Project Portfolio

2020-23

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4th (Penultimate) year

Bachelor of Mechatronics Engineering (Honours)

Masters of Biomedical Engineering

The University of New South Wales, Sydney

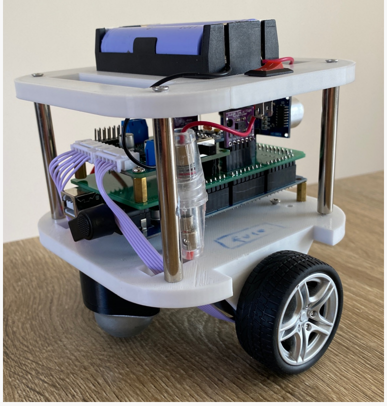
Autonomous Micro Mouse

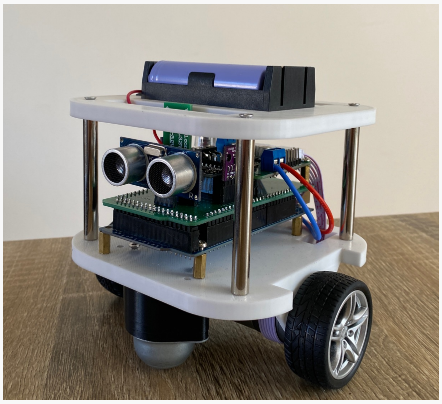
2023

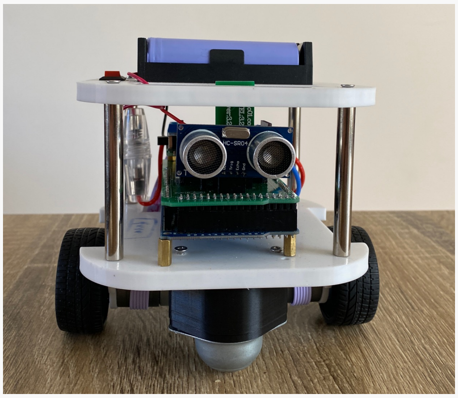
Link

Overview

Autonomous robot which could explore a maze and find the shortest path to a given goal. The robot used external distance and heading sensors to localize the robot within the centre of a maze cell. Robot movements were PID controlled using a combination of wheel encoder readings and sensor feedback. Alternatively, the maze walls could be identified using a top-down view camera and computer vision using Open CV in Python.

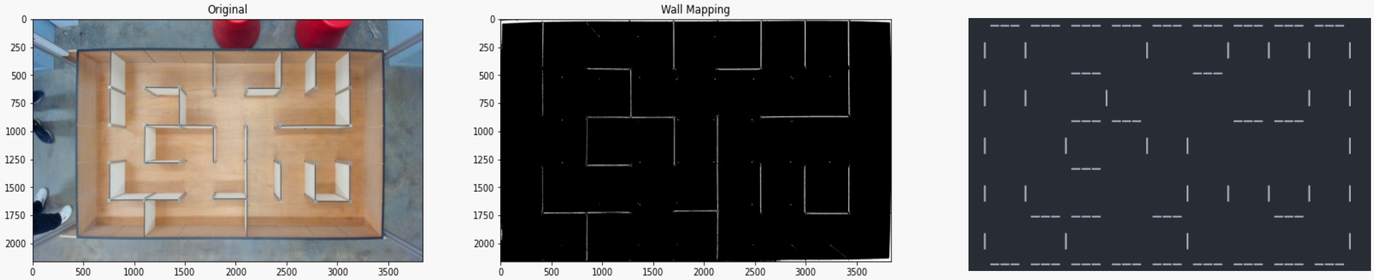






Computer Vision using OpenCV

- Derived a matrix representation for the maze from an existing image using OpenCV.
- Graph of the maze's connected cells generated from the matrix.
- Shortest path to the goal was identified using Dijkstra's algorithm.



Original Image -> Masked Image -> Ascii Representation

Notable Challenges and Solutions

Challenge	Solution
Many loose jumper wires required for each sensor and motor driver.	Designed a simple PCB to eliminate the need for wires. Sensors connected to PCB via header pins
Difficulty driving straight using only wheel encoder counts	Sensor feedback from an Inertial Measurement Unit (MPU6050) to correct heading using a PID controller
Ensuring Robot does not crash into the walls of the maze	Sensor feedback from onboard LiDAR's and Ultrasonic Sensors to avoid collision
PID Tuning to drive forward specific distance and maintain constant heading during movement	Systematic approach to adjust Kp, Ki and Kd to ensure fast settling time whilst avoiding overshoot
Large main function in Arduino program	Separating sensor functions into separate classes and passing by reference to call sensor methods

