Infrared Remote Control

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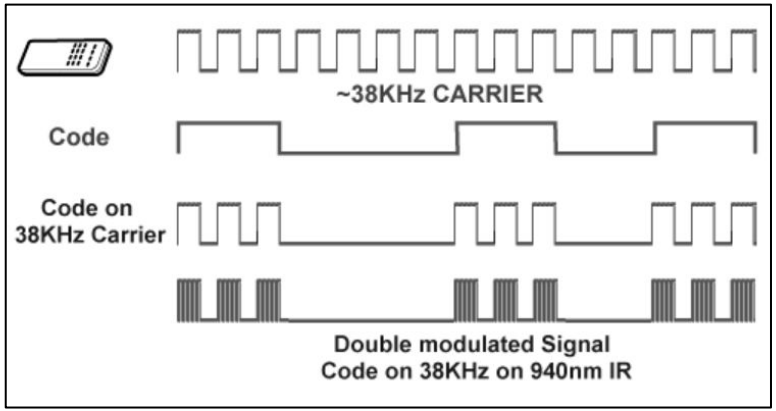
Introduction

How Does a TV Remote Work?

- The remote is a transmitter that sends infrared signals using an LED, with the appropriate wavelength, (around 940nm) to the TV's receiver
- the IR signal must be modulated to a specific frequency set by the receiver, so that infrared noise is filtered and the signal is amplified (32-40 kHz)

Figure 1. Basics of Remote Control Signal



Problem Descriptions

1. **Missing Remote**
2. **Effective Range**
   a. Poor button transmission due to angle and or low battery
3. **Battery Lifetime**
   a. no built-in indicator for battery life
4. **Hot-Keys**
   a. Traditional remotes come with pre-programmed hot-keys
   b. The most used TV features differ from person to person
   c. Lack of customization
5. **Access to Controls**
   a. One-user
   b. Prevents multiple people from having access to the TV
6. **External Devices**
   a. Lack of universal remotes due to constant new technology and devices

Proposed Solutions (½)

- **Missing Remote**
  - Mounted transmitter
  - Remote access from mobile device
- **Effective Range**
  - Mounted transmitter
  - Easy-clip that can attach to a standard, thin TV along the bottom
- **Battery Lifetime**
  - Externally power (plug-in) or larger battery space provided by additional batteries in parallel
  - Piezoelectric added to the PCB for low battery indication

Proposed Solutions (2/2)

- **Hot-Keys**
  - GUI to allow users to create a custom layout
  - UI with complete customization to allow user to choose as little or as many personal remote keys
- **Access to Controls**
  - Due to wifi/phone usage for remote access, there can be multiple users
  - Ranked queue based on which devices were connected first, to prevent issues caused by multiple signals sending at once
  - Ability to remember devices for easy future connection
- **External Devices**
  - General purpose microcontroller extends the functionality of our app beyond IR protocols
  - Provides additional libraries for whatever device types we want the user to be able to connect with

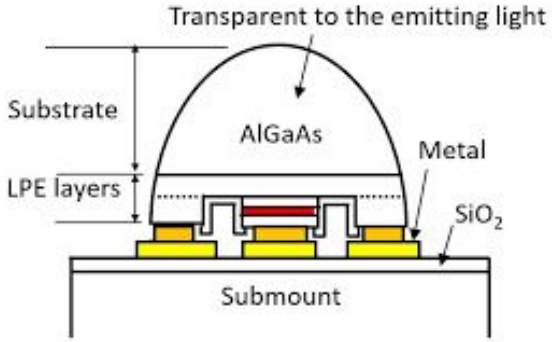
Demonstrated Features

1. **Functional Communication with Various TVs from the Microcontroller**
2. **Connection between user-phone, and microcontroller**
    a. Using what we learned about WiFi earlier in the semester, we can create a simple interface and verify that the phone is able to communicate with the microcontroller, and subsequently the TV
3. **Multiple Users**
4. **Effective and Attractive User Interface**
    a. Sampling from users outside the group will be used to correct issues with the UI, and external research on complaints about modern remotes will influence how the UI works.
5. **At least 1 external device**
    a. To make the remote “universal”, there should be at least one device that can be controlled with the same interface that is not the TV. This could be a bluetooth speaker, a light system, etc.

Available Technologies

- **PCB**
  - Costs $50
  - Designed and laid out in Eagle
- **Microcontroller**
  - ESP32-WROVER-E
    - On board bluetooth transmitter and receiver for external device
    - Wifi for phone communication
    - Plenty of GPIO’s for the outputs to the LED
    - 2 cores to handle the front and back end of the project
    - Costs $3.60

Available Technologies (Continued)



- **IRED**
  - Appropriate Wavelength
  - High current allowance for stronger output signals
  - Digikey Part Number: 475-SFH4727ATR-ND
    - Max Current Input: 2A
    - Wavelength: 950nm
- **Power Transistors**
  - The GPIOS will need to power MOSFET gates
  - Transistor requires decent bandwidth since the signal must be modulated around 40KHz
  - Digikey Part Number: 3141-G1002LTR-ND
  - Costs $0.50

Engineering Content

1. **PCB Design**
    a. A PCB will need to be designed, with careful selection of components
        i. For example, LED wavelength, necessary transmission power, the implementation of MOSFETs on the board, ESP32 placement, etc.
    b. This step is going to require a lot of research into how actual remote controls implement their circuit boards - what IREDs they use, which transistors they use, what kind of passives are needed, how the microcontrollers interact, etc.
2. **Communication Protocols**
    a. Requires the learning of different TV protocols and how to navigate their OS, and the implementation of higher level libraries for the microcontroller to use
        i. we will need to know what to ping on the device address wise and what data to send in order to get to higher level functionality like “open netflix”
        ii. In order to interact with multiple TV types, we need to know the protocols of all these receivers
3. **User Interface**
    a. Requires the implementation of high-level coding
    b. application should be designed so that non-tech users can easily connect devices and operate the TV

Conclusion

In eliminating the common issues people face when using the traditional television remote, such as loss of the remote, poor battery life, poor range, lack of remote access, and lack of customizability, we hope to create a superior television watching experience that is more efficient, user-friendly, and free of frustration.

Sources

- https://www.laser.com/dhouston/ir-rf_fundamentals.html
- http://techiesms.blogspot.com/2016/01/ir-protocol-decoding-and-transmiting.html#:~:text=NEC%20protocol%20is%20most%20commonly,mark%20and%204.5%20ms%20space.