New Implementation
Of
Hide and Seek

Project 21 Project Proposal
By: Ken Fester & Jesse D. Crowe
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TA: Sam Sagan

1 Introduction

1.1 Objective:

One of the biggest pushes in today's technology is a push for virtual, augmented, and merged reality in everyday life. Currently a major problem for this focus on these new forms of realities is the ability to know what the user is looking at in front of them in an easy and efficient way. Currently a few ways to notify a user what objects or location are in front of them requires the use of various forms of computer vision. This requires clear view of the object and fails when the vision system fails, also computer vision requires a high degree of computing power. Another way of identifying targets to computers is the use of QR codes, but that requires the QR code to be seen by the user.

We hope to create a non-computationally intense way for a device to determine when a user is facing a target. Our proposed solution is to use a mixture of RF and IR communications. We plan to use the RF side of the project to determine when a device is in front of the user, and the IR system as a way to send information to the user once the target is in the users' field of view.

1.2 Background:

We are in a world where the want and need for information quickly and efficiently is a fast growing market. Now there are many products out currently which can do this in a pretty effective way. For example you can verbally ask your phone just about anything and information on the topic will be right at your fingertips. However, what if you have a question about something you are currently looking at. It seems a bit repetitive to look at it and then type the name of it in on your phone or say it out loud. What if we can cut out that step all together? Merely being near something in front of you is enough to get you to a plethora of information if you so choose. Now there are some similar products that use computer vision to do similar tasks however the amount of computing power and cost of these products are very high. Our project will focus on being a proof of concept for this idea of being able to be notified and receive information on anything near you as quickly if not more quickly than say, looking it up on your phone.

This ease of access will encourage people to ask questions and learn more about what they see. We believe the biggest reason people don't pursue questions they have about what's in front of them is not because they don't have the resources to do so. We think it's because the ease of access is just not quite where our audience would like it. A product that solves this problem and makes it so easy that it virtually requires no effort or time will be a product people will want.

1.3 High-Level Requirement List:

- Device must be able to notify the user when the target is in their field of view.
- Device must be able to send and receive data over IR channel.
- Device must be able communicate with user.

2 Design

2.1 Block Diagram:

We propose to make a proof-of-concept in the form of a merged reality hide-and-seek game that will be based on a mixture of radio frequency and infrared communications. The game will be played by two users. The first user's, which will be referred to as the "Seeker", goal it is to try and find the second user. The second user's, which will be referred to as the "Hider", goal is to remain out of face-to-face contact with the Seeker. We hope to use a directional antenna radio frequency system to allow the Seeker to be notified when the Hider is generally in front of them and use RSSI to approximate the distance between them. This will work up to 100 meters. LED's will help the seeker know just how far away they are and an IR system will allow the seeker to actually tag the hider once they are close enough together. This distance will be no further than about 2 meters. It should be noted if we wanted to commercialize this product we would want each user the capability to be either the hider or the seeker. However, we believe it is outside the scope of this course to implement such a design.

