PORTFOLIO Projects

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CRISTINA FIANI

2021

BIOMEDICAL ENGINEERING PROJECTS

Master's individual project – UCL (October 2020 - April 2021)

Description

Aortic stenosis is one of the most common heart valve diseases among the elderly over 65 years old. Patients with severe aortic stenosis have been recently treated with a minimally invasive procedure, Transcatheter Aortic Valve Replacement (TAVR), aiming to insert a new heart valve through a catheter. Therefore, the prosthesis size selection relies on 2D or 3D imaging techniques which are shown to lack accuracy. Poor sizing of the aortic stent leads to complications, including Paravalvular Leak (PVL) or the rupture of aortic walls.

Integrated impedance measurements and Electrical Impedance Tomography (EIT), placing electrodes on the inner catheter may accurately determine the size and the shape of the balloon surface and, consequently, the aorta where the aortic stenosis is located.

- Evaluated the extent to which impedance measurements can enable us to distinguish the size and shape of cylinders and elliptic cylinders modelled as balloon catheters.
- Used an analytical approach based on Ohm's law and the resistance formula using Electrical Impedance Tomography and Diffuse Optical Tomography Reconstruction Software (EIDORS).
- Computed absolute 3D EIT reconstructions using a dual solver approach.
- Validated the analytical approach results with experiments using a simplified EIT circuit built at home due to the pandemic.

Supervisors

Dr James Avery
Dr Kirill Aristovich

Outcomes

- Personal outcomes include the gain of knowledge in computational designing and simulations with MATLAB using EIDORS and building a simplified EIT circuit with Arduino.
- Development of communication and proactive skills.
- Regarding the project, the simulations led to the ability to determine the sizes and shapes of the stent such as being ellipsoid, thus to a better sizing of the aortic stent. Further research with a real EIT system is required to confirm these results.
- Presentation at Conference EIT in June 2021. https://eit2021.clr.events/event/128728:eit-2021

Third-year design group project - UCL (October 2019 - April 2020)

Description

- Designed and built a personalized cushion for wheelchair basketball players.
- After meeting players and experiencing wheelchair basketball, my team and I were able to find an alternative solution to expansive personalized wheelchairs which can cost over 3000 pounds. The solution allows amateur players to use standard wheelchairs available in basketball courts, the cushion enables the person to 'become one' with the wheelchair which improves comfort, safety, stability thus performance.
- Collaborated with *Infi-Tex* company; using their pressure maps to test the prototype.

My roles

Team Leader, researcher and planner.

Supervisors

Eve Hatten
Dr Pilar Garcia

Outcomes

- Developed leadership, communication and solving-problem skills.
- Experienced the whole design cycle: created a product starting from an idea to the prototype, obtaining user feedback, testing it and designing a business plan.
- Gained knowledge in mechanical testing with ElectroPuls (3000).

Website Development - UCL (October 2019 – March 2020)

Description

- Developed a clothes-swapping website using Python and Flask.
- It aims to provide an alternative when needing or wanting new clothes, allowing users to avoid participation in the fast-fashion industry, which has a hugely negative impact on the environment.
- The website implements different functionalities (sign up, log in, edit profile, upload items, browse items, swap items) and includes testing and deployment.

My roles

- Team designer and planner.
- Planned and designed the website from the requirements, use cases, UML diagrams, user interface and implementation of the development of a website.
- Coding.

Supervisor

Sarah Sanders

Outcomes

- Learned to work as part of a SCRUM team.
- Developed programming skills in web development including HTML, CSS, Bootstrap, Database SQL and version control/collaboration with GitHub.
- Modules passed: Systems Engineering and Web Development.

Solid Biomechanics and Bio Fluid Mechanics Modelling Projects – UCL (year 3)

Solid Biomechanics

Description

- Developed a conceptual multibody dynamic model of the upper limb using ADAMS, performing a kinematic simulation of two different activities and researching the limitations and validity of the model.

My roles

Researcher and planner.

Outcomes

- Gained knowledge about the mechanics and anatomy of the upper limb and designing a simple conceptual model that mimics the human.
- Produced a scientific paper and obtained a 95% mark.

Bio Fluid Mechanics

Description

- Modelled two squared microchannels using ANSYS CFX software, with laminar and steady flow assuming the fluid to be a continuum- one for Newtonian and one for non-Newtonian blood and observed contours for different parameters.

My roles

Researcher and planner.

Outcomes

- Gained knowledge about modelling, finite element analysis and biofluids.
- Produced a scientific paper and obtained a 72% mark.

Machine Learning – Francis Crick Institute (July 2019 – August 2019)

Description

- Worked on a machine learning project for biomedical image segmentation in Guillaume Salbreux's lab (Theoretical Physics of Biology Laboratory).
- Guillaume Salbreux's lab collaborates with Jean-Paul Vincent's lab (Epithelial Cell Interactions lab) and for my project, I met Sophie Hodara Herszterg who focuses on the arrangement of cells within the Drosophila wing during development. We worked together to use image analysis to quantify the development process.
- One of the limiting steps is to obtain a large amount of well-prepared training samples. A researcher can easily segment (trace the outline of) individual cells but it is time-consuming, it can take days.

