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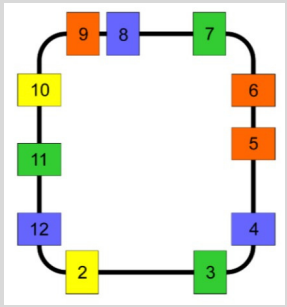
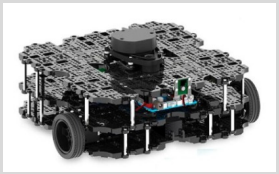
Mail Delivery Robot





What?

Developed a control system based on the bayesian localization techniques to deliver mail to arbitrarily chosen offices (coloured and numbered nodes) on a closed loop path, starting at an arbitrarily chosen initial location.

How?

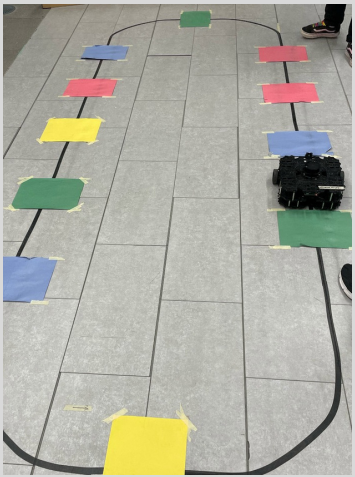
Using ROS (python) to program the turtlebot the following we implemented:

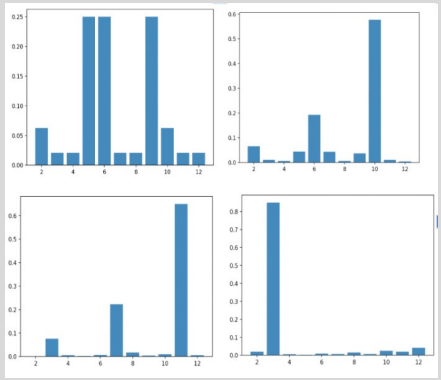
- Used Turtlebot's front camera to detect colours and lines and implemented PID controller to achieve line following when black line is detected
- Matrix multiplication between the state model and probability array resulted in the prediction model
- The state model was updated by computing the Hadamard product between the state prediction and measurement matrices.
- If the node was a delivery node and confidence was above 80%

z_k | $x_k \sim$	blue	green	yellow	orange
blue	0.60	0.20	0.05	0.05
green	0.20	0.60	0.05	0.05
yellow	0.05	0.05	0.65	0.20
orange	0.05	0.05	0.15	0.60
nothing	0.10	0.10	0.10	0.10

```
[[[0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
  [1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
  [0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
  [0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
  [0. 0. 0. 1. 0. 0. 0. 0. 0. 0.]
  [0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
  [0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
  [0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
  [0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
  [0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]]
```

measurement and state model





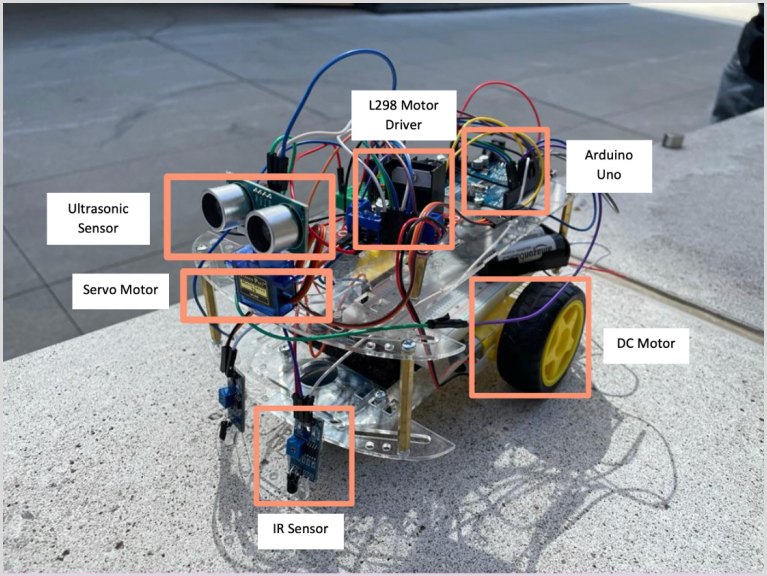
Convergence of state predicition

Result?

the robot was required to start at office 12 and stop at offices 9, 8, and 3. The state prediction converged by the time the robot had traversed the first half of the map, meaning at first it passed office 3 due to low confidence, however, stopped at 8 and 9. In the second round of traversal, the robot stopped at office 3.

ROS code: GitHub Link

Autonomous Mini-Car with IR and Ultrasonic Navigation



What?

Developed an autonomous mini-car with precise line following and obstacle avoidance capabilities. Implemented "Fancy Bang-Bang" control algorithm, compensating for motor and wheel limitations. Utilized C++ programming with modular code organization and sensor integration.

How?

