I.F.F. (Identification Friend or Foe) System

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ECE 445 Final Report - Spring 2016

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May 4th, 2016

Project No. 11

Abstract

This piece of equipment will reliably determine the status of a target. FUCK I DONT KNOW. This project is a reliable method to determining the status of friendly or enemy soldiers during combat eee reduce the number of friendly fire or misfire accidents between soldiers on foot during combat. A “friend or foe” detection

Contents

1 Introduction

The purpose of this project is to create a system that quickly and accurately identifies friendly targets among military personnel on foot. Similar systems exist for aircraft, however not many exist for infantry.

The idea is to develop a two-way communication system so that when a soldier aims their weapon in the direction of a friendly target, they will receive notification through an LED that the target is friendly and not an enemy. Throughout this document the infantry unit with the weapon will be referred to as the "friendly interrogator" and the target will be referred to as the "friendly target".

1.1 Objectives

1.1.1 Goals and Benefits

- Reduce the number of friendly fire & misfire accidents during combat.
- Notify friendly personnel of friendly target when aiming in their direction.
- Other applications include paintball, airsoft arcade laser tag, and various recreation sports.

1.1.2 Functions and Features

- Laser transmitter on friendly interrogator to send unique I.D.
- Photodiodes on friendly target detect unique I.D. and verify its signal.
- R.F. transmitter on friendly target to send acknowledgement back to interrogator.
- R.F. receiver on friendly interrogator to verify that the target is friendly.
- LED to indicate friendly or enemy on interrogator unit with system response of less than 190 ms (human reaction time[3])

These functions and features are summarized in the system block diagram shown in Figure 1.

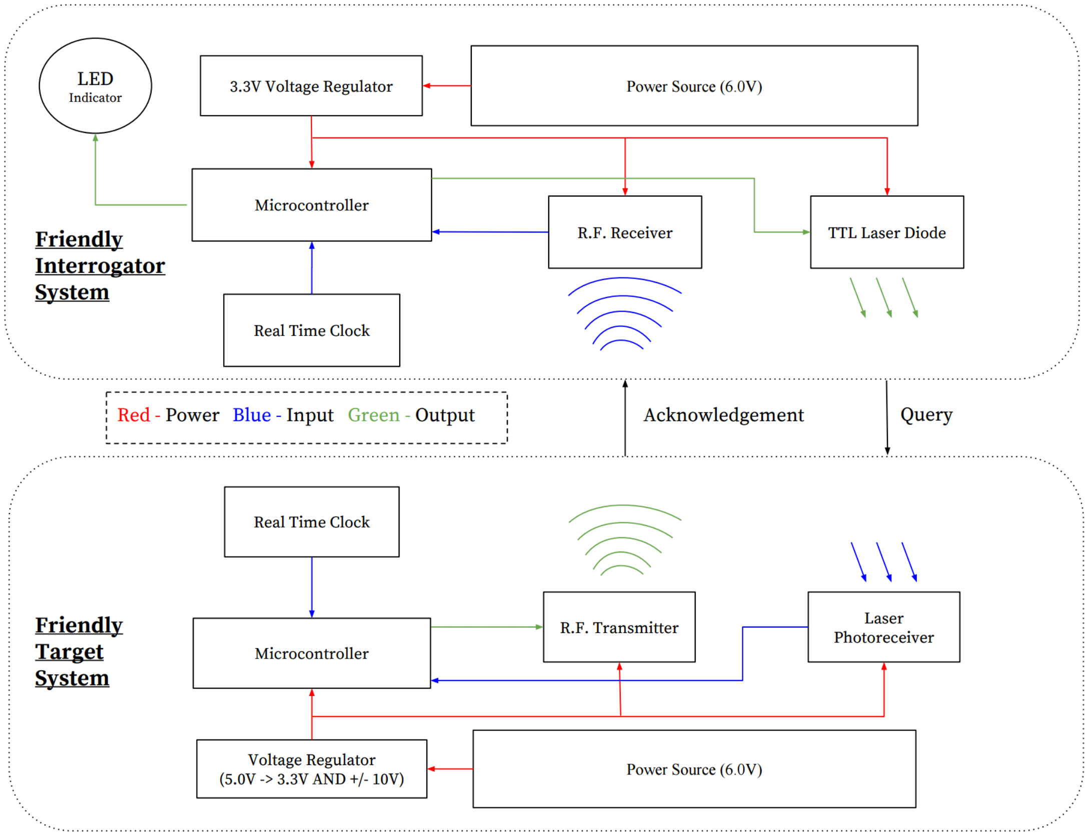

Figure 1: System Block Diagram

The two-way communication system on both units is further divided into two one-way communication channels. The laser transmitter on board the friendly interrogator will send a signal to the photoreceivers on the friendly target. The R.F. transmitter on board the friendly target will then send acknowledgement back to the friendly interrogator.

