Portable Audio Frequency-Shift Keying Sensors using a Hamshield mini

Nolan Pearce*, KE8JCT, Stephen S. Hamilton*,†, KJ5HY and Kate J Duncan*,†, KB2ZOO
United States Military Academy*, Army Cyber Institute†
{ nolan.pearce, stephen.hamilton, katherine.duncan}@westpoint.edu

Abstract

The newly developed Hamshield mini and commercially available electronic devices integrated with the Hamshield can be used to create an auto-reporting ham radio motion detector. Open-source Arduino code, a Passive Infrared (PIR) sensor, and looped audio frequency shift keying (AFSK) transmissions were assembled to create a low-power, low-cost, open library, small form-factor device that expands upon current automatic remote beacon sensors. In this paper, we detail an open-source amateur radio QRP VHF/UHF packet radio using the Hamshield. Furthermore, the compatibility with Arduino single-board microcontrollers will enable current amateur radio technologies.

Key Words

QRP, Arduino, Packet, AFSK, Automation

Introduction/Background

The Hamshield mini is a new crowd-funded piece of amateur radio technology that appears constrained only by its user's imagination; the mini is capable of data, voice, CW, remote control, and telemetry all within a form factor of approximately a USB stick. This new device is part of a larger trend in technology where fast, cheap, open source projects replace legacy hardware systems as is often performed with the Raspberry Pi. This "rapid prototyping" utilizes readily available feedback to provide quick solutions to simple problems and for which no conventional solution exists. This project is intended to provide substance and evidence for ad-hoc solutions to unusual and emergent situations, while utilizing the Hamshield.

Solution

The Hamshield mini is integrated with a PIR sensors to form a mobile movement detector. This device automatically relays a predetermined AFSK message on the 2m ham band when triggered by a change in the PIR sensors output voltage. This message can then be decoded on a remote ground station far from the sensor itself. The PIR sensor's low voltage operation and small form factor made it easily compatible with the end goal of the project. To create this code, the Hamshield's AFSK example code on github [1] was downloaded and modified for this project. This was then combined with another open-sourced demonstration of the PIR sensor [4] and modified to run in a continuous loop. Figure 1 describes the schematic of the system.

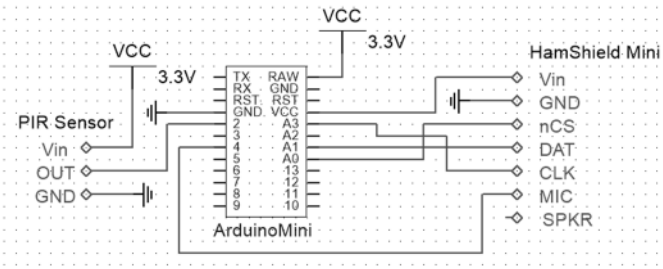

Figure 1

Design

Several competing factors created the final design of the device. The Hamshield's low-cost and aspects such as low power consumption, small form factor, and open-source code, were factors in deciding on it for the use as our disposable remote sensor. First, the goal of the project was to develop a low-cost, open source solution for an AFSK mobile messaging movement detector. Arduino pro minis have common libraries and low operating voltage (3.3 Volts) and cost as little as $10. Next, the system needed to be battery-powered with an extended lifespan (24 hours). Anker phone batteries provide long battery life and are the same size of a mini breadboard. Additionally, the Hamshield operates at a power output of 200 milliwatts [1], which is desirable for line-of-sight QRP (low power) communications. Finally, the device must have as small form factor; although the Hamshield mini was prototyped with longer wires plugging directly above the Arduino on the breadboard this form factor can be reduced.

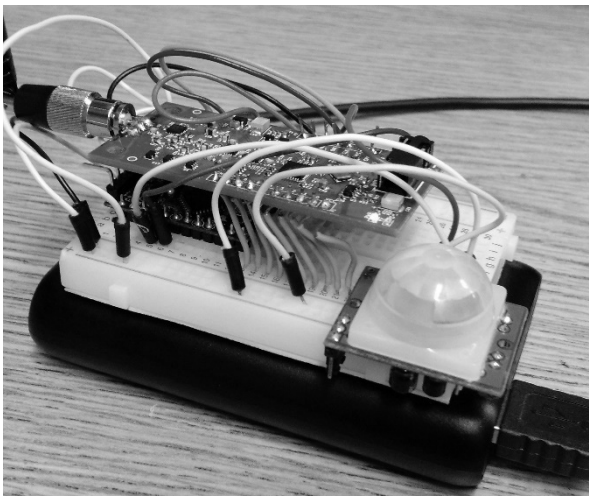

Figure 2

Figure 2 shows the prototyped product; clearly visible are the battery, Arduino mini, PIR sensor, and Hamshield over top of the microcontroller. The antenna, an ANT-500, acted as the largest component of this system: a promising feature of this project is the ability in integrate more features onto the Arduino to increase capabilities, such as a distance measurer or other telemetry devices.

Results

The finished project operates effectively with low power consumption, a small form factor, and easily obtainable components (the total system cost was under $70). The code remains open-source and compatible with Arduino technology [3]. Due to the operating voltage of the PIR sensor (using low-power 3.33 Volts instead of 5 Volts), its sensitivity results in minimal false positives for movement. However, even with the low radiated power of the system, and the low-profile ANT-500 antenna, the testing was successful. Measured tests showed the furthest transmission range to be approximately 50 meters, which could be increased by using a higher gain antenna. The decoding station operated from a portable laptop with QTMM (freeware AFSK decoding software) and an RTL-SDR. Figure 3 shows the output from the decoder.

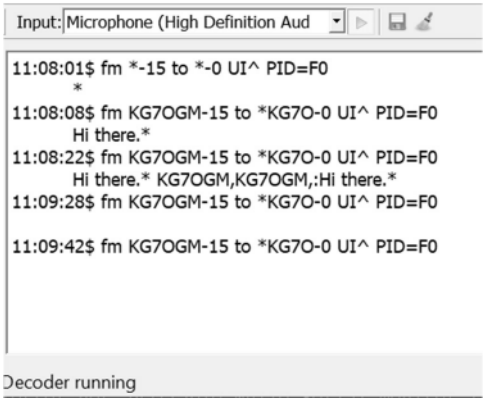

Figure 3

The small size of the device enables the system to be integrated into various situations, and with proper construction and enclosure, the device can be used in most environments. The "fish-eye" lens of the PIR sensor also allows for a wide coverage area (5m), with just a single device.

Conclusion

The increase in crowdfunded and open source radio technology represents a change in the mindset of engineer solutions for communications; oftentimes these rapid prototyping devices offer quicker feedback than conventional research and development methods. This project stands as a demonstration towards the usefulness of this technology. Using commercially available components, the Hamshield mini performs effectively as a remote PIR sensor. In further studies, the Hamshield's capabilities can be expanded. The Hamshield, could operate as