Achieved smooth line following using IR sensors and "Fancy Bang-Bang" algorithm. Enabled obstacle detection and localization with an ultrasonic sensor and a servo motor for point cloud generation. Implemented path selection logic for unobstructed navigation

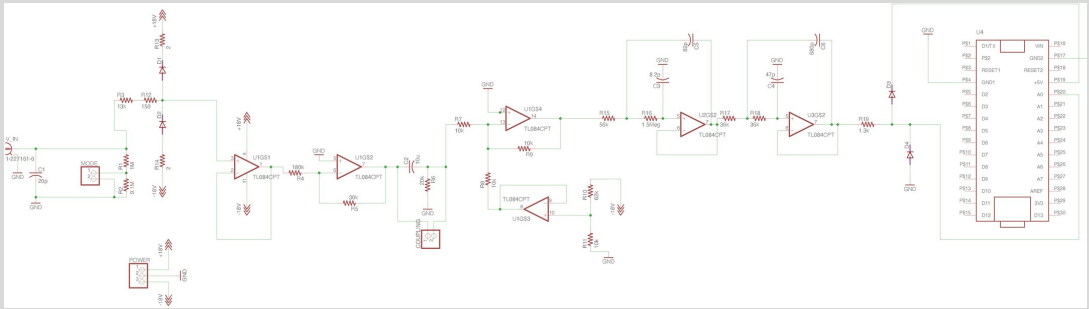
Result?

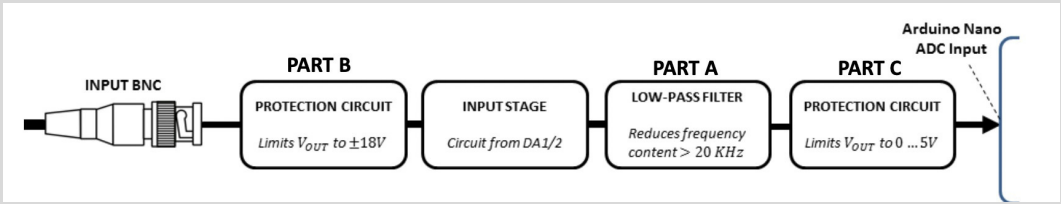
Created a reliable mini-car capable of navigating complex paths and handling obstacles. Reduced motor oscillations, ensuring smoother line tracking, even with motor and wheel limitations. Validated system performance through comprehensive testing and fine-tuning. Demonstrated expertise in C++ programming, modular code design, and sensor integration.

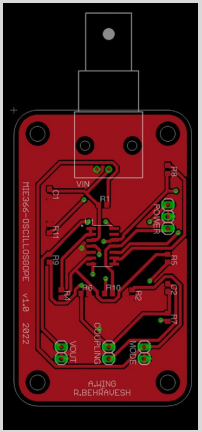
Demo Link: Big Bang Racer Demo

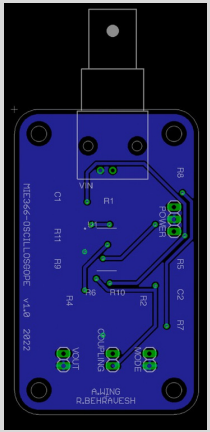
Code: Big Bang Racer Code

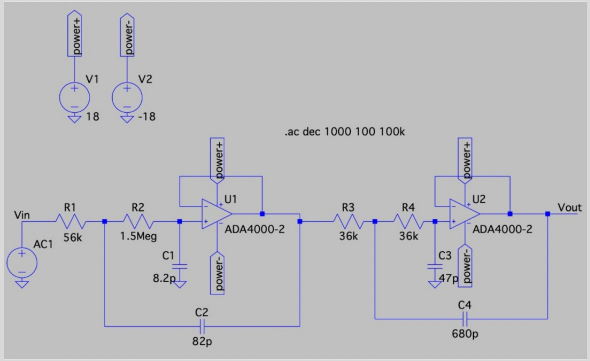
Oscilloscope Design - Electronics for Robotics











What?

designed the circuit and PCB layout of a front end of an externally powered oscilloscope that allows two input ranges (1x and 10x modes), attenuates content frequency above 20 kHz, and allows AC/DC coupling.

How?

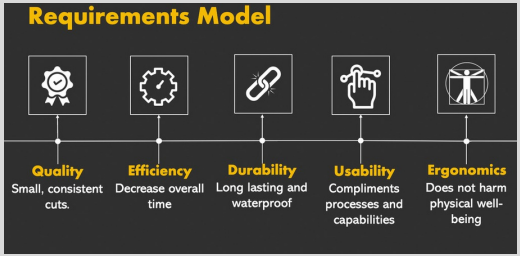
Using low pass filters, adders, buffers, and SPST switches, the circuit was simulated on **LTspice**, then transferred to **Autodesk Eagle** where the PCB layout was created using surface mount method . The low pass filter was designed using analog **Analog Filter Wizard**.

