SAN FRANCISCO STATE UNIVERSITY
SCHOOL OF ENGINEERING

Team K.I.A
Road Safety Control System for Autonomous Car

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Overview

- Road Safety Control System for Autonomous Cars
    - Our initial plan for this projected consisted of building multiple intelligent autonomous cars that communicate between each other. This meant that the cars had to be connected to each other in some way. There were two main tasks that we were trying to complete, 1)Smart Launch Control, 2)Smart Lane Merging.
- Motivation Behind Project
    - The motivation behind this project came from various different reasons. One reason was the freedom that autonomous vehicles bring the to people. Being able to have the car drive itself and maintain a high safety standard while on the road is the next step in vehicles.
    - Yet our focus was centered towards a higher goal which was safety. We wanted to show that it is possible to have vehicles that can perform safely when given full autonomy. Our initial joke to this was “we’re giving autonomy to cars so we can text and get from point A to point B safely” and to some extent yes this was true but, I guess, the most intriguing part of this project was the actual communication that handled the safety not so much the freedom of autonomy.

Project Design

- Initial Thought Process
    - Before we could even purchase the components we would need, we had to think of how our project would work. We had an initial concept of how it should work when we first proposed it but had no clue of how we could actually implement it.
    - Starting from the beginning we had to choose between building an RC car from scratch or buying an RC car and try to see how much of it we could scrap and use. We decided to purchase the RC car and salvage as much of it as we could.
    - Second, we had to decide what we were going to use for the communication. This led us to choose between two components, 1) Bluetooth Module 2) Wi-fi Module. Initially we had chosen to do the project using bluetooth module but later changed it to using the wi-fi

module because working with the bluetooth module proved to be too difficult.
    - For our wi-fi module we went with the ESP8266 NodeMCU 1MB because of its extensive capabilities.One thing great about this module was the extensive I/O Pins that it offers besides the usual RX/TX pins. This meant that we had more choices as to how we used the module.
    - We needed something that would be our detection. We initially thought we could implement both IR sensors and an Ultrasonic Sensor to serve as our detection modules. It turned out to be a little too much so we scrapped the ultrasonic sensor and kept the IR sensors.
    - For the IR sensors we had to think of a way to arrange them in a way that detection could happen at either the left, or right side, as well as detection in front of the vehicle.
    - Consideration was done to adding IR sensors to the back to detect proximity from the rear of the RC but we did not end up attempting this.
    - We divided these tasks between each group member. One member took care of researching the communication through the wi-fi module, another researched how we could use the IR sensors and the third member researched our big-brother camera concept and image recognition.

- <u>Design Implementation</u>
    - Implementing the design was not that difficult, but it did involve several steps before actually implementing everything together.
    - We needed to find out how everything would work. Our initial step in the design implementation was taking the RC vehicle apart and removing anything we didn't need. Since the RC car was purchased most of the mechanical design for it was already there, we just had to figure out how transfer our new design into our old design.
    - Our next step was debugging each individual component and test out how it worked. We needed it to work a specific way in order for the vehicle to function properly with the Tiva C Launchpad.
    - The reason we opted for individual debugging of our components is because there was no possible way to understand how our project was working, without properly understanding how each component acted individually.

- After individual debugging of the component we started putting them together and debugging them by pairs. What I mean by pairs is we were debugging the wi-fi module with the IR sensors, while we were also debugging the wi-fi module with our H-Bridge, which controls our wheels.
- It is in this step where we started implementing interrupts. Once we understood the communication of things, we needed to work on their functions. None of the debugging up to this point has been done with the RC car, everything has been done using a breadboard and some LEDs that simulate our RC functions.
- After the debugging process it was time to start testing what we had with the actual RC cars.

Project Implementation

- It is important to connect the wires to correctly.
  - Left IR Sensor output to PD0 Tiva
  - Right IR Sensor output to PD1 Tiva
  - 5V output from Motor Driver to VBUS
  - Ground Motor Driver to Microcontroller Ground (Important)
  - PF2 Tiva to Clockwise Motor Driver input
  - PC6 Tiva to IN3 Motor Driver
  - PC7 Tiva to IN4 Motor Driver
  - PA5 Tiva to D5 Wifi Module
  - PA6 Tiva to D6 Wifi Module
  - PA7 Tiva to D7 Wifi Module
  - PE1 Tiva to D8 Wifi Module
- The power for the whole system is manage by L298N H Bridge, L298N has a build in 5V regulator that can be use when we supply power less than 12 to the chip. Using 5V and ground to power both Tiva C and ESP8266 wifi module.
- Battery power are made of 6 of 1.5v-AA-Battery. Connect into series which give a total of 9V. This 9V then feed directly to L298N H bridge.
- We use 4 pin from esp8266 connect to Tiva C which receive the signal as the interrupt for 4 commands: Straight, Left, Right, Brake/Backward.
- Total of 3 Infrared sensor are connected directly to Tiva C. Two of which are attached on the side to detect the road, and the other one is directly in the front to detect the obstacle.

