SOEN 422 EMBEDDED SYSTEMS

IMMEDIATE RESPONSE VEHICLE

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PROBLEM DESCRIPTION

As there are many local fire departments in the busy city of Montreal, we would like to address the problem where fire trucks have to maneuver through difficult paths in traffic to get to the targeted danger zone. One of the biggest issues is that there is no way to clear traffic in advance of the fire truck moving. In a situation where every second matters, the need for a quick response, clearance, and effective path for transit is key, especially for fires.

PROPOSED SOLUTION

- Two beacons, representing two locations (fire department and targeted danger zone), will signal the local fire department's vehicle if a fire is detected.
- When a fire is detected, the targeted danger zone updates its status on a cloud database (Ubidots).
- Danger zone residents will be notified of fire and fire department status by email.
- The fire department is notified of the incoming status of the targeted danger zone, causing a red LED to light up, and a vehicle will drive along the road (black tape).
- If an object on the path is detected, the car will stop and trigger a buzzer until the path is clear for the car to continue.
- When the car arrives on site, it activates its fan to rid the hallway of smoke, making the path clear for firefighters to enter.
- There will be a manual override mode that allows a user to control the car with their iPhone (Bluetooth app) for easy maneuvering at the location .

COMPONENTS

DEVELOPMENT BOARDS + DRIVERS

2X TTGO LoRa32, 2X SN754410 Quadruple Half-H Driver
(Powered by 5 4.5-6.5 V battery & AA Batteries respectively)

SENSORS

Two IR Sensors (Detecting Black Lines)
Fire Sensor
Ultrasonic Sensor (Detecting Objects)

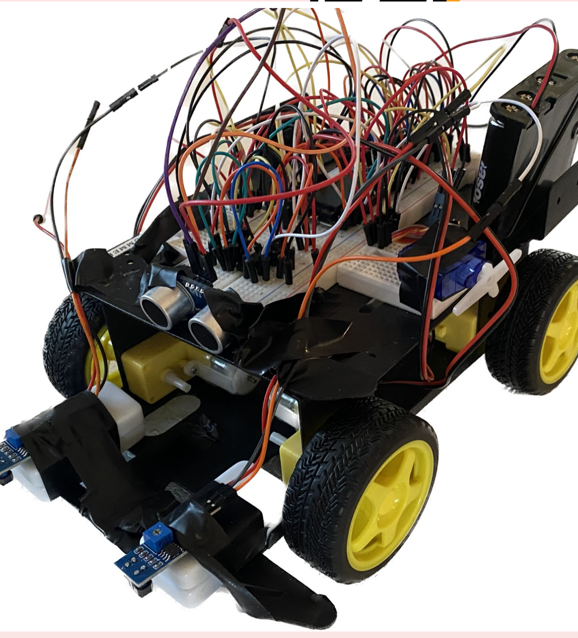
ACTUATORS

4 Servos (4 wheel drive, wheels designed to be synchronized)
Buzzer (Upon detecting objects)
Servo (Fan)
Red LED

POWER SUPPLY

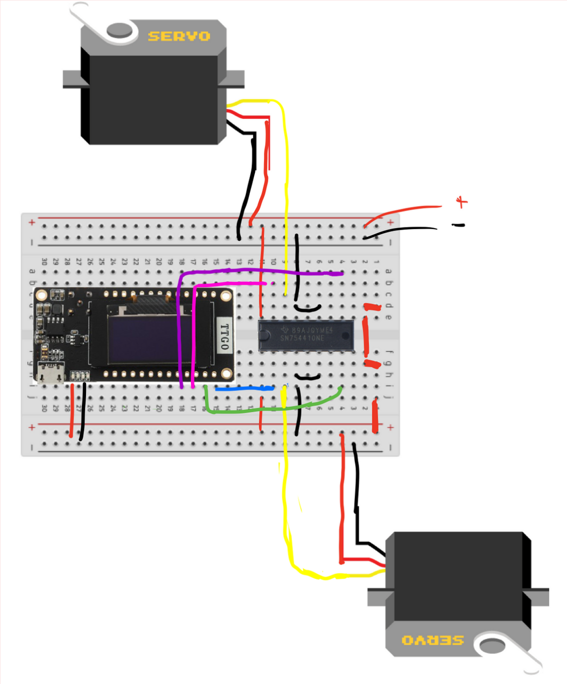
5 AA Batteries (4.5-7.5V) and a portable charger (5V)

