First Responder Quadcopter

Mock Design review

TA: Daniel Gardner

Team Members:
Eric Gendron gendron2
Itamar Aronson iaronso2

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1.0 Introduction

1.1 Statement of Purpose

There is currently no unmanned aircraft specifically designed to assist law enforcement or firefighters in the field. Some police departments have begun to use small drones for video surveillance but that is currently the only thing they can be used for. Our aim is to provide a system that will allow the unmanned drones to be useful in other areas than just an aerial video feed. Our initial design will include basic modules such as a camera, a thermal imaging device, and a glass breaking device. It will also provide a versatile platform allowing for more modules to be created in the future that are fully compatible with the quadcopter.

1.2 Objectives

1.2.1 Goals and Benefits

- Give police and firemen a birds eye view of any situation
- An unmanned option that can keep people out of dangerous situations
- Faster and cheaper deployment than a manned helicopter
- Provide users with a platform for interchangeable modules that can provide more assistance than standard video quadcopters

1.2.2 Functions and Features

- Camera control in every direction
- Real time camera feed
- Dual camera ability with a thermal camera
- Pay load drop
- Two-way voice Communication
- Low weight

2.0 Design

2.1 Block Diagrams

The two main parts of our experiment are the module system on the quad-copter and the controller. The module system is what sets this quad copter apart from other ones on the market. The modules included in our project are a camera, a thermal camera, and a glass breaking device. The system will also be designed in a way to allow for more modules to be designed and easily integrated into the system in the future.
2.2 Description of Blocks

2.2.1 Controller

2.2.1.1 Power Source

The power source for our controller will be a Tenergy 12V, 2000mAH rechargeable battery. The capacity on the battery will allow for the controller to operate for an hour and 43 min while powering two display screens for the camera modules, the transceiver, and the joystick controls.

The transceiver will require 400mA of current at 12V. The LCD screen will require 380mA. The two joysticks (Load1 and Load2 in figure 1) both require 0.9mA at 4.7V. There is a potential need for a second screen which will require another 380mA.

\[
T_{total} = \frac{E_{max}}{I_{max}} = \frac{2000mAh}{1163mA} = 103min = 1 hour and 43 min
\]

2.2.1.2 Power Regulators

The Two display screens and the transceiver require a 12V input voltage which is why the 12V battery was chosen. The Joysticks however...
require a maximum of 5V so a linear regulator consisting of a resistor and a Zener diode was used in order to step down the 12V from the battery to a 4.7V that the joysticks can use. The linear regulator was used over a buck converter because of the very low power draw of the joysticks. The circuit and plot of the simulation run can be seen in figures 1 and 2.

\[
I_{R2} = \frac{12V - 4.7V}{5k} = 1.46mA
\]

\[
I_{Load1} = \frac{4.7V}{5k} = 0.94mA
\]

\[
\eta = \frac{P_{out}}{P_{out} + P_{loss}} = \frac{0.94m^2(5k)}{0.94m^2(5k) + 1.46m^2(5k)} = 0.29 = 29%
\]

\[
P_{loss} = 1.46m^2(5k) = 10mW
\]

The regulators for the joysticks are only 29% which is bad for a regulator, but the power loss is only 10mW per joy stick which is negligible.

![Figure 1: Power Distribution circuit](image1)

![Figure 2: Voltage across the Load and current through the Load](image2)
3.0 Requirements and Verification

<table>
<thead>
<tr>
<th>System</th>
<th>Requirements</th>
<th>Verification</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller Power Distribution</td>
<td>1. Power source</td>
<td>1. Power source</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>a. Must provide 12VDC of power at output</td>
<td>a. Monitor voltage using a multimeter at the output of the battery for 40min and ensure that a steady 12VDC is present the whole time.</td>
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<td></td>
<td>b. Must be able to output 1163mA for longer than 30min</td>
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<tr>
<td></td>
<td>a. Must step down from a 12VDC input to 5VDC at most.</td>
<td>a. Probe the voltage across the Zener diode in the linear regulator and ensure the voltage stays between 5V and 3.3V for the 40min operating time.</td>
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</tr>
<tr>
<td></td>
<td>b. Must stay above 3.3VDC at all times during operation</td>
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4.0 Safety Statement

The power source is the most dangerous part of the controller design. If the power regulation or the battery charging are handled incorrectly it can lead to the battery malfunctioning and in some cases it can explode causing damage to the controller and potentially the user. The batteries like to see a smooth DC current output. Some voltage regulators involve rapid switching which will cause a ripple in the current. We chose the 12V battery so that there would be no need to step down the voltage for the screens and transceiver which pull a majority of the current. We used linear regulators to step down the voltage for the joysticks so there would be no switching involved. The only danger to the battery will come from the charging device.