Wearable Telecommunication Sensor Embedded Glove

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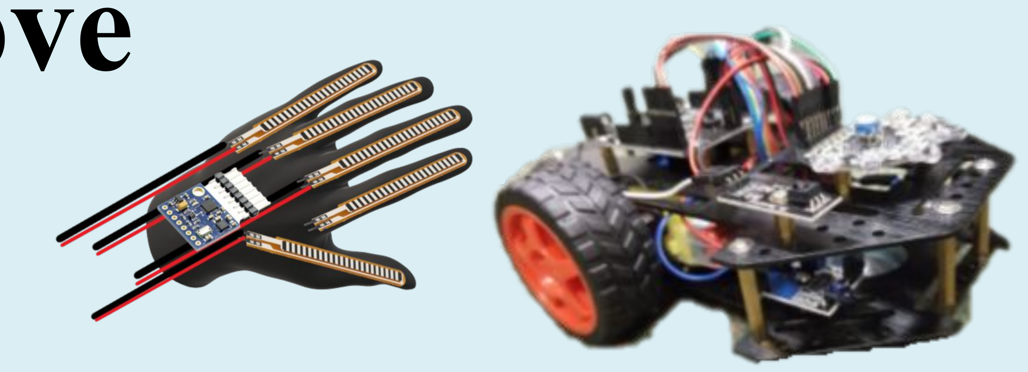
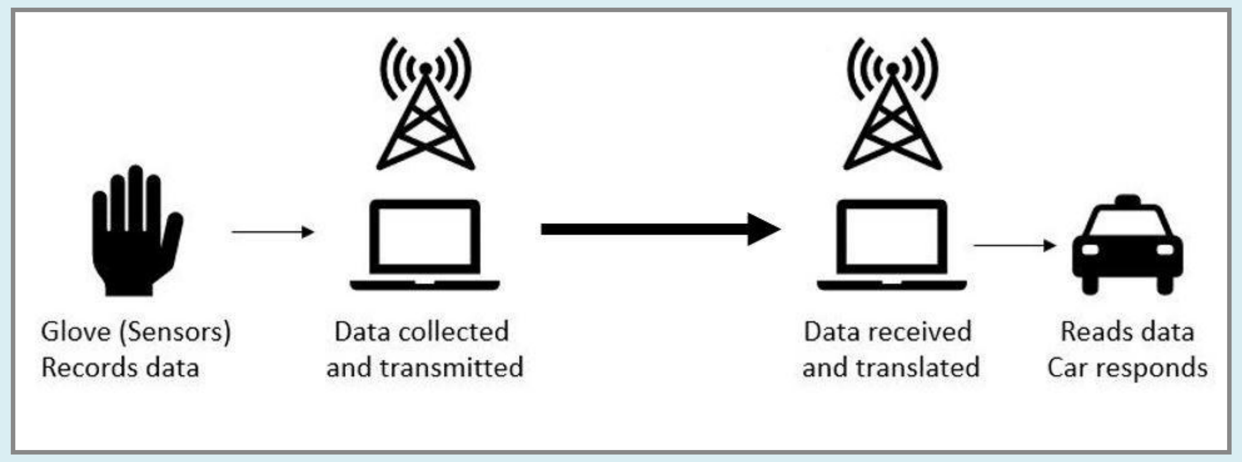


Abstract

Wearable technology is quickly becoming the next big consumer interest, with important applications to benefit everyday life. Such devices aim to combine user convenience and advanced technology to offer new and innovative solutions to complex and unique challenges. The inspiration for this project came from the idea of having ease of hand movements instead of pressing buttons on a remote control. Immediate applications exist, like a sign language sensor-embedded glove that is able to translate hand motions into text and voice. Using similar logic and intention, this project consists of a tactile glove that records hand movements with sensors, and translates that motion into commands for a secondary device. In the scope of this yearlong project, the secondary device is a robotic car. This can be of use to combat ready soldiers on the field who depend on rapid decision-making and benefit from "hands-free" applications. This wearable technology will eliminate the risk of soldiers being disarmed in order to operate a secondary device, such as a drone or unmanned vehicle. The system places a focus on communication - that is, the ability to communicate with the device at different ranges.