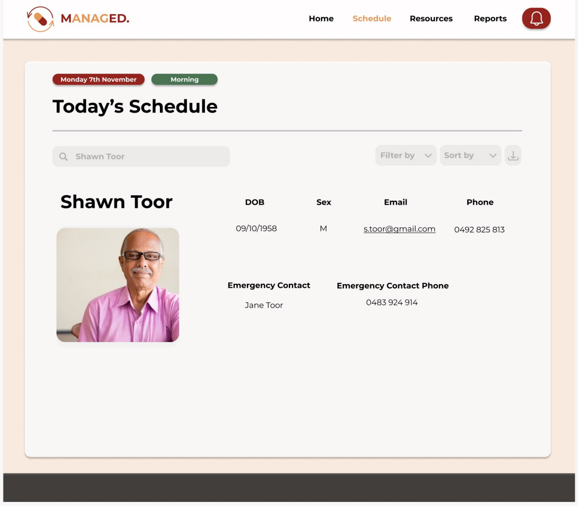
Patient Management System

2022

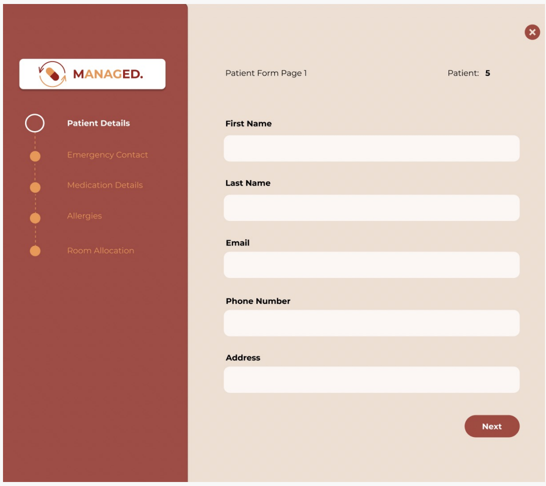
Link

Overview

Design and implementation of a Patient Management System for a fictitious nursing home. The system is displayed to a practitioner in the form of a webpage, where the practitioner can view and edit a patient's health and nutrition plans and requirements for the day. The system runs off a Microsoft Access database with authentication and access rights. The webpage is implemented using a combination of HTML, CSS and JavaScript for aesthetics as well as PHP for dynamic nature of the pages.



Patient Summary Page



Patient Registration Page

Key Skills

- Derived a matrix representation for the maze from an existing image using OpenCV.
- Graph of the maze's connected cells generated from the matrix.
- Shortest path to the goal was identified using Dijkstra's algorithm.

Notable Challenges and Solutions

Challenge	Solution
Database design to link a patient's ID to all their information and requirements.	Design of database using Third Normal Form (3NF). Appropriate use of Primary and Foreign Keys to link table information (such as nutrition requirements and allergies).
Integrating Database contents into the webpages	SQL Queries made using PHP through an ODBC connection to retrieve data from the database

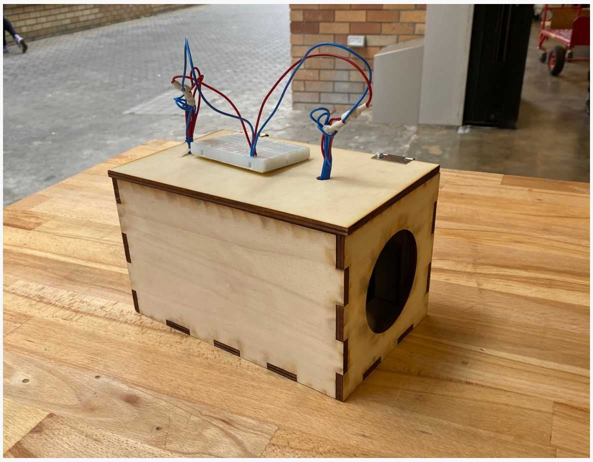
PanBox (Engineering World Health)