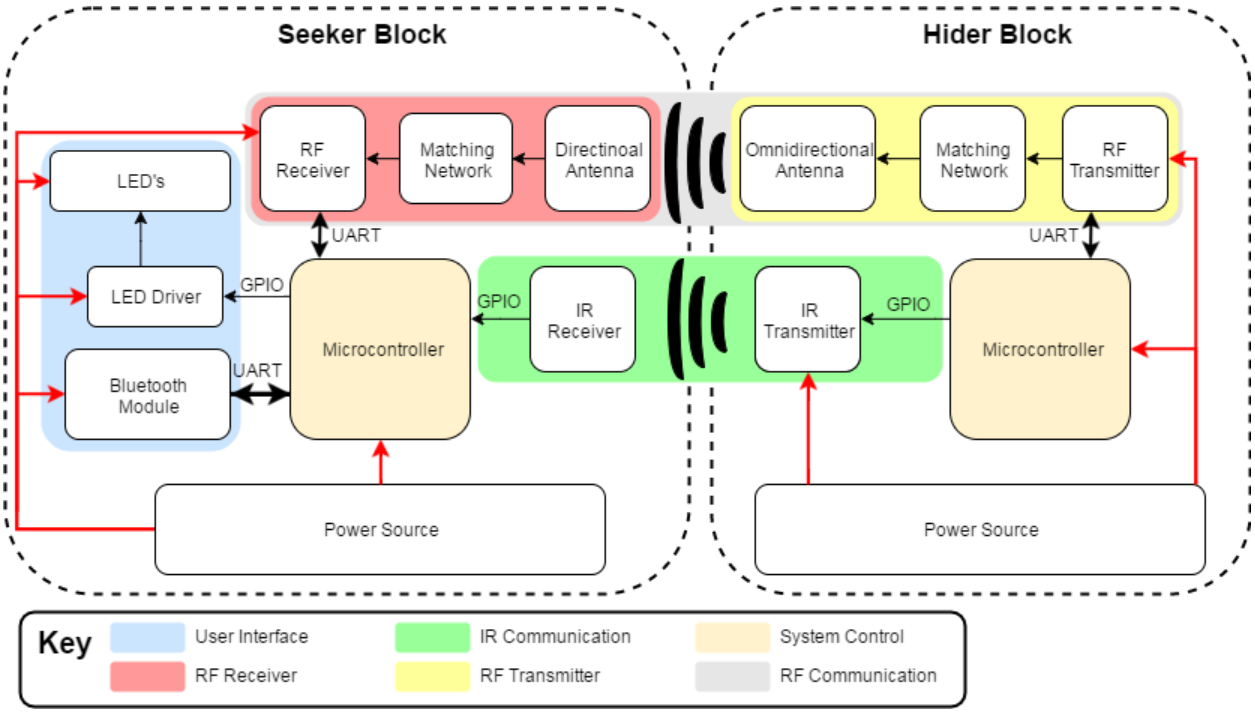

Figure 1: High-level block diagram of seeker block circuit (left) and hider block circuit (right).

2.2 Physical Design

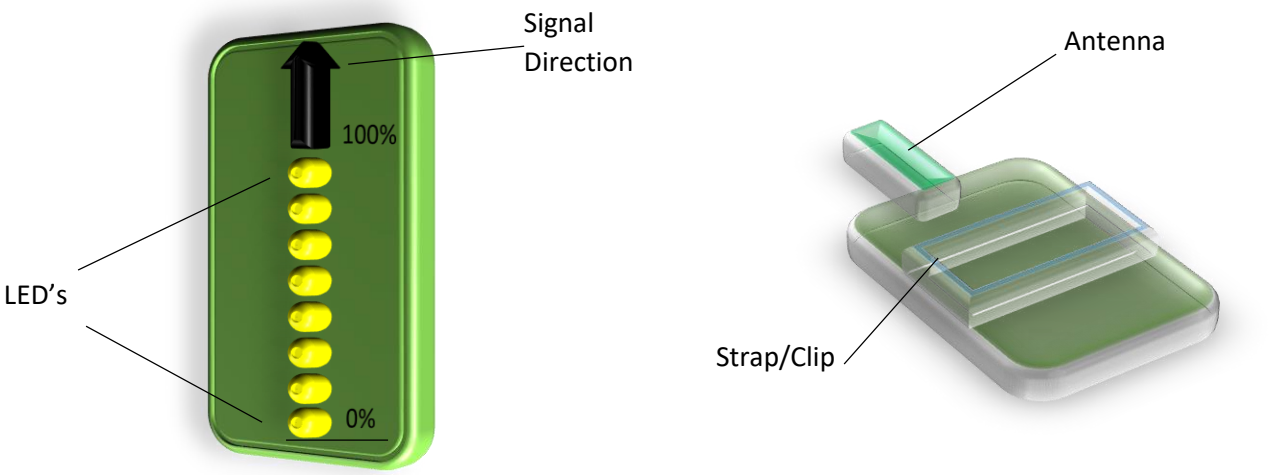

Figure 2: Physical designs of seeker device (left) and hider device (right).