Problem Statement



A completed system will be able to do the following:

- Record finger and hand movements
- Transmit collected data to a secondary device
- Translate and process finger and hand movements into readable commands for a secondary device

System Overview

Devices

- Robotic Car
- Glove
- Arduino Uno/Mega 2560

Sensors

- Flex Sensor(s)
- Inertial Measurement Unit (IMU)
- Piezoelectric Sensor

Analysis Tools

- GPS Module

Communications

- NRF Tx/Rx Chips

Communication

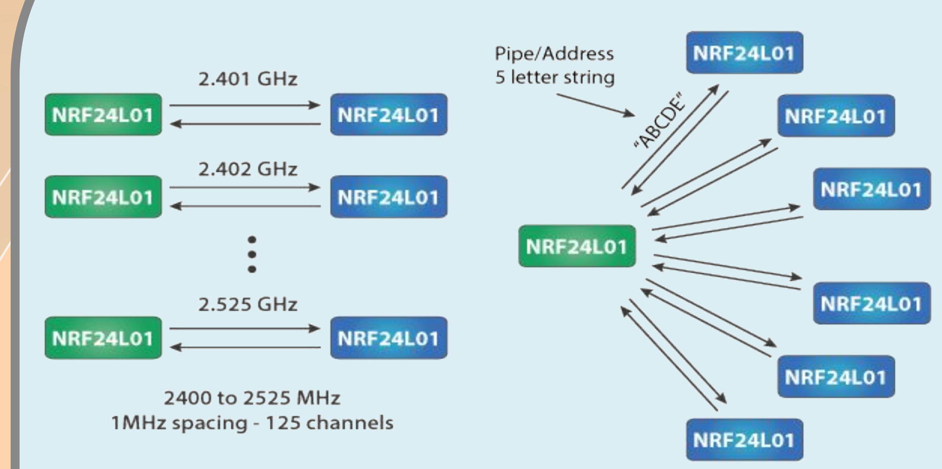


Figure : nRF24L01 Channels and Data Pipes

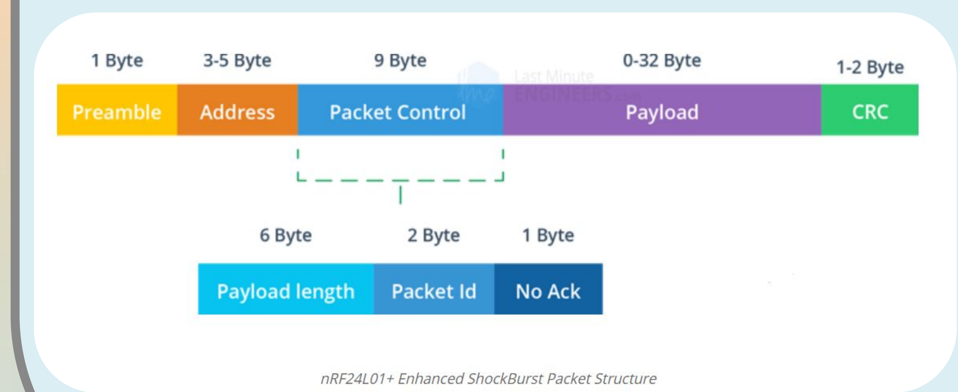


Figure : nRF24L01 Data Packet Breakdown

For communication modules, the nRF24L01 Transmitter and Receiver chips were chosen due to their larger range, lower power consumption, and 3 data rate options of 250 kps, 1Mbps,and 2 Mbps. There are 125 channels to send the data via GHz frequencies (*top left*). Each RF chip sends a packet of data consisting of 5 main byte sections (*bottom left*) to another RF chip via unique data pipes. Each data pipe has a corresponding address, which is used to differentiate communication devices, and improve security and error checking.