2022

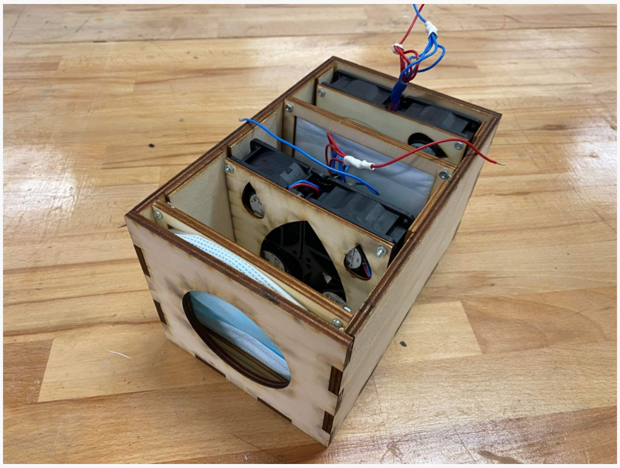
Link

Overview

A low–resource solution was developed to tackle the issue of oxygen concentrators in Ugandan hospitals being affected by the dusty environment which when entering an oxygen concentrator dramatically reduces the lifespan of the product. There are currently no solutions designed specifically for dusty environments and the filters are often hard to reach for replacement. This product is an external filter unit which reduces the intake of dust into the oxygen concentrator, thereby improving the lifespan of the product. This project was a proof of concept and focused on rapid prototyping with limited materials.



Exterior of PanBox



Internal Filter Mechanism of PanBox

Key Skills

- Derived a matrix representation for the maze from an existing image using OpenCV.
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Notable Challenges and Solutions

Challenge	Solution
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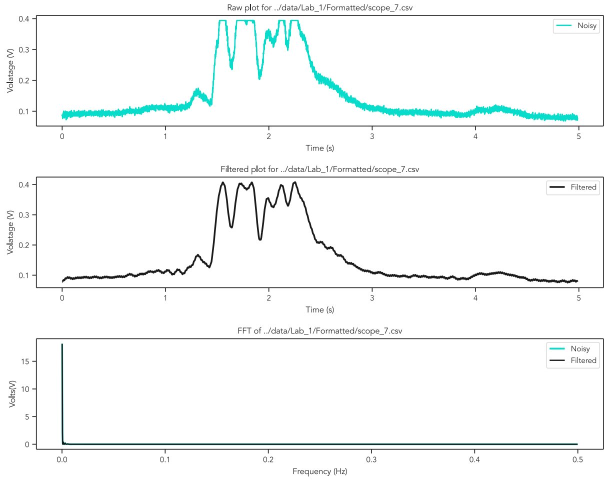
Smart Wearable Technology

2021

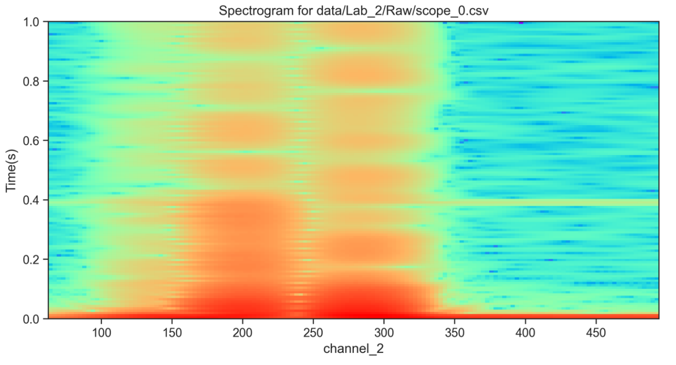
[Link]

Overview

As part of a Vertically Integrated Project (VIP) with the ChallENG Program, this project centers around using skin vibrations in the throat region to record and identify spoken words of the NATO Phonetic Alphabet. The sensors used were Piezoresistive and Triboelectric sensors. As the leader of the Software team, I developed and implemented several data visualization programs including filtering using FFT and bandpass filters, as well as using neural networks to match signal spectrograms



FFT Analysis



Spectrogram Analysis

Key Skills

- Derived a matrix representation for the maze from an existing image using OpenCV.
- Graph of the maze's connected cells generated from the matrix.
- Shortest path to the goal was identified using Dijkstra's algorithm.

Notable Challenges and Solutions

Challenge	Solution
Database design to link a patient's ID to all their information and requirements.	Design of database using Third Normal Form (3NF). Appropriate use of Primary and Foreign Keys to link table information (such as nutrition requirements and allergies).
Integrating Database contents into the webpages	SQL Queries made using PHP through an ODBC connection to retrieve data from the database

