RC Car Alert and Detection System

Mock Design Review Document

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1 Introduction

1.1 Objective

Often, as a user of an R/C car is enjoying driving, the radio signal from the controller may fall out of range as the car drives away from the controller. When the R/C car falls out of range, the R/C car will no longer move and the controller must either walk in the direction of the car, assuming they know where it is, or must go find the car. This problem can lead to user frustration in the event that they lose sight of the car, or that they must retrieve the car in order to operate it again.

Our proposed solution is to implement a range detection and alerting system for the user. The system will determine when the R/C Car nears the end of its range and will alert the user at that time. This prevents the user from unknowingly letting the R/C car out of range. Additionally, the detection system will be able to determine the direction of the car such that the user knows where to retrieve it from if they do drive the car out of range, or which direction they must drive it such that it comes back in range.

1.2 Background

This project is important because it allows for the user to have more knowledge about the vehicle while still maintaining control of the vehicle. When Professor Oelze pitched a similar project with an R/C boat, we identified a few feasibility issues with his project and modified it to allow for it to be more feasible. While an R/C boat range detection is important, it is not easily tested as there not an accessible lake nearby in which to do testing. Additionally, Professor Oelze wanted a system that would return the boat back to him if/when the boat went out of range. Although this is an interesting feature, the internal components of the R/C must be hacked and modified to allow for this to occur. Another issue we identified with this return feature was that it limited the user’s control over the vehicle and that the user may not want that function to occur.
Therefore, we modified Professor Oelze’s original pitch to adapt to the problems we observed along with what we felt was feasible. In changing the R/C boat to a car, we are able to test in more accessible areas. When we first tested the R/C car range of the R/C car we plan to implement the system on, we observed that the R/C car we purchased has a range of over 40 meters [1]. Through this, we believe that the user can easily lose sight of the vehicle and as such needs a way to understand where the car is relative to them. In implementing a system that detects the relative location of the car, it is less likely that the user will lose the vehicle and that they will have a greater awareness of where the car is.
2 Design

2.1 Block Diagram
2.2 Physical Design

Figure 2-1 shows the physical R/C Car we will be utilizing for the project. This R/C Car was chosen for its ability to remove the body off of the chassis, allowing for the electronics and battery to be installed underneath such that the system remains discrete in its implementation and operation. Figure 2-2 shows the body separated from the chassis.

For the controller, we will implement a system that can be attached to the current controller. Figure 2-3 shows the controller. The implementation will take into account the orientation of the controller in respect to the user and the size of the PCB board.
2.3 Functional Overview

2.3.1 Power Supply
A power supply is required in both the car and the controller to provide adequate power to each of the blocks and its subcomponents.

2.3.1.1 Battery
The battery must be able to keep the circuits continuously powered during use of RC car, preferably multiple uses.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The battery must be able to provide at least 160 mA at 8.6-9.2V for the duration of 1 hour.</td>
<td>1. Apply a consistent 160 mA draw against the battery for 1 hour. Measure the voltage after 1 hour, ensuring the voltage is within 8.6-9.2V.</td>
</tr>
</tbody>
</table>

2.3.1.2 Voltage regulator
The integrated voltage regulator supplies the required 3.3 V and/or 5 V to the entire system. The regulator must be able to handle the peak voltage of 9.6 V.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. The voltage regulator must provide 3.3V and/or 5V +/- 5% from a 8.6-9.2V source.</td>
<td>2. Measure the output voltage using an oscilloscope, ensuring the voltage is within 3.3V and/or 5V +/- 5%.</td>
</tr>
</tbody>
</table>

2.3.2 RF Detection
The remote signal from the controller will be received by an antenna in order to determine the signal strength using a logarithmic detector.
2.3.3.1 Antenna
A 2.4 GHz antenna is responsible for picking up the RF signal from the remote controller. It will be optimized to allow for maximum throughput and maximum range. The range will need to be greater than the range of the car itself.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. The antenna must be matched at 50 Ω +/- 5% between 2402-2484 MHz.</td>
<td>3.</td>
</tr>
<tr>
<td>4. The antenna must have a greater effective area than the car antenna.</td>
<td>a. Test the antenna with a network analyzer.</td>
</tr>
<tr>
<td>5. The antenna must be omnidirectional to within 6dB.</td>
<td>b. Verify that the impedance is within required range from 2402-2484 MHz.</td>
</tr>
</tbody>
</table>

2.3.3.2 RSSI Detector
The RSSI detector must be able to detect signals coming from the antenna at the 2402-2484 MHz range. It will be able to scale the signal logarithmically (dB) to help determine the signal strength [5].

