this pump using the DAQ breakout box we needed to build circuits using a MOSFET Buz11 chip with resistors and load voltages along side a BC547 NPN transistor, We also used a relay to switch the pump on and off with the rest of the circuit being used as a signal process in which five volts coming for the DAQ box switches between voltage differences and provides the pump with sufficient voltage to run for the desired time.



Capping Station:
This set up familiarised itself with the previous station in the like terms that a similar circuit as the last but without an implemented relay. The design intent in programming terms was to keep things as free flowing and as operative as possible to reduce the complexity of altering this system to carry out different procedures possibly in the future.



Conclusions:

- This project us provided the opportunity to apply the theoretical knowledge we learned throughout the course and develop our practical skills. Overall the project was a success and was a valuable learning curve.
- The objective to automate a vial capping process had been achieved and included a fully automated quality inspection station.

The main limiting factor of the project Included:

- The amount of time needed for the fabrication of different parts.
- If time permitted a conveyance system could have been included to facilitate incoming and outgoing product.

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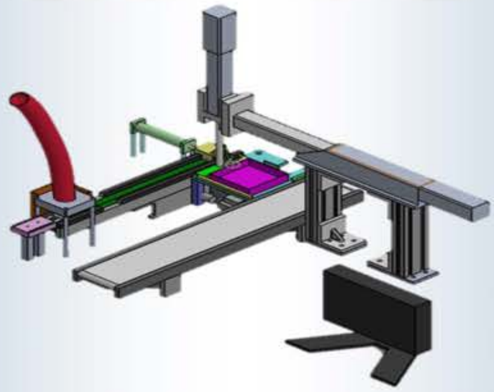
Automated Packaging System

Introduction

This project was designed to package a medicine bottle in a small box and move the packages box from the system to be dispatched. This was done to show case our many different skills that we acquired over the last three years in this college. Skills included but not limited to design, manufacture, communication, leadership and team work skills. The system is intended to be fully automated and is designed to be simple and efficient as possible.

Aims of The Study

The aim of the project is to show case our skills on open day by having the project running completely in sync on open day. open day.



Result

A final concept was designed and can be seen in the drawing above. The system works using a series of conveyers, cylinders, sensors, boxes and the Festo arm, these are all controlled using the Siemens PLC.

What does it do?

- A medicine bottle is stored in a magazine and realised using a cylinder.
- It goes through a quality check station using sensors to test if the lid and product are in place.
- If it fails it is removed from the system and it if it passes it continues on.
- It is moved into a precise location via a cylinder and a nest for the bottles.
- A vacuum is used by a Festo arm to pick the bottles and place it in a box.
- The Festo arm has a subprogram to get three different positions.
- When the three positions are achieved the box is moved to another row.
- When the box if full it is moved onto another conveyer to be removed.

How it works

- The system is controlled by the Siemens PLC which is controlled by a program written by a team member.
- The PLC controlled the conveyer and Festo arm using replays and controls the cylinders using an air manifold.
- The Festo arm has a sub program controlled by Festo Control Tool

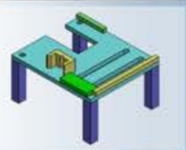
Conclusion

- This project was an over all a success because the project showcases the many different skills that were thought to us over the year, also the project improved them skills further.
- This project was also a success in the form that the project carried out everything that was outlined in the brief. Its has automated the process of packaging the medicine bottles after going through a series of quality checks.
- Lastly the project successfully fulfilled a lot criteria for the course like, communication, report writing, presentation skills, linking in with business students, applying modules to real life situations and taking lead in a project.

Design Process

First research was done on many different automation systems on how the packaging is carried. There is many different aspects of a packing system-

- **The movement of the product** up to the packaging system, like a conveyer or a feeder bowl of been manually handled.
- **The area where the product is lifted** for packaging, for example been lifted off the conveyer or been picked up from a precise location.



- **The lifting of the product** the product can be lifted using different heads like a vacuum or a claw gripper.