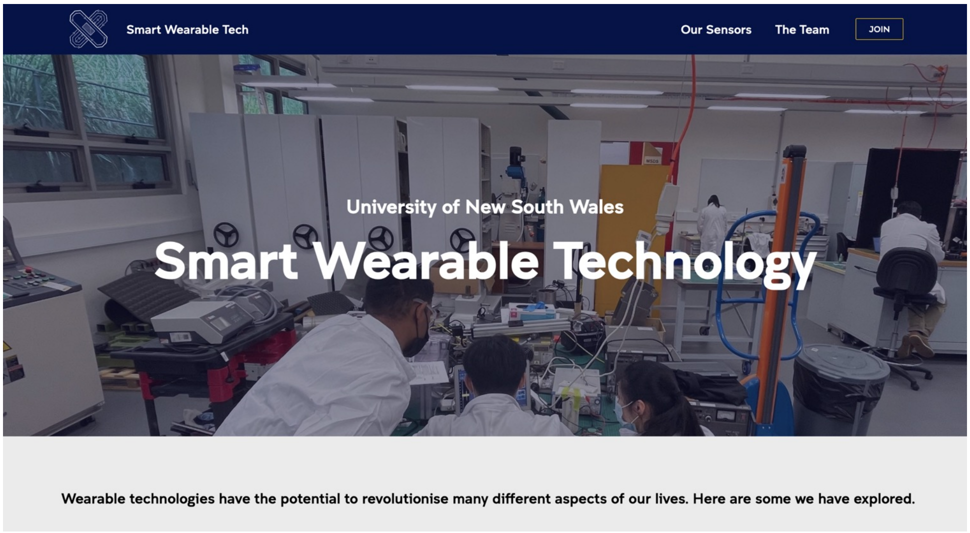
Smart Wearable Technology Website

2021

Link

Overview

During mid-late 2021 during the second Covid lockdown, a website was designed and created for the Smart Wearable Technology Project. As my first attempt at a website, React JS was used as the framework on which the website was built on. There are some minor bugs when viewed on larger screens (laptop is ideal), but most of the react components and pages are properly functioning. A link to the website can be found here.



Smart Wearable Technology Website Title Page

Key Skills

- Introduction to the ReactJS framework for creating web applications.
- Introduction to HTML and CSS for styled web pages.
- Developed skills to create logical project and file structure.
- Further experience with GitHub and the practice of conventional commit messages.

Notable Challenges and Solutions

Challenge	Solution
Database design to link a patient's ID to all their information and requirements.	Design of database using Third Normal Form (3NF). Appropriate use of Primary and Foreign Keys to link table information (such as nutrition requirements and allergies).
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Cooled Baby Seat for Overheating Protection

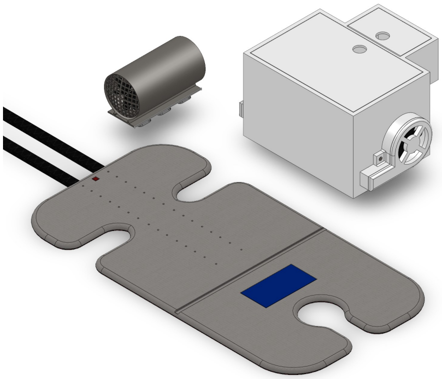
2021

Link

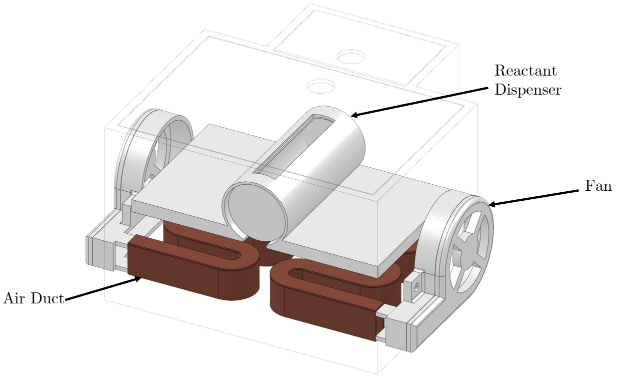
Overview

There are more than 5000 emergency incidents related to unattended children in vehicles each year in Australia. When a child is left in a vehicle, the cabin temperature can rapidly increase and quickly reach fatal levels. As such, this project aims to create a solution to this problem by introducing a functional baby seat with cooling abilities to keep the child's core temperature stable in the even of being unattended.

The working principle behind the design is to use a cooling mechanism, similar to an instant ice-pack, which would rapidly decrease the temperature of the baby seat in the event of high temperatures as detected by an NTC thermistor.



Assembly of Baby Seat



Internals of Cooling Unit

Key Skills

- Organised consistent group meetings with structured agendas and meeting minutes.
- Functional Requirement analysis to identify critical features .
- Information Axiom analysis to describe in further detail the requirements of the product
- Detailed research into temperature sensors.