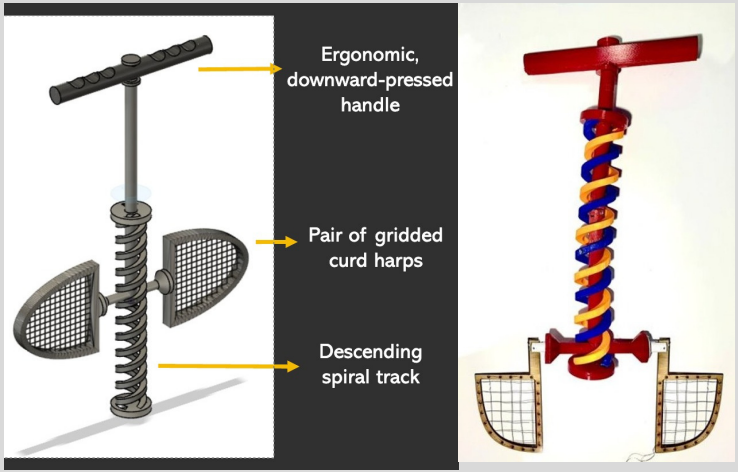
Results?

The circuit was simulated on **LTspice** and the circuit successfully modeled the intended outputs when switched between the two modes and AC/DC coupling.

Recieved a 97% on the Assignment

The Curdinator - International Design Project





What?

Developed and prototyped a design to improve the curd cutting process of an artisanal cheese maker in Thailand

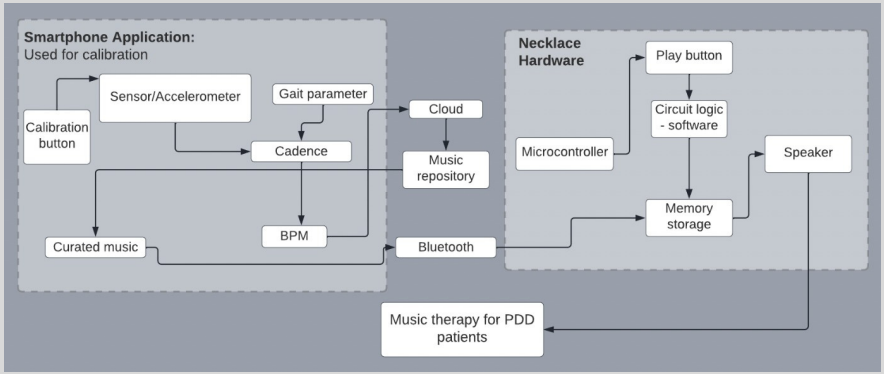
How?

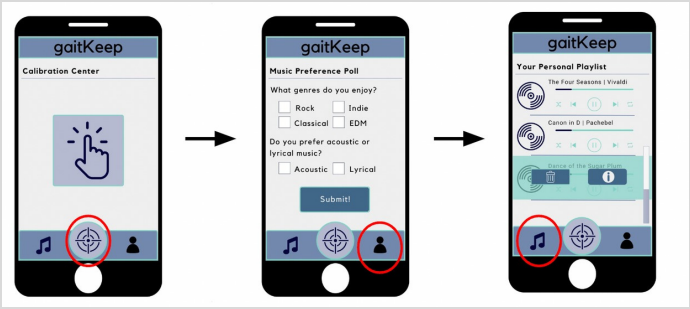
- Developed a requirement model to ensure correct design decisions are made
- Developed CAD model using **Fusion360** 3D printed and Laser cut components to prototype design
- Verified functionality through testing and verification process

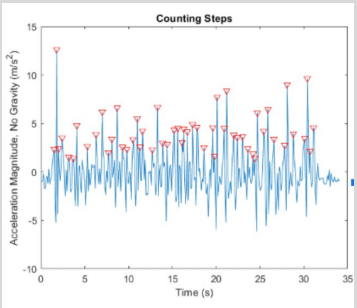
Results?

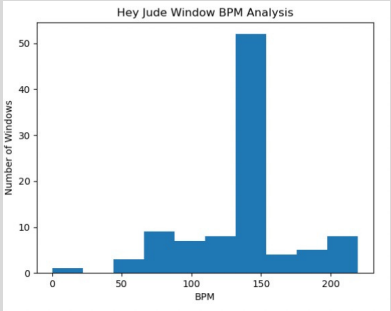
The design achieved the requirements and passed the validation and verification steps

GaitKeep - Biomedical Engineering Competition - 3rd Place









What?

Developed and proof of concept prototype to decrease gait variability in parkinson's dementia patients

How?

Using Rhythmic Auditory Simulation which is shown to improve cadence in medical research

- designed and prototyped a necklace with a built-in speaker integrated with a phone app
- the app serves to calibrate the necklace by identifying what cadence the user walks at using a short walking test of 100 steps
- Used MATLAB script to determine optimal walking cadence by collection accelerometer data from phone
- Using Python BPM algorithm and discrete wavelength transform WAV files to match music with user cadence

Results?

Ranked 3rd place at the University of Toronto CUBE biomedical engineering competition