The next step was to plan the project, aspects in this included -

- Taking the research from part one and applying it into making concepts.
- Do research on what resources and equipment are available.
- Finalise the project and develop a drawing.
- Develop a list of jobs and schedules
- Lay out mile stones and essential jobs that are critical.

Fabrication

- There are lots of resources available in the project room for this automation project like the framework, the PLC, cylinders, conveyers, sensors and the Festo arm.
- The fabrication was carried out in the GEW and the tool room for the brackets, legs, precision nest and magazine.

- Set up the Siemens PLC including -
  - Studying the data sheet.
  - Wiring up sensors and the air manifold.
  - Testing small programs and stations
  - Programing the entire working program.
  - Fault finding and testing.

- Set up Festo arm -
  - Studying the data sheet.
  - Creating configurations.
  - Programing the FCT.
  - Testing with PLC.

Safety

Safety is a big concern with an automation project and in this system we have taken many precautions when design this cell.

- An E-Stop was introduced.
- Dump valve
- Sensors on the doors so when they are open the system will shut down.
- Perspex on the boarder of the cell to protect operators and bystanders.

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Main roles in the project included the design and assembly of the project.

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Main roles included the set up, program and control the Festo arm.

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Main roles in the project included the programing and testing of the PLC.

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Main roles in the project included the fabrication of the parts.

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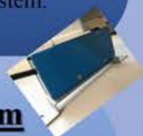
Automatic Transport, Sorting & Weighing System

Vibration Bowl Feeder

- used as the storage and fed individual item onto transportation line.
- when a random number or types of items are put into the bowl feeder, those items will transport one by one to the conveyor system and make some classification process due to the item requirement standard.
- Make easy way for sorting system

Sorting system

- This sorting system is used to classify the different types of colour.
- From the USB camera and LabVIEW, the colour of items can be detected by the sense of colour intensity.
- Base on the program, the items can be sort out by interface of pneumatic cylinder.
- In the program, the colour can be choose at the beginning, then the unwanted colour will be rejected by the cylinder.
- The require items is then drop to the potting box at the weighing system.

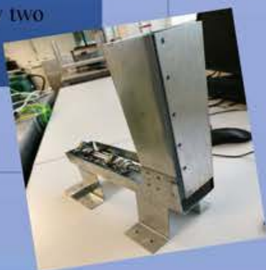


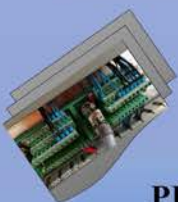
Transport System

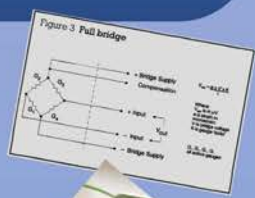
- This transport system consists of 3 phase motor, conveyor belt and Lenze frequency controller.
- The 3 phase motor allow the conveyor to turn in clockwise or counter-clockwise direction.
- Lenze frequency controller has different kind of code which operates in various function. Besides, it can control the conveyor speed by monitoring the frequency generated.
- Binary code frequency control is used in the project as to make the conveyor move faster or slower.
- As from the project, only two speed has to be control.

Weighing system

- Weighing system involved the load cell and the strain gauge amplifier.
- The load cell is a 2kg load cell, but it has been zoom to sense within 700g.
- The strain gauge amplifier then attenuates the output of the load cell and substitute the output voltage into labview system through the DAQ device.
- Due to some noise, the output of the load cell is inconsistency. Hence, a low-pass filter is added in the program to filter the noise.
- The voltage is then converted into unit volts by using some mathematical function.

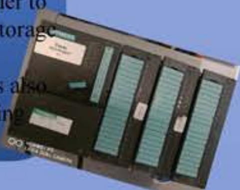






PLC system

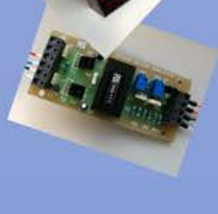
- PLC programming is known as Programmable Logic Controller
- It use logic diagram to control input and output.
- In this project, it is used to sort out the different colour inspected by the USB camera which turn on the cylinder to push the item over the storage box.
- Otherwise, the cylinders also used as placing the potting box at the right place.