Notable Challenges and Solutions

Challenge	Solution
Database design to link a patient's ID to all their information and requirements.	Design of database using Third Normal Form (3NF). Appropriate use of Primary and Foreign Keys to link table information (such as nutrition requirements and allergies).
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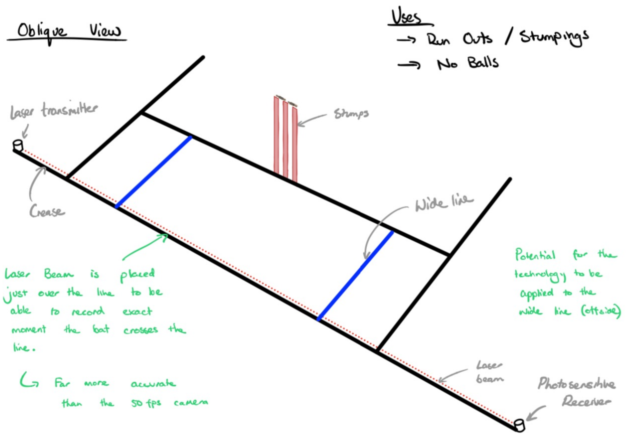
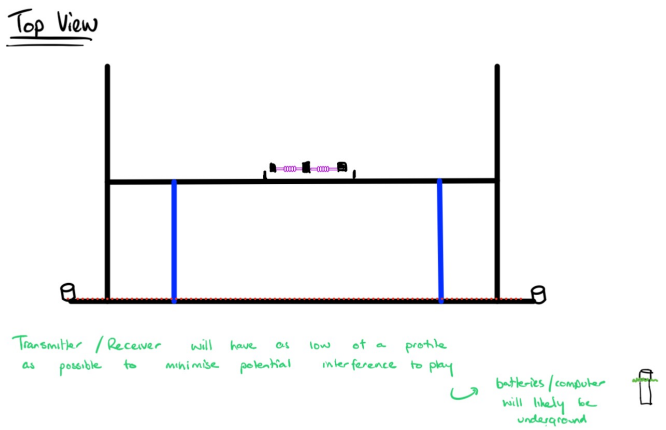
Run Out Detector Cricket

2020

Overview

A proof-of-concept project to determine whether a batsman is run out in cricket. A run out is a form of dismissal where the batsmen fails to make his ground before the opposition break the stumps with the ball. Currently, run outs are most often determined by examining camera footage which is severely limited by frame rate. Often, the deciding moment is within two frames and hence inconsistent decisions are made. This project aims to remove camera limitations from the decision making process and instead introduce a light based, electronically operated system to determine run outs. The initial prototype was made using Arduino; however, a new and faster iteration is being planned using IR LED's and phototransistors.





Key Skills

- Light detection methods (LDR. Laser diodes, Phototransistors)
- Graph of the maze's connected cells generated from the matrix.
- Shortest path to the goal was identified using Dijkstra's algorithm.

Notable Challenges and Solutions

Challenge	Solution
Database design to link a patient's ID to all their information and requirements.	Design of database using Third Normal Form (3NF). Appropriate use of Primary and Foreign Keys to link table information (such as nutrition requirements and allergies).
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Smart Pedometer

2020

Overview

As an introductory Arduino project, I designed and created CAD models for a smart pedometer. A physical circuit was also created using an Arduino UNO, an LCD and an MPU6050. Through this project, I was able to learn the basics of Arduino programming and circuitry, as well as an introduction to CAD using Fusion 360 and basics of I2C communication. This pedometer could distinguish with relative accuracy the difference between walking and running and informed the user on their progress towards a daily goal of 10,000 steps.

Front of Pedometer Housing

Side View of Pedometer Housing

Key Skills

- Fusion 360 to model the casing for the pedometer.
- Building prototype on a breadboard with jumper wires.
- I2C Communication Protocol.
- Interface Arduino with sensors (MPU6050) and modules (LCD).
- Verification and Validation using a series of real-world tests to test accurate step counting and rejection of false positives.

Notable Challenges and Solutions

Challenge	Solution
Gyro Drift made MPU6050 measurements more inaccurate over time, leading to incorrect and unstable readings.	Read gyro values for the first 10 seconds of operation with the sensor laying flat, calculate approximate rate of change and compensate by adjusting readings by scale factor.
Defective LCD screen on first attempt.	Various debugging techniques, both software and hardware, including adjusting potentiometer, checking solder connections and reinstalling libraries. Once all failed, it could be determined the unit was defective. Replacement worked fine first go.
Sketching and Dimensioning in Fusion360 to create custom geometries.	Learned basics of parametric design, including sketching, fileting, mirroring etc.
Finding appropriate thresholding values for an accurate step count between running and walking.	Experimented with a variety of threshold values for IMU measurements, narrowing the threshold until sufficient accuracy.