By looking at the block diagram it is clear that we have two separate circuits, one for the hider block and one for the seeker block. As mentioned earlier, if we wanted to commercialize this product we would make sure to give one user the functionality to be a hider and a seeker so as to let them pick and switch between the two easily. Due to the limited time we have during this course we decided to have two separate devices. The seeker's portion will be a handheld device about the size of a phone with LED's on the front indicating the received signal strength of how close the hider is and an arrow pointing in the direction the antenna is receiving. The hider's device will be about the same size except it won't have any external lights. It will be able to clip to the strap of a backpack to make it easy to carry without having to hold it. Prototype images of the devices can be seen below.

2.3 Functional Overview & Block Requirements

2.3.1 Power Sources

Our project will be powered by multiple outputs voltages from our test bench to power each circuit. Note that there are two power supplies (one for the hider and one for the seeker). This is due to the fact that the hider and the seeker will need to be able to separate in the validation portion of our project. This might require portable power supplies.

Requirement: Must be able to supply 3.3 volts, 5 volts, and 12 volts.

2.3.2 Microcontrollers

The microcontroller provides overall control for the system. This includes managing RF, IR, Bluetooth module, and LED driver.

Requirement: Must have GPIO, UART, and SPI interfaces for communication with other modules.

2.3.3 Matching Networks

Used to transfer the most efficient power between antenna and RF blocks. These will be implemented once we are able to measure our antennas' parameters.

Requirement: Be able to match RF block impedance.

Requirement: Be able to match antenna impedance.

2.3.4 LED Driver

The LED driver will be powered by 3.3 volts from the power supply and will get information from the microcontroller on which LED's to light up. The driver will be a shift latch register.

Requirement: Drive LED's independently.

Requirement: Output a voltage of 2.0 volts (LED's forward voltage drop)

Requirement: Controlled by microcontroller's GPIO.

Requirement: Must be able to expand for more LED's

2.3.5 LED's

The LED's will be an array of LED's in a line that will communicate to the user how strong their signal is based on direction and proximity to the hider.

Requirement: Diffused LED, easily viewed by user.

2.3.6 Bluetooth Module

This module is used to provide communication between our system and a cell phone app. It allows for additional functionality in gameplay such as score, random matchmaking, and rankings.

Requirement: Must be able to run on a 3.3 volt control line.

Requirement: Is FCC certified.

Requirement: Meets Bluetooth regulation.

2.3.7 RF Receiving Block

The RF receiving block will act as the receiver for the directional antenna so that it knows how far away the hider is. It will use RSSI to determine this and will communicate this information to the microcontroller.

Requirement: Includes RSSI capabilities.

Requirement: FCC compliant.

Requirement: Ability to receive ISM bands of 2.5 GHz.

Requirement: Able to receive signals up to 1 W.

2.3.8 IR Receiver

The IR receiver will allow the seeker to "tag" the hider within a certain distance. It will receive a signal from the directional antenna through the matching network and send the information to the microcontroller once this occurs.

Requirement: Ability to receive IR signals up at least 2 meters.

Requirement: Receive IR signals with line on sight.

2.3.9 Directional Antenna

The directional antenna will pick up a signal from the omnidirectional antenna in the hider block if the antenna is oriented towards the hider. It will then pass this information on to the RF receiver through the matching network.

Requirement: Tuned for the 2.4 GHz ISM band.

Requirement: Physically small enough for commercialization (less than 150mm x 70mm)

Requirement: Single main lobe, with a solid angle less than or equal to a human's field of view.

Requirement: Orientated such that the received signal originated from the intended direction.

2.3.10 Omnidirectional Antenna

The omnidirectional antenna will take information from the RF transmitter (through the matching network) in the hider block and transmit this information in all directions so the seeker can pick up on this signal in all directions.