OPC

LabView system

- LabView provides a graphical programming which visualize most of the things.
- It is normally used for data acquisition, instrument control and automation system.
- Main program in the project.
- Provide HMI panel for operator to control the process.
- Control PLC I/O which allow to control the cylinder through labview and get the sensor feedback from the plc system.
- Program the vision system colour inspection.
- Get the data from load cell, provide filtration and convert into required unit.



Universal Rear End Loader

Introduction

The purpose of this project was to design build and test a rear end loader for the back of a tractor.

It had to safely lift a weight 2 tonnes to an operating height of 3 metres

It had to be universal to all tracotrs.

It also had to be a cost effective alternative to the expensive front loaders currently on the market.

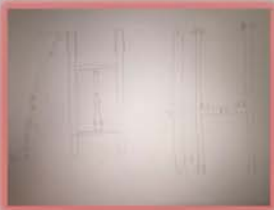
Research

Extensive research was carried out before the start of this project. The team attended several agricultural and machinery shows such as the Ploughing Championships, Fintona Machinery Show and other local agricultural shows. Time was spent talking to local farmers at livestock marts and at local agri stores. The team discovered a gap in the market for a cost effective rear end loader which would be universal to all tractors. A product which would be aimed at all but particularly the small/part time farmer.

Design Concepts

For the project 3 different concepts were considered, the team dilibereated over each concept until the final design was procured.

Below is the first concept of the final design, however some changes were made by the start of fabrication.

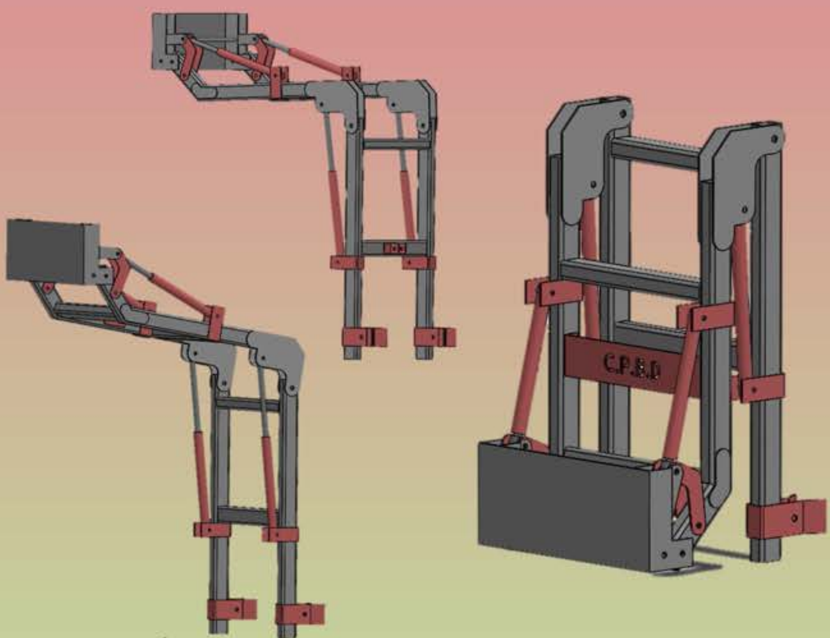


Safety

This project has been designed to take the farmer out of dangerous situations where the farmer is risking injury to themselves or others, taking away back braking tasks such as lifting feedstuffs eg bales of hay, straw or silage, loading trailers with dung or stone with ease. Taking the farmers out of these situations not only makes life easier for them but also seriously reduces their risk of serious back and other strain related injuries.