OUR VEHICLE

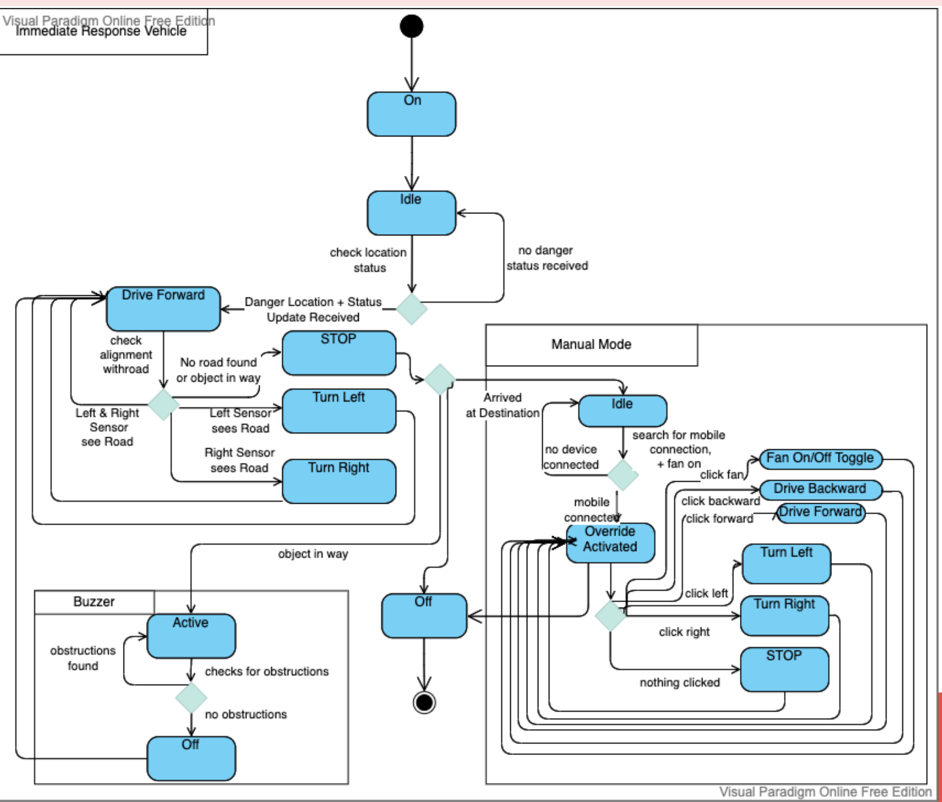


LESSONS LEARNED

- **Always Read Specification of Components** (i.e. working voltages, analog / digital pins, compatibility for different components).
- **Importance of Testing**: We created small test files in which we ran code for each of our sensors / actuators and in a isolated form before putting them on the vehicle. We also tested alternatives of our prototype in multiple phases and made changes based on test results (i.e. using ultrasonic vs IR to direct vehicle).
- **Importance of Good Design Practices and Teamwork**: We initially determined our requirements as a team and designed the use cases and steps together. This helped build a team bond and all of us have a good understanding.
- **Importance of Addressing Issues related to cyber-physical systems**: We had a lot of ideas in theory made sense (i.e. code was able to be written); however, the actual result didn't end up working (i.e initially, we want to use ultrasonic to determine vertical height of objects up close). So, it is important to understand how realistic and what real life conditions would affect the results especially when it came to synchronization.
- **Optimization for Performance** (speed, acceleration on turns, weight): We had to consider a lot of physical metrics to allow the car to move efficiently. For example, we adjusted a lot of our delays for sensors, limited weight of battery packs / chassis , and controlled max speed for turning voltages.



SETUP FOR FRONT-WHEELS (SIMILAR FOR REAR-WHEELS)



FINAL PRODUCT

Our vehicle was built upon the bottom half a chassis (due to the weight force required to turn) and operated smoothly along the black path on the poster boards. Jumper wires were used to connect all the actuators and sensors to the TTGO and synchronize the 4 wheels with our microchips along the breadboards. A 5V portable battery was used to power the TTGO with its sensors/actuators, while the 2 drivers / 4-wheel drive used 5 AA batteries to power the drive independently (4.5-7.5 V range, as our drivers/microchip supports 4-36 V only). We also ensured our sensors were measuring at accurate distances (2.5-10 cm for IR, and 15 cm for Ultrasonic) after multiple testing in working ranges. We adjusted our car to evaluate the turning with IR sensors with a small delay due to fast readings causing the sensor to be overwhelmed; however, we successfully allowed the vehicle to read and move at a good speed.

DESIGN: STATE CHART DIAGRAM