Supervisors

Dr Matthew Smith

My roles

My role involved combining the U-net network, a published artificial neural network and a "Sensory Organ Precursor (SOP) detector", in other words, a Python program I have developed using a convolutional neural network to recognize the SOPs and create weights.

Outcomes

- Presented my project at a symposium and received positive feedback.
- Learned and developed skills going from computing to physics and biology.

- Working in such an incredible environment surrounded by people with different knowledge and backgrounds was fulfilling.

Scenario Weeks - UCL (Years 1 and 2)

General Description

Week-long team projects focusing on a technical engineering design project as part of the Design and Professional skills module.

A. Design and build a Positive Expiratory Pulmonary device for a child with cystic fibrosis - Volunteer for *Remap* (11/02/2018-15/02/2018)

Description

- Designed and built a prototype of a Positive Expiratory Pulmonary device for a child that needs to use the device everyday (usually 3 sets of 10 breaths per day) who finds the traditional device 'boring'.
- The prototype was made such that it tells stories, with characters chosen by the child while using it for his treatment.

My roles

Researcher and planner.

Supervisor

Dr Rebecca Yerworth

Outcomes

- Positive feedback from the user.
- Produced a full and simple guide of the prototype for a young audience.

- Gained knowledge about the challenges faced by a hospital-based clinical engineer, technical drawing, 3D printing, the whole design cycle and medical ethics.

B. Business strategy and pitch an image-guided surgery system developed by a UCL research group (07/01/2019-11/01/2019)

Description

- Designed a business strategy for a medical device developed by a UCL research group taking into account what is required for a business case and demonstrating the ability to sell ideas to interested parties.

My roles

Researcher, implementer and team worker.

Supervisor

Dean Barratt

Outcomes

- Produced a portfolio of the business strategy, timeline, market route, regulations and risks. Pitch presentation in front of a jury, presenting key details concisely and persuasively to an external, non-expert audience.
- Developed an awareness of the full economic costing of a medical project.
- Developed business and communications skills.
- Learned about ethical risks and regulations of medical devices.

C. Develop a computer mouse simulator (10/12/2018-14/12/2018)

Description

- Developed a computer mouse simulator replacing device for a client without a hand and very limited movement but intact muscles.
- Created an analogue and digital circuit using Arduino programming detecting Electromyography (EMG) signals from electrodes placed on a single arm when muscles are clenched or relaxed to enable the client to use a computer.

My roles

Team leader, researcher and planner.

Supervisor

Dr. Rebecca Yerworth

Outcomes

- Device tested with simple computer games and successfully passed the tests. Final device functioning for 5 degrees of freedom (left/right, up/down, movement and click).
- Produced a risk assessment template.
- Developed skills in electronics and programming.

D. Design a peristaltic pump (29/10/2018-02/11/2018)

Description

- Designed a functional peristaltic pump and demonstrates that it works.
- Built a prototype using different and efficient manufacture methods (3D printed, laser cut or milling machine).
- Designed the pump in CAD software and produced 3D technical drawings.
- Investigated and analyzed manufacturing methods.

Supervisor

Eve Hatten

My roles

Team leader, researcher and planner.

Outcomes

Developed skills in design software and manufacture devices.

E. Design a wearable, non-invasive and safe smart-cloth (19/03/2018-23/03/2018)

Description

- Designed a t-shirt to measure back bending using flex sensors.
  Back pain may be caused by poor position technique when exercising, hence, depending on how your back is, the neopixels on the front of the shirt change colours for different stages and a sensor buzzes to alert the user.

Supervisor

Eve Hatten

My roles

Researcher and planner.

Outcomes

- Produced a report and presentation of the prototype in front of the jury.
- Developed skills in Arduino programming, problem-solving and compromising in a team.

F. Develop a smartphone healthcare application to detect the pulse rate (05/02/2018-09/02/2018)

Description

- Developed a smartphone healthcare application to detect the pulse rate using the rear camera and LED flash of a smartphone.
- Programmed an application using Basic4Android and presented a pitch of the finalized application.

My roles

Researcher.

Supervisor

Dr Terence Leung

Outcomes

- Consolidated the engineering learned in Physics of the Human Body and Cardiac Engineering of pulse rate image and signal processing using Fourier Transform.

IMPACTIVE PROJECT (October 2018 – July 2019) - with *Remap*

Description

- The aim of Project Impactive is to create a positive impact on persons' lives with a disease and make a difference to help them become more independent.

My roles

I was mainly involved in two different roles:

- Publicity: I participated in volunteering fairs at UCL, presenting the project to students and tutors. I also used social media to promote projects and connect more volunteers.

- Engineer and team leader: I led a team of 4 students. Designed a hearing device for a deaf adult who wanted to be able to notice different sounds when cycling such as cars, motorcycles, bicycle bell etc.
- Built the final prototype using design, electronics and programming skills.

Outcomes

- Learned about designing and technical concepts as well as leadership, how to manage, organize and communicate with the team.
- Met other students from different years and courses.