Fabrication

- All steel was sourced from a local builders yard in sligo.
- Certain brackets were laser cut off site by a steel fabrication company in Northern Ireland.
- The team reconditioned the hydraulic rams for the project and new hydraulic hosing was fitted.
- All pins and bushes were manufactured by the team in the GEW.
- All welding and other fabrications were carried out by the team in the GEW.



Initial Testing

Initial testing was carried out once we had the rams mounted on the project, we tested at this stage to ensure that the starting angle on the rams was suffiece to start the lift.

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Derivation Codes in Group Algebras

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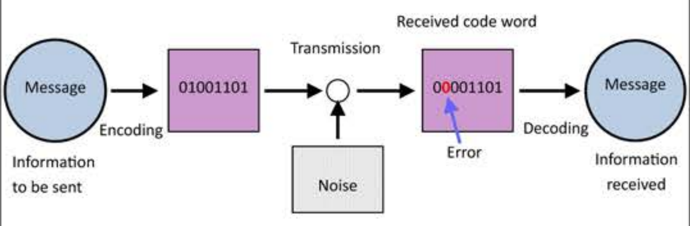
Abstract

Error correcting codes play an essential role in the effective transmission of data. Applications include satellite communication, data compression and storage, networking, synchronization and cryptography. The basic parameters of a code are field size, length, dimension and minimum distance. The problem is to optimise these conflicting parameters so as to form a bespoke code that has the right parameters for a particular task. The solution proposed here is to apply derivations (linear transformations satisfying Leibniz's rule for multiplication) to group algebras. The image of the group algebra under a derivation (and all of its iterations) gives a subspace. This gives a method for constructing codes (subspaces). The task is to analyse the parameters of these codes using the structure of the derivations and the underlying group algebras. It may then be possible to choose the group algebra and the derivation such that a particular combination (direct sum) of subspaces leads to a code with the desired parameters.

Diagram illustrating how coding theory is used to correct errors when transmitting information across a noisy channel.



Derivations

A derivation on a ring R is an additive group homomorphism that satisfies a multiplicative rule known as Leibniz's rule. Thus d is a derivation on a ring R if it satisfies the following two equations, for all elements x and y of a ring R.

$$d(x+y) = d(x) + d(y)$$

$$d(xy) = d(x)y + xd(y)$$

The set of all derivations on a group algebra KG has the structure of a ker_d- module, where ker_d is the kernel of the derivation d.

Lemma. Let R be a unital ring with characteristic p and C_{p^m} the cyclic group generated by the element x. Then there exists a unique derivation d on the group ring RC_{p^m} such that

$$d(x) = 1 \text{ and } d(R) = 0.$$

Lemma. Let $G = H \times A$ be a finite abelian group, where H is a p regular group and A is a p group with a minimal set of t generators. Then

$$|Der(F_{p^n}G)| = |F_{p^n}G|^t = p^{n|G|t}$$

The Image of a Group Algebra under a Derivation

A group algebra is a vector space V over a field K. A derivation can be represented by a linear transformation $T: V \rightarrow V$. The image of the group algebra under the linear transformation T is a T-invariant subspace W of V. Denote the restriction of T to W by T'. Then $T': W \rightarrow W$ is a linear transformation and the image of W under T' is a T'-invariant subspace of W. In this way the process can be continued. However, after m steps the derivation map is an isomorphism on the range space of the transformation T^m.

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Codes from Derivations

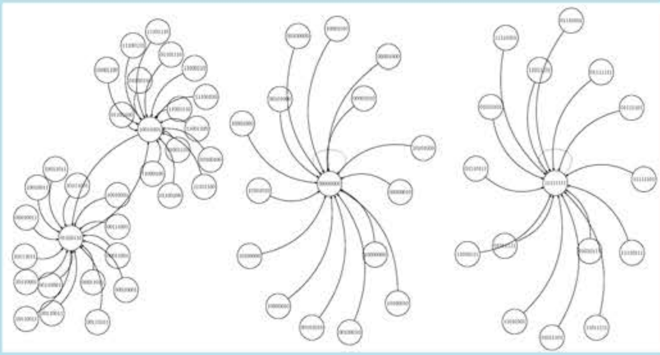
Linear block codes are subspaces of a vector space. The q-ary [n, k, δ] code is a linear code of length n, dimension k and minimum distance δ. We can form codes by applying a derivation to a group algebra. The resulting subspaces are linear codes.

