MRSD Project Course Assignment 12

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# Problem Statement

Our team ‘AutoPirates’ is working with NREC to develop an autonomous water taxi. We would be developing perception algorithms (to detect the obstacles) and path planning algorithms (including obstacle avoidance). There would be some cases (especially in the initial phase of development) where our perception algorithm will fail to detect the obstacles or our path planning will fall to avoid the obstacles. In these cases, if the users of the boat (right now the development team) fail to notice the obstacle (like if they are distracted) then the boat can collide with the obstacle. This can cause heavy damage to the boat or the obstacles. So, to prevent this we need a visualization other than simulator running on our laptop to tell us if the obstacle data is near. This will help us in debugging our algorithms to certain extent.

# Solution

We are designing a device called ‘AlertPirates’ which is essentially a new visualization/alarm system of our autonomous water taxi. The system will indicate when obstacles are near to the boat using red LED and a sound alarm. If there are no obstacles in the range of boat then it will show the status with green LED.

The device would be receiving data of obstacles from the perception algorithm running on the laptop. This circuit would be built using ATMEGA 328 microcontroller with Arduino bootloader which will receive serial commands from ROS (ROS topic will publish obstacle presence for Arduino).

# Parts Used

|  |  |  |
| --- | --- | --- |
| S.No | Part | Quantity |
| 1 | ATMEGA 328 | 1 |
| 2 | 16 MHz Crystal | 1 |
| 3 | 33 pf capacitor | 1 |
| 4 | FT232RL | 1 |
| 5 | USB Mini Connector | 1 |
| 6 | LED’s | 3 |
| 7 | Resistance 220E | 1 |
| 8 | Resistance 10K | 1 |
| 9 | Resistance 1K | 1 |
| 10 | Capacitor 0.1 uf | 3 |
| 11 | Capacitor 4.7 uf | 1 |
| 12 | Capacitor 10nf | 1 |
| 13 | Ferrite Bead | 1 |
| 14 | Reset Switch | 1 |
| 15 | Connector 4x2 | 1 |
| 16 | Transistor BC547 | 1 |
| 17 | Buzzer | 1 |

# Analysis

1. ATMEGA 328 TQFP: Though we are connecting very few peripherals to the microcontroller (2 LED’s and a buzzer) so we would be having very less processing for microcontroller. In this case something like ATTiny or ATMEGA 8 would have been a better choice. But, our device would be communicating to laptop through ROS. It will need some heavy header files to be stored (328 has 32k flash), so we selected 328 to be on the safer side. TQFP package is compact, power efficient and relatively easy to solve.
2. FTDI 232RL: This is a USB to serial convertor. The communication between device and laptop would be using USB 2.0 protocol which is more than sufficient for us (we would be using 115200 as the baud rate)
3. Ferrite Bead: A ferrite bead is connected in series with the USB power supply to reduce EMI noise from the FT232R and associated circuitry being radiated down the USB cable to the USB host.
4. Capacitors in circuit (Power): 4.7uf with power supply handle low frequency ripple, input noise and major output load changes. 0.1f capacitors will handle noise and fast transients.
5. BC547: It is NPN transistor which we need to amplify the current for the buzzer. Microcontroller might not be able to provide entire current if we don’t use NPN transistor.
6. Connector (4x2): This connector will allow us to upload the bootloader on ATMEGA 328.
7. Power: We would be providing the power only through USB (mini connector) and we want the circuit to be compact, which is why we haven’t used over voltage/reverse polarity projection.

# Mounting circuit on boat

We have 4 holes in the PCB which will help us in mounting the circuit. We are planning to 3D print an enclosure into which the PCB would be outfitted using 4 screws. The enclosure will have an opening for the USB connector/cable. We are also planning to print the top part of the enclosure using transparent PLA material so that we would able to the color of LED’s which tells us the status of boat/obstacles. The 3D include would be mounted on one of the walls/sides of the boat near to the platform where have our processing unit.

# Links to FreeFDM Results

1. <https://www.freedfm.com/freedfm/0024819104267794/results/summary2.htm>
2. <https://www.freedfm.com/freedfm/0024819104267794/results/plots.htm>