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. It must maintain accurate log conformance for signals in the 2402-2484 MHz range.</td>
<td>6.</td>
</tr>
<tr>
<td></td>
<td>a. Connect the RSSI circuit to a signal generator.</td>
</tr>
<tr>
<td></td>
<td>b. Generate signals with frequencies ranging from</td>
</tr>
</tbody>
</table>
2.4 Schematics

2.4.1 Voltage Regulator

Figure 2-4 shows the schematic for the voltage regulator. Based on the variability of standard 9V batteries, it is desirable that the voltage regulator is able to handle the 9V battery as it discharges. Therefore, the following schematic accounts for the variability as the voltage regulator chip, LM317M, is an adjustable voltage regulator capable of handling an input voltage range from 1.25 to 37 V.

![3.3V Voltage Regulator Circuit](image.png)

Figure 2-4: Voltage Regulator Circuit
2.5 Circuit Calculations

2.5.1 Voltage Regulator

For the voltage regulator circuit, the Figure 2.5 show the base circuit. From the base circuit and the LM317M datasheet, the equation for $V_{out}$ is $V_{out} = 1.25(1+\frac{R_1}{R_2})$ [10][11]. With the $R_1 = 240\Omega$, $R_2$ must be $394\Omega$. Based on these values, the $R_1$ and $R_2$ values may be adjusted for depending on resistor value availability.

![Base Voltage Regulator Circuit](image)

Figure 2-5: Base Voltage Regulator Circuit
3 Ethics and Safety

According to IEEE Code of Ethics, “We … in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession… agree: to accept the responsibility in making decisions consistent with the safety, health, and welfare of the public…” [9]. As the primary focus of this project is to expand and build on our personal and professional careers, must uphold and remain consistent in our diligence for safety and ethical decisions. Therefore, as a team, we will ensure that we utilize proper safety precautions in the lab and during testing.

Since the car has design capabilities to potentially limit or remove the user’s control of the car, we must follow IEEE’s #2 Code of Ethics, “to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist” [9]. Therefore, the user of the car will be cognizant and aware that the car is taking in GPS signal and processing the relative location between the car and the user. Additionally, the user will be aware of the functions of the car, and that the car may operate at a range that the user is unable to see the car. In this event, there may be potential for conflicts if the car encounters another individual or object. As such, we will recommend that the user operates the car where visual contact can be maintained, or that another individual is able to maintain visual contact with the car and able to communicate back to the user when a safety risk is encountered.

By IEEE Code of Ethics #10, “to avoid injuring others, their property …”, we must be aware of the safety risks of operating a 9V battery on a moving R/C car [9]. While the 9V batteries are potentially hazardous on their own, the risks of a dragging battery are high due to the operation of the car. To aid in the safety of everyone around and using the R/C car, the battery will be securely mounted to the chassis of the R/C car underneath the body of the car. This will limit the ability to snag any wires running from the battery to the PCB board and limit the ability for the battery to be jarred off the car and dragged underneath. Additionally, the R/C car will not be operated in environments where there is the potential for a water hazard. This is due to the
limited space availability and the possible inability to waterproof the battery. Since the overall system may have exposed connections to air, and the battery is not to be wet, we do not want the R/C car to be exposed to a potentially dangerous hazard.
4 References


[4]“47950-2011 Molex | Mouser.” Mouser Electronics, www.mouser.com/ProductDetail/Molex/47950-2011/?qs=P9FOrrFf77IlZl5lQ5qJ6cQ%3D%3D&gclid=EAIaIQobChMIl9Ga2Ke31gIVVlmGCh3vZwZFEAQYBCABEgKP8_D_BwE.