Example: Let $KG = F_2C_8$ and let d be the derivation defined on KG by

$$d: F_2C_8 \to F_2C_8, \quad where \quad x \mapsto x^2 + x^4 + x^6 + x^7$$

The range space of this derivation is a 4-dimensional subspace of F_2C_8. This subspace is a [8, 4, 4] binary code. In fact, it is equivalent to the extended binary Hamming code Hâm(3,2). It can simultaneously correct any single error and detect any double error.

Diagram showing a derivation mapping on a subset of the group algebra F_2C_8.



Example: The vector 11101110 gets mapped to the vector 10011001 under this derivation.

The diagram illustrates that a derivation applied to a group algebra can be used to construct a directed graph. An interesting question is whether the properties of the graph are related to the properties of the code and if so how are they related.

Further Work

The goal of this research is to:

- Produce linear codes by applying derivations to group algebras
- Analyse the parameters of the resulting code
- Establish relationships between the parameters of the code and the properties of the group algebra
- Establish relationships between the parameters of the code and the characteristics of the particular derivation
- Determine the relationship between the parameters of the code and the properties of the underlying digraph
- Develop a method for designing a code with certain parameters by using the relationship with the properties of the group algebra, the derivation and the digraph
- Produce algorithms for implementing such a code

Acknowledgements

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Development of an Automated Ergonomics Detection and Alert System

Abstract:

Some occupations require completing fine movements under a microscope for long periods of work time. This type of situation puts individuals at risk of repetitive strain injuries (RSI) and other ergonomics risks. Research suggests that injuries are primarily caused by bad ergonomic posture over long durations of time. The development of a work duration and posture monitor would assist in limiting over-work time, as well as encourage good ergonomic posture during work time. The automated system is primarily based on sensorization of the work environment. This will limit the effects on the work process and tasks. The results of this research can aid in limiting the risk associated with day-to-day work of surgeons and those in occupations with similar environments.

Introduction:

This project focuses on improving the ergonomics of professions that require long hours of microscopy use. When working at a desk in an office environment, the proper ergonomic position is known as the 90/90/90 position; referring to the angles to which one's elbows, hip joints, and knees should be angled. (Figure 1A)

This setup is not dissimilar to those who must use a microscope on a table top for long hours at a time. However, as shown in Figure 1B, the microscope often makes it difficult to maintain the ideal 90/90/90 posture.

Figure 1: (A) Proper ergonomic posture when working at a desk or office environment (PanadolNZ); (B) Example of a typical posture when using a microscope (MicroscopyU)

Operators who work for an industry partner are responsible for the repair of probe cards used in semi-conductor quality testing, (Figure 2) Repair work mostly revolves around the arrays of probes in the centre of the card with repairs typically being microns in scale. Operators work in 12-hour shifts alternating between days and nights. These prolonged working hours in uncomfortable positions, can lead to higher risk of ergonomic injury. Muscle strain primarily affects the neck, shoulders and upper back areas, while some have also expressed experiencing fatigue in hand muscles after a day's work.

Researchers studied the similar environment of surgeons and assistants in laparoscopic surgery, and found considerable stress associated with the performance of high-precision work under the microscope for extended periods of time. Their findings suggest that there is considerable stress and suggest that the main contributors are likely work duration and improper posture. *(Rosenblatt, McKinney and Adams, 2012; Zihni et al., 2016)*

