Pulsar the Yellow Canary: An Environmental Monitoring Exploratory Vehicle

CAL POLY POMONA

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Authors: Ayman Jabri, Carson Umsted, Lin Kaung, Steven Lee, Salayman Sales, Francisco Trigueros
Advisor: Dr. Toma Sacco

Abstract

Locations can be hazardous or sometimes difficult to enter. To ensure safety, people want to gather information to determine if it is safe to enter without endangering human lives. Performing a similar purpose as the yellow canaries used in early coal mines, our prototype vehicle's purpose is to determine whether or not the conditions are survivable. By creating a vehicle capable of live video surveillance, GPS tracking, and analog temperature sensor data, our group could demonstrate the potential and usefulness of the device. Although it does not provide all necessary data to ensure health, the vehicle can be easily adapted to make use of more sophisticated sensors. This is meant as a demonstration of the ability to use multiple data sources and relay them to the user. As a group, we were successful in completing the project and exhibiting the potential for expansion. Although there were some areas where hardware optimization could be improved, the project was successful in its mission.

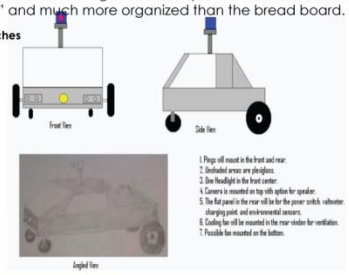
Design

The goal was to make a solid, tough, and versatile body design that would be able to traverse tough terrain and survive harsh environments. The sketches below represent our initial designs for the construction.

For the vehicle to perform its functions, we used both an FPGA and microcontrollers, which communicate through an XBEE RF Module. The camera transmits its data using its built-in 2.4Ghz RF transmitter which is received through another module connected to the host computer. The Graphical User Interface (GUI) responsible for displaying the data and allowing user input was developed using Microsoft Visual Studio. The GPS data is automatically inputted into Google Maps and the satellite imagery is displayed in the GUI. In addition, 4 ultrasonic PING sensors are used for object avoidance.

In our design of Pulsar, the Yellow Canary we designed a printed circuit board to fit all of the sensors we are using in our design instead of using bread boards, which can be very unorganized. We decided to use PCB because it's more reliable since all the wires are using will be soldered as opposed to the bread board where wires are inserted and we run the risk of the wires disconnecting. We also decided to use a PCB board because the size is a lot smaller than a bread board. To give an example the bread board is 8" x 10" the PCB we designed is 5" x 7" and much more organized than the bread board.

Figure 1. Initial Sketches



Components

1. Object Avoidance Sensor Operation
2. GPS
3. Xbee (For Wireless Communication)
4. PIC Microcontroller Integration
5. FPGA Integration
6. GUI (Graphical User Interface)
7. DC Drive Motors

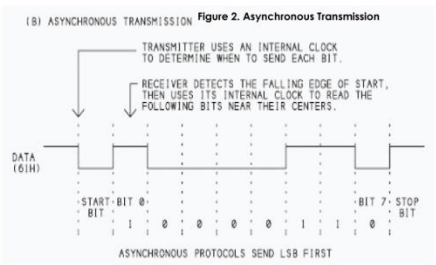


Figure 2. Asynchronous Transmission

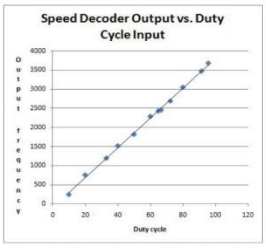


Figure 3. Drive motor speed decoder output

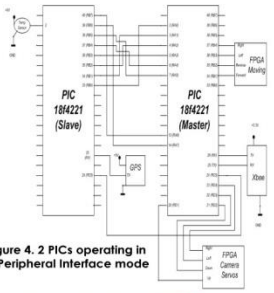


Figure 4. 2 PICs operating in Serial Peripheral Interface mode

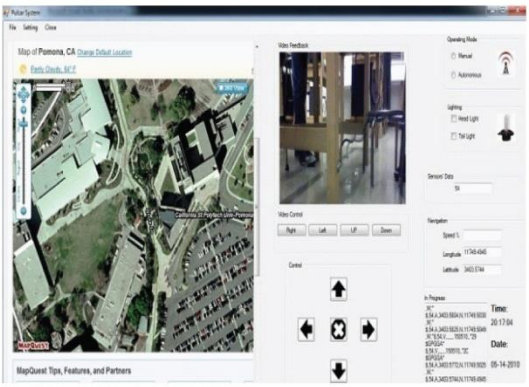


Figure 5. Graphical User Interface (GUI)

Figure 6. The Yellow Canary

Conclusion

- The project was a success because we were able to meet the overall vision we set forth in designing and constructing a vehicle capable of providing data about its environment. This project allowed us to make extensive use of the skills that we have acquired in all of our different electrical engineering courses such as: digital signal processing, control, radio frequency communication, power, and digital hardware design.
- Some other skills we learned on our own include PCB design, mechanical design and software engineering.

Future Development

- In the future, we would like to implement an autonomous mode where the user can input GPS coordinates and the vehicle will travel to that destination on its own.
- In addition, we would also like to improve upon the body structure by using lighter material to reduce the overall weight and improve the overall battery life.
- We would also like to implement more sensors to furthur demonstrate the vehicle's ability to relay useful information about its environment.