- The traffic light are build from ESP8266 with with 3-LED connected in series with 220 Ohm resistor which we program to be able to control through local network.

Components

- Wires
- 3 x Tiva TM4C123GH6PM Launchpad
- 3 x ESP8266 NodeMCU 1MB Flash Wi-fi Module
- 3 x Dual H-Bridge DC Stepper Motor L298N Drive Controller Board Module
- 9 x IR Sensors/Blasters (3 per vehicle)
- Keil uVision IDE
- Python IDLE
- DC Motors - 4 for each RC used
- Batteries
- Electrical Tape
- Soldering Iron
- Recommended Equipment for Debugging
    - Resistors
    - Breadboard
    - LED’s

Team Member Roles

- Ivan
    - Researched the wi-fi modules and how communication can be established through it. This meant having the modules either transmit data or transmit signals to the Tiva C Launchpad.
    - Debugging of the IR sensors with the Tiva C Launchpad.
    - Signal Communication from Wi-fi Module to Tiva C Launchpad.
    - Manage project demo/presentation.
- Abdi
    - I provided the materials necessary for this project.
    - Lead Hardware Engineer
    - Lead Software Engineer
    - Stayed up all night
- Korkarn

- Established connection from the esp8266 wifi module to the Tiva C launchpad which would take a command from COM port making the esp8266 act like a server which is able to take commands from local network.
- Soldering the necessary connection on cars, wifi module, battery and Tiva C together.
- Writing code for controlling the car through Computer using Python.
- Creating a power management system which enable the car to be power from only the battery with no external power.

Results

- Our initial goal on this project was to build 3 autonomous cars that were able to communicate with each other and handle safety protocols. Up to this point we have been able to implement everything successfully except the mapping of our vehicles. The equipment that we had available to us was not up to par with what we needed it to do therefore we had to postpone the mapping. On the other hand, we were able to successfully implement the vehicle functions properly. The RC cars are still able to communicate with each other but so far we are lacking the coordinate communication between them, The cars are able to be handled in three different way, only two of the ways have been fully implemented.First, the RC car is able to function solely on the IR sensors without the wi-fi communication. Second, the RC car is able to function with the wi-fi module signals. This means that the wi-fi module can interrupt the signal of the IR. In this second way we are able to control the RC car remotely using a GUI with embedded commands. Third, the car is able to communicate with each other through a coordinate mapping system through an overhead camera. This last step is not fully implemented. Like previously mentioned, we have been able to successfully tag the vehicles for image tracking but our camera does not support a wide range view therefore our space is limited. With this limited space we were not able to fit all vehicles properly.

Project Discussion

- **Sustainability**
  - Is this project sustainable? For this project our main focus was not so much the sustainability of it, we focused more on the task that we wanted to

accomplish. This is not to say that our project isn't environmentally friendly, we in fact do no damage to the ecosystem. One factor that greatly affects our sustainability are out batteries. The amount of components that we are using for this project consume too much energy, this gives our project a very short battery life span.

- **Social and Political Constraint**
    - This project relies highly on data communication this means that data has be gathered constantly and sent in real time in order for the system to function properly. This creates a huge privacy issue in the sense that even though the system is not sending any personal information out, it is sending geographical information. This can be seen, for some, as an invasion of privacy.
- **Economic Constraint**
    - Monetarily speaking this project was not that costly considering that we built 3 models, so we spent an average of $100 per car. This amount also includes extra parts for replacements, wires, debugging material as well as shipping costs. With the knowledge we gained while implementing this project we are certain that we can drop the cost down.
    - The amount of power this system uses would require the use of a better performance battery system. This means a more expensive type of battery.
    - The build of the project is not time consuming and can be done if a matter of 2 hours. This implies a lower labor cost.
    - The biggest economic issue the project faces is the battery performance.

Conclusion

- The project was very difficult to maintain in a stable environment because the many different uncontrollable variables. The battery was the biggest issue that we faced. When it came to debugging the vehicle we used a lot of power, we ran through a lot of batteries. Unfortunately when we presented our project we didn't get any recording of the functions of it. We were able to add videos of the debugging process.
- Even after the final presentation of the project we were still facing issues with power. Since we use many batteries to power the entire system, we need to constantly get new batteries, something that at the current moment sets us back.