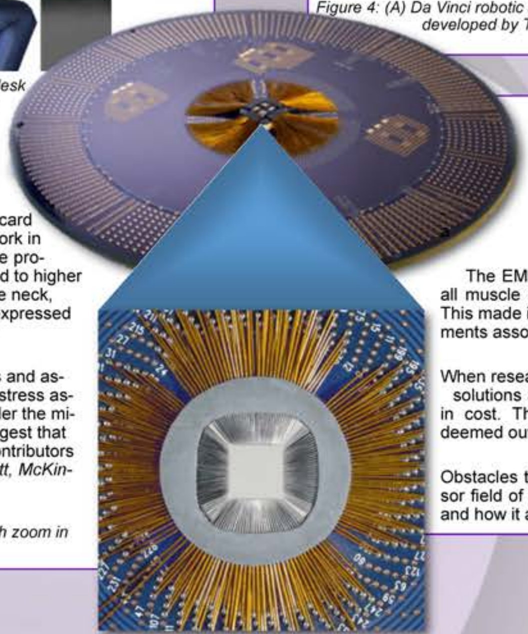

Figure 2: Example of a typical probe card used in industry with zoom in view of probe array (Rucker Kolls Inc., FormFactor)

Methods:

Different technologies have been explored to date. In the initial stages of research, focus was put on analysing the hand gestures of the operators and trying to gauge fatigue through patterns in their hand muscles. This included tests with the LeapMotion sensor (Figure 3), EMG readings, and force measurements.

Based on findings from initial work and the limitations discovered. The approach changed focus towards the use of smart environments for duration tracking, combined with vision systems for posture tracking.

Figure 3: LeapMotion hand gesture capture technology (LeapMotion)

Creating a network of sensors within the environment allows for an automated and non-intrusive approach to work duration monitoring. Posture tracking is more complex and past research shows that vision systems provide the most robust data, compared to wearables or other sensor networks.

Options in tele-robotics, such as the Da Vinci system shown in Figure 4A, and haptic feedback systems, shown in Figure 4B, were also investigated.

Figure 4: (A) Da Vinci robotic surgery system (NewAtlas); (B) Haptic feedback device developed by Tohoku University for micro-manipulation (Tohoku University)

Results:

When testing some of the initial explored technologies, some limitations were discovered. The LeapMotion, for example, was not able to accurately detect hand move ments since the setup only allowed for it to be placed short distance from the operators' hands.

The EMG tests found that the electrical patterns encompassed all muscle activity and thus, there was much noise in the signal. This made itextremely difficult to differentiate the specific measurements associated with the repair work.

When researching tele-robotics options, it was found that most solutions are custom-built, and typically several millions of euros in cost. This far exceeds the budget of this project and was deemed out of scope.

Obstacles to consider moving forward include obstructions to sensor field of view from the environmental setup, and potential noise and how it affects collected data.

Next Steps:

Tracking hand gestures and strain proved to be a more complicated task than anticipated and may not be the best approach to preventing injury.

A custom sensor network is currently being developed to fit within the working environment. This network will deduce whether repair work is being performed and track work duration. Since it is an environmental enhancement, it has minimal-to-no impact on the work process and productivity. Once the network accurately tracks work duration, additional technology will be added to track posture.

Preventing excessive work durations and promoting proper postures will help to prevent injury for these operators and the technologies will be applicable to any other areas of industry requiring microscopy use and micro-manipulation, i.e. medical, pharmaceutical, etc.

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Keywords:

Repetitive strain injuries (RSI), improving ergonomics, health and safety, sensorization

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Models of gene interaction in bovine granulosa cells

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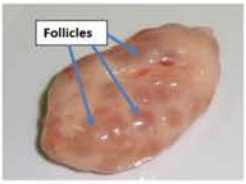


Abstract

Twinning and silent heat contribute greatly to the profitability of cattle husbandry.

Twinning is a desirable trait in beef cattle and undesirable in dairy cattle. It has been observed that twinning is associated with higher level of IGF-1 in the blood. For this reason we try to gain an understanding of the impact of IGF-1 on the bovine ovarian follicles. Bovine ovarian follicles contain a layer of granulosa cells which produces two hormones: estradiol (E2) and progesterone (P4). The ratio of these hormones during the estrus cycle indicates either normal or silent heat (lack of manifestation of symptoms). The information required for the production of these two hormones is communicated through mRNA concentrations of enzymes involved in the steroidogenesis pathway. We have created models of mRNA and hormone concentrations in the granulosa cells.