Analysis

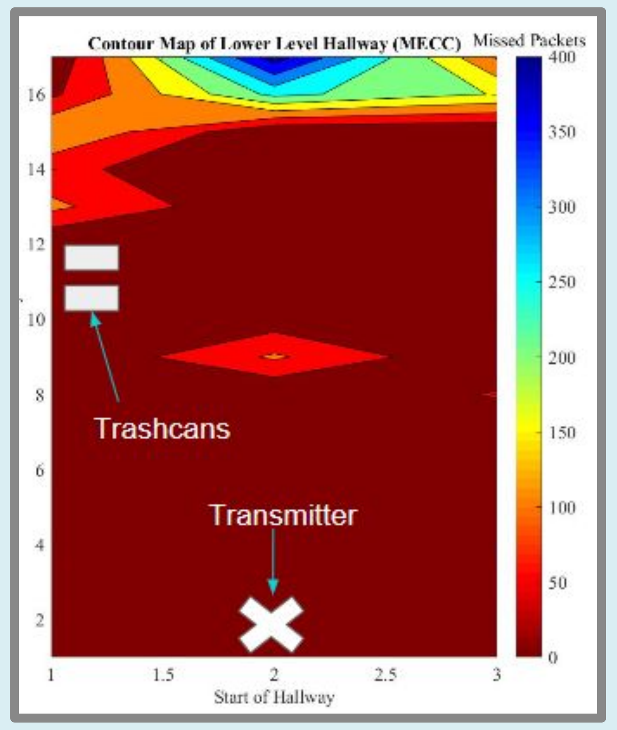


Figure 1: Contour Map of Lower Level Hallway

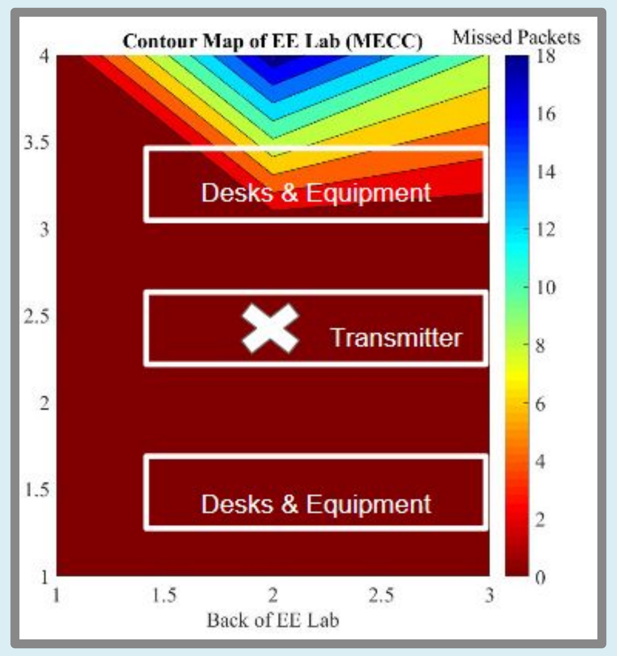


Figure 2: Contour Map of EE Lab (MECC)

Analysis on the communication was performed in three different environments: indoors with a clear line of sight, indoors in a cluttered environment, and lastly, outdoors with a clear line of sight. First, the transmitter was kept stationary, while moving the receiver along the hallway to test the range of the completed system. **With a clear line of sight, the range was about 165 ft. indoors.** It successfully received all, if not most data packets (indicated by the dark red color, called a "hot" area) within 120 ft. from the transmitter (*top left)*. As the receiver approached the end of the hallway, the missed data packets increased to about 400 (indicated by the blue color, called a "cold" area), suggesting this is where the signal strength started diminishing. Within an indoor cluttered environment, the receiver was moved to the four corners of the lab while the transmitter remained centered (*bottom left)*. The receiver missed only about 18 data packets in one corner of the lab, suggesting the signal strength was still predominantly "hot," even with surrounding clutter. Lastly, **the range was tested outdoors which resulted in data transmission of up to 330 ft.,** with a lag zone starting at 295 ft.

Final Design

Figure 3: "Tap to Activate"

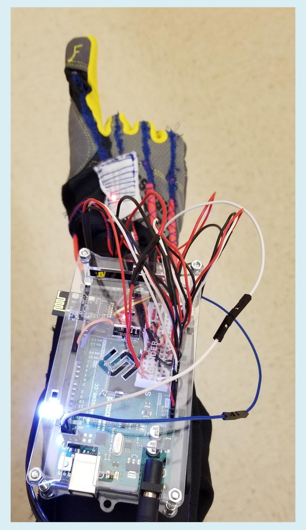


Figure 4: "FORWARD"

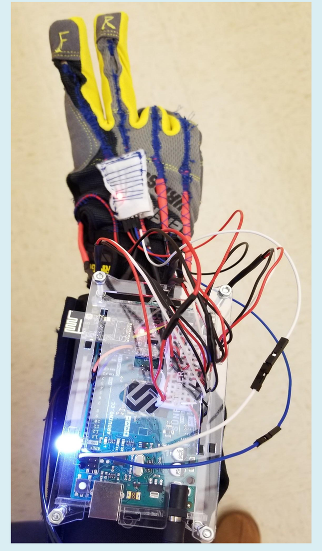


Figure 5: "TURN RIGHT"