An important aspect of this project is encryption and ensuring an enemy cannot pose as friendly to the interrogator. This will be addressed in two ways. Both systems will contain a locally synced clock so that ...

1.2 System Level Requirements

Requirements are imposed on both the R.F. subsystem and the laser subsystem to accurately receive packets. From a system perspective, the requirements are as follows:

1. R.F. Transmitter/Receiver - Must be able to both transmit and receive at least 90% of 8-bit packets sent over a distance of 5 meters with a carrier frequency of 315 MHz 50 MHz.
2. Laser Transmitter/Receiver - At least 90% of transmitted laser packets must be received by the photoreciever at 5 m.

Requirements are also imposed on the system speed. These are

1. Speed of System - A friendly target at 5 m should be marked friendly within 190 milliseconds.

2 Design

2.1 Design Procedure

2.1.1 Friendly Interrogator

Voltage/Power Regulation There are strict requirements on the power module to provide at least 8 hours of a steady 3.3V output. Originally, in the design review, a 3.3V boost-converter was going to be utilized along with a single AA battery (1.5V) to supply the entire interrogator unit. This proved to be a difficult implementation For this reason,

Laser Transmitter A 5 mW 650nm laser transmitter was used for the interrogator which was placed inside of casing made out of a hollow aluminum tube. This coupled with single convex and concave lens was used d

R.F. Receiver

TODO

2.1.2 Friendly Target

Voltage/Power Regulation

TODO

Laser Photoreceiver

TODO

R.F. Transmitter

TODO

2.1.3 System

Microcontroller

TODO

FROM TEMPLATE: Discuss your design decisions for each block at the most general level: What alternative approaches tothe design are possible, which was chosen, and why is it desirable? Introduce the major design equations or other design tools used; show the general form of the circuits and describe their functions.

2.2 Design Details

2.2.1 Friendly Interrogator

Circuit Schematics

TODO

PCB

TODO

2.2.2 Friendly Target

Circuit Schematics

TODO

PCB

TODO

2.2.3 System

FROM TEMPLATE: Present the detailed design, with diagrams and component values. Show how the design equations were applied. Give equations and diagrams with specific design values and data. Place large data tables in an appendix.Circuit diagrams that are too large to be readable on a single page should be broken into pieces for presentation.The full diagram may be included in an appendix.Use photographs only as necessary and treat them, along with all other graphics except tables, as figures.

3 Verification

INCLUDE R&V TABLE IN APPENDIX IN BACK
TODO

FROM TEMPLATE: Discuss the Requirement and Verification Table from your design review. Including the table in an appendix will help avoid lengthy and tedious narrative description in the main text, which may not be of immediate interest to your imagined audience of managers. Do not discuss lowlevel requirements unless they failed to verify, or you found that they were critical in some unexpected way, or you need to makes changesfor instance, to the tolerances or acceptable ranges of quantitative results. It is important to hit the main points and explain any requirement that is not verified, but keep the discussion concise and refer interested readers to the appendix for details. Note that the design procedure, design details, and design verification can be organized in different ways. The Word template provided by the ECE 445 staff puts the first two in one chapter and the second in another; however, a separate chapter for each is also common, with chapter sections reiterating the main project components. If you do the latter, avoid unnecessary repetition of component descriptions. Another option, though rarely used, is to organize the report according to components or blocks, with each chapter describing the design procedure, details, and verification for a single component or block.

4 Costs

TODO FROM TEMPLATE: Labor cost estimates should use the following formula for each partner: ideal salary (hourly rate) actual hours spent 2.5 include estimates for electronics and machine shop hours, as applicable. For parts, use real values when you know them; make realistic estimates otherwise. List both the retail cost and what you or the department paid (in this case you may list labowned pieces as free).If the project might be commercially viable, estimate the cost of massproduction by listing bulkpurchase costs. Make sure any tables are numbered appropriately, given titles, and cited directly in the text.

5 Conclusion

TODO FROM TEMPLATE: Bring together, concisely, the conclusions to be drawn. It may be appropriate, depending on the nature of the project, to begin or end with a twoor threesentence executive summary. The reader needs to be convinced that the design will work. Summarize your accomplishments. If uncertainties remain, they should be pointed out, and alternatives, such as modifying performance specifications, should be spelled out to deal with foreseeable outcomes. Usewords, not equations or diagrams. Devote a section to ethical considerations with reference to the IEEE Code of Ethics and any other applicable code (e.g., the AMA Code of Medical Ethics for certain bioengineering projects).

6 References

TODO FROM TEMPLATE: Follow the IEEE reference styles provided in this document for various kinds of sources. If you need to cite something for which there is no example, simply use common sense and providein a neat and orderly manner emulating the IEEE reference stylethe information necessary for another researcher to find that source. References [1][3] are examples of a manual, datasheet, and web page, respectively. References [4][7] are more standard, scholarly sources: a book, chapter in an edited book, journal article, and conference proceedings. Reference [8] is a technical report, and reference [9] is class notes. Cite all references consecutively in the text, as is done here. (ECE Editorial Services provides a more detailed description of IEEE reference style on its wiki: http://go.illinois.edu/ecethesis .)

References

[1] Lieutenant Colonel Charles R. Shrader, *Amicicide: The Problem of Friendly Fire in Modern War*, 1982.

[2] W. B. Garrison, *Friendly Fire in the Civil War: More than 100 True Stories of Comrade Killing Comrade*. Rutledge Hill Press, 1999.

[3] G. T. Taoka, "Brake Reaction Times of Unalerted Drivers," *ITE Journal 59 (3): 1921*, March 1989.

Appendix

Subsystem	Module	Requirement	Verification	Points
Friendly Interrogator Unit	Laser Transmitter	Light from the laser must register a signal that can be detected by a photodiode at the following ranges: - Short Range (5 m) - Medium Range (15 m) - Long Range (30 m)	1. Measure and label each distance on ground surface. 2. Place 1 photoreceiver at target location. 3. Connect multimeter to output of photoreceivers. 4. Setup laser on stable surface at source, and connect directly to a lab bench power supply at 3.3V. 5. Note the value on the multimeter as the base/reference voltage. 6. Aim laser at target photoreceiver, using the red dot for guidance. 7. Confirm that the multimeter is displaying a voltage larger than that of the voltage measured in step 5. The voltage should be larger than the fluctuation from noise.	3
		Must have adjustable focus to achieve a spot radius ranging from 1.33 mm to 8mm at a distance of 5 m from the source.	1. Place the laser in a vice on a lab bench to hold it steady. 2. Place a sheet of paper or cardboard upright 2 m from the lens of the laser. This will be used as a backdrop for the light from the laser. 3. Connect the positive and negative leads of the laser to a lab power source. 4. Provide 3.3V to the leads using the power source. 5. Place a mark at the center of the current spot of the laser on the backdrop. 6. Place marks 1.33 mm and 8 mm from the center mark on the backdrop. 7. Adjust the focus of the laser so that the edge of the laser's spot ends at the 1.33 mm mark. 8. Adjust the focus of the laser so that the edge of the laser's spot ends at the 8mm mark (expanding to hit the areas between 1.33mm and 8mm).	5
		Laser must have ability to be sourced by a 3.3V amplitude 5kHz square wave.	1. Test with breadboard and signal generator. 2. Connect laser to appropriate circuit including resistor, NPN transistor and source signal. 3. Generate a 3.3V amplitude 5kHz square wave with a signal generator. 4. Connect op-amp and photoreceiver circuit to opposite end of breadboard. 5. Measure output voltage of photoreceiver with oscilloscope. 6. Confirm that output voltage of photoreceiver is 5kHz.	1
Friendly Target Unit	Laser Photoreceiver	Op-amp must amplify voltage received by photodiode enough to be registered by the and not exceed the maximum for the MCU (i.e. 0 < Vout < 3.7) with the 5mW laser incident on the photodiode from 10cm with the tightest divergence, the voltage should be between 2 and 3.7V	1. Power up photoreceiver unit. 2. Place a digital multimeter on the output of the photoreceiver. 3. Shine a 5mW laser directly onto the photoreceiver from 10 cm away. 4. Ensure the multimeter reading does not exceed 3.7V. 5. Ensure the multimeter reading does not fall below 2.0V.	9
		Photodiode must have ability to detect laser pulses at a bandwidth of at least 5kHz and must have ability to detect 90% ± 5% of packets sent to it.	1. Write software to probe and record the analog value at the input ports of each photoreceiver on the MCU at 5kHz. 2. For each photoreceiver: 3. Shine a 75% duty cycle red light at the photoreceiver for 10s. 4. Establish a cutoff voltage value where a high can be distinguished from a low. EG any signal greater than 1V is a 1, less than 1V is a 0. 5. Using the cutoff voltage established in (4), calculate the duty cycle of the probed values over the 10s 6. The duty cycle calculated in (5) should be between 74 and 76%	
Both F.I. Unit and F.T. Unit	Power Module	Voltage regulator must be able to output a constant voltage of 3.3V with ± 0.1V deviation (i.e. 3.2V < Vout < 3.4V), with a current supply of max 100 mA.	1. Place voltage regulator connected to the lab bench power source. Supply 6V. 2. Place multimeter in parallel with V_OUT and GND. 3. Read voltage and compare to 0.3V tolerance	5
		Must be able to supply at least 3.3V for a period of 8 hours ± 5%.	1. This verification requires both the friendly interrogator unit and the friendly target unit to be tested separately due to the different current consumptions on both. 2. Independently, on two separate circuits, connect all required components to each power module, so for example, for the friendly interrogator unit, connect the R.F. Receiver, MCU, and laser. 3. Power all components on using a lab bench power source. 4. Note the current usage on the lab bench power source. 5. Ensure that, given the capacity of the power module for field use, this current can applied for 8 hours ± 5%.	

Both F.I. Unit and F.T. Unit	Real Time Clock (RTC)	Local clock on independent units must be synced to within ±10 seconds.	1. Write software to generate interrupts at 1 second intervals on both units. 2. Connect both MCUs to oscilloscope and note frequency of interrupts. 3. Confirm that both rates of interrupts are identical. 4. Once software written for entire system, confirm that "seconds" variable is within a 10 second tolerance, by randomly sampling both units.	1
	Microcontroller (MCU)	Ability to both take input from digital source and output data in a digital form. A logic "high" cooresponds to 3.0V ± 10% and a logic "low" cooresponds to 0V ± 10%.	1. Power MCU appropriately. 2. Write software to set a two independent output pins to a logic "high" and logic "low" respectively. 3. Measure output voltage of pins and compare to that of 3.0V and 0.0V.	3
		Ability to control laser transmitter to send digital data at a frequency of at least 5 kHz (interrupts fired at every 0.2 ms).	1. Connect MSP430 to breadboard and power. 2. Write software to trigger a high signal on any desired output pin using Timer_A3 at a rate of 5 kHz (.2 ms). 3. Connect output pin of MSP430 to oscilloscope and compare square wave to that of desired interrupt rate.	
	R.F. Transmitter/Receiver	Must be able to both transmit and receive at least 90% of 8-bit packets sent over a distance of 5 meters with a carrier frequency of 315 MHz ± 50 MHz.	1. Write software on an MCU attached to the transmitter to broadcast 8 bit packets with data values staying constant. 2. Write software on an MCU attached to the receiver to count the number of packets received. 3. Place the MCU/transmitter 5 m away from the MCU/receiver. 4. Run both software programs. 5. Count the percentage of missed data values is less than 10%.	7
	Laser Transmitter/Receiver	At least 90% of transmitted laser packets must be received by the photoreciever at 5 m.	1. Measure and label 5m ground surface. 2. Setup target at 5m. 3. Place 1 photoreceiver on the target. 4. Connect microcontroller to the photoreceiver output. 5. Setup laser on stable surface at source, and connect power and ground leads to a lab power source. Power at 3.3V. 6. Using the laser spot as a visual guide, aim the laser at the photoreceiver and secure it in place. 7. Run a 5kHz signal through the laser broadcasting 8-bit packets and count the total number of packets missed over a period of time. 8. Use the microcontroller to ensure at least 90% of those packets are received.	9
	Speed of System	A friendly target at 5 m should be marked friendly within 190 milliseconds.	1. Upon completion of both friendly interrogator system and friendly target system place both systems at a distance of 5 meters apart. 2. Write software to keep track of time between when the operator switches on the laser until the friendly target acknowledgment signal is received from the target. 3. Store this result in a register upon testing. 4. Compare to that of the desired value of 190 milliseconds.	7
				50