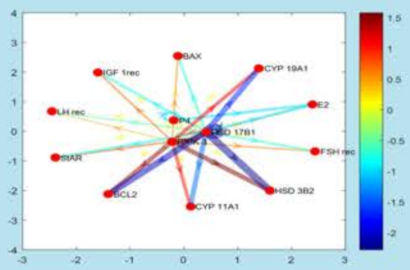
The granulosa cells were obtained from bovine ovarian follicles of diameter 5 – 8mm (middle sized follicles) and >8mm (dominant follicles). Data were collected every 8 hours for 24 hours.
The cells were stimulated by adding:

- 25ng/ml IGF-1, 50ng/ml IGF-1, 100ng/ml IGF-1, 25ng/ml FSH , 50ng/ml FSH and control (small follicles) or
- 25ng/ml IGF-1, 50ng/ml IGF-1, 100ng/ml IGF-1, 50ng/ml IGF-1+2ng/ml LH and control (dominant follicles)

Genes measured
- responsible for the atresia of the follicles (BAX, BCL2), RIPK3,
- the gene directly responsible for progesterone production (HSD 3B2)
- genes directly responsible for estradiol production (HSD 17B1, CYP 19A1) and STAR and CYP11A1.

Receptors (IGF1r, LHr, FSHr)
Hormones (P4, E2)

Gene and Hormone Regulatory Matrices (GHRM)



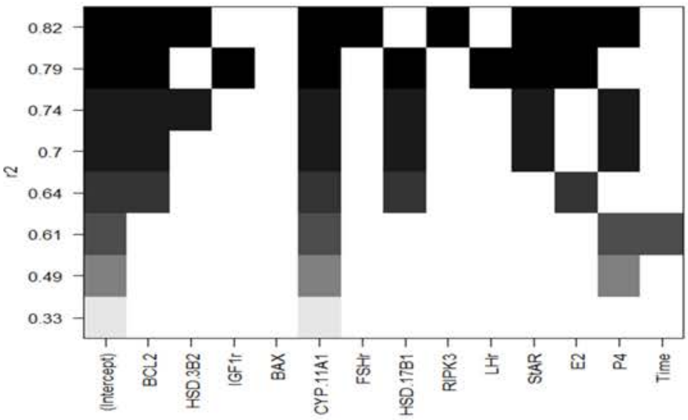
Control group (5-8mm in diameter follicles):

Gene Regulatory Matrices (GRMs) are a well known technique for modelling the interactions (promotion and inhibition) between genes [1], [2], [3]. This assumes that the process is a Markov process. This technique is used here, but with genes and hormones, to create Gene and Hormone Regulatory Matrices (GHRMs).

Principal Component Regression (PCR)

PCR is based on principal component analysis (PCA). PCR predicts the response based on the dependent variables using the standard linear regression model. This technique uses PCA to choose the dependent variables in the model. An example for CYP19A1 is shown below.

PCR Model of CYP19A1: in dominant follicles



RESULTS

The GHRM matrix yielded an error < 1% on the training dataset.
However, when used on a test dataset, it produced significant errors.
The PCR model built on the training dataset was used for calculations of gene expression rates and hormone concentrations in the test dataset and errors obtained were smaller than those produced using the GHRM for that dataset indicating that the PCR may be a better modelling technique.
The errors of PCR models varied among models for respective genes and hormones.

Further Work

- Investigation of the accuracy of these techniques based on the data available in public repositories.
- Creating the network of IGF-1 impact on the chosen genes and hormones using Reactome.

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2018 Sligo Engineering Expo

The Sligo Engineering Expo 2018 would like to acknowledge the contribution of the 2018 core production team of
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