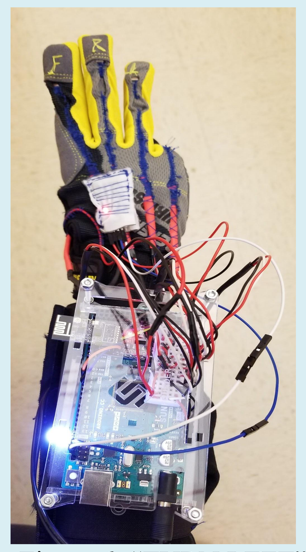


Figure 6: "TURN LEFT"

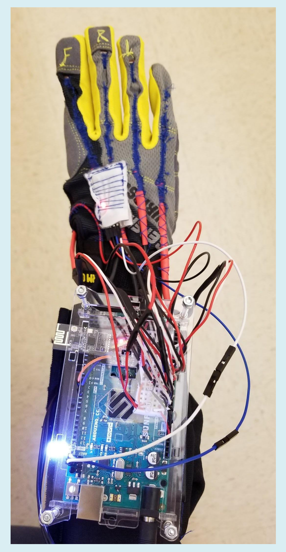


Figure 7: "BACKWARDS"

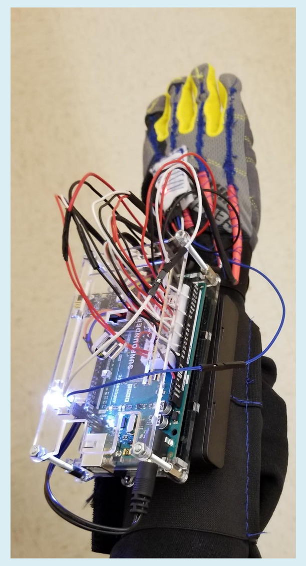


Figure 8: "TURN LEFT BACKWARDS"

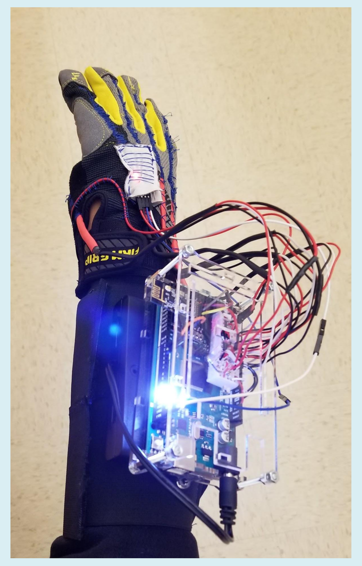


Figure 9: "TURN RIGHT BACKWARDS"

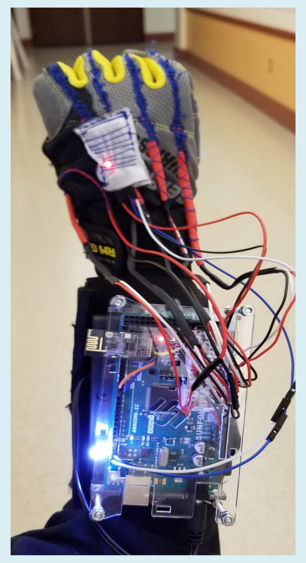


Figure 10: "EMERGENCY BRAKE"

Conclusion + Future Work

Overall, our completed wireless system was successful in being able to allow the user to activate the sensor embedded glove to prevent any unintentional commands. Once the LED light was on, this signaled to the user that the glove was ready for use. Second, the glove was able to record seven different finger/hand movements that would be processed and translated to be sent to a secondary device (robotic car) and have it respond accurately in real time. Additionally, our wireless communication system was able to provide a large range indoors and outdoors. With a clear line of site indoors, the user was able to transmit finger/hand commands with an approximate range of 165 ft (50m). It was found that even in cluttered environments, only one corner of the room was missing some packets, which suggests that cluttered environments did not have a large impact on the signal strength indoors. Finally, the range outdoors was good up to 295 ft (90 m), implying great signal strength outdoors. For future work, we would like to be able to use the sensor embedded glove to control multiple secondary devices as well as increase the amount finger/hand movements to provide the user with a variety of commands.

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