Requirement: Tuned for the 2.4 GHz ISM band.

Requirement: Beam Pattern should be omnidirectional, oriented such that signal power is constant at equal distances.

2.3.11 RF Transmitter

To be used to allow tracking of the hider. Feeds the omnidirectional antenna and acts as the beacon in our system.

Requirement: Maximum output of 1 watt to be FCC compliant (may change due to antenna directivity).

Requirement: Ability to transmit on ISM band 2.4-2.48 GHz.

2.3.12 IR Transmitter

The IR transmitter will continually transmit an IR signal so when the hider is close enough and the seeker is pointing its device at the hider, the seeker will be able to "tag" the hider and the game will be finished.

Requirement: Ability to transmit IR light a minimum 2 meters.

Requirement: Must not emit any light that may be visible to humans.

2.4 Risk Analysis

The most critical component of this system would be the directional antenna. The successful design and implementation of this antenna, such that it closely meets our intended requirements, allows for our device to operate as intended. This component is used to detect when the target is it front of them, which is the ultimate goal of the project.

The intended operation of this component is that it will have the most gain in front of the user, with as close to a null as possible that wraps around and behind the user's side. This allows the device to sense that it is facing the target. If the antenna fails to meet this requirement the users may get false positives that the target is in front of them. This failure will derail the intent of the project, and cause stress to users during operation. Luckily we will be able to test this prior to releasing it.

We will use design software to simulate our design to ensure that it should theoretically work as intended. This part of the design will require a majority of our time and resources. We will need to design it such that it can be implemented on a PCB microstrip board. This imposes certain requirements on the materials used for the PCB, such as good dielectric materials and low resistivity of the metal. Having a bad dielectric layer will cause the antenna to deviate further from the simulated results. The more resistive the PCB the more loss the antenna will experience, and the more heat the antenna will produce.

3 Ethics and Safety

With any product that is intended to be released to the public, there comes certain set of hazards that could harm people or other devices. Ultimately, we would want our product to work as intended and in a way that when used properly will not cause harm.

Since this project has a large RF component, we must be sure to adhere to FCC regulations. The radio spectrum is a natural resource that needs to be used responsibly so that all may be able to benefit from it. We need to ensure we don't cause harm by radiating unintentional energy into the atmosphere. This could cause unintended affects, such as jamming other devices on the ISM band, which could interrupt services running on the band that could be critical to people's health and safety. This would violate the IEEE Code of Ethics which includes the responsibility "to avoid injuring others" [3]. Another safety concern that will have to be addressed is the RF radiation of our product. We will need to ensure that being in close proximity to our device for extended periods of time does not cause any discomfort or harm to people or their property. We will design our project to provide safe amounts of RF radiation, based on current information on the topic of RF exposer.

This device also may create an ethical dilemma when used inappropriately. The purpose of the device is to allow a user to track a consenting target. It could be possible to slip our device on an unknowing victim, allowing said victim to be tracked without their knowledge. We know this risk; we would need to devise a way to keep non-consenting parties from being tracked. Upon releasing of this product to the public, we would inform the users of this inappropriate use, such that they may combat it. We see this as a way of disclosing "factors that might endanger the public", as it pertains to the first IEEE Code of Ethics [3].

On the user's side of the device, we would oppose selling histories and logs of what the users device has sensed was in front of them. This information could be sold to create a profit at the user's expense of privacy. Upon commercialization we would notify the public of such risks, and oppose implementing any way of storing user's data. We see this as a means to "rejecting bribery" as stated in the IEEE Code of Ethics [3].

References

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[2] w. xue; w. qiu; x. hua; k. yu, "Improved Wi-Fi RSSI Measurement for Indoor Localization," in IEEE Sensors Journal , vol.PP, no.99, pp.1-1 doi: 10.1109/JSEN.2017.2660522, Available: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7835628&isnumber=4427201 [Accessed: 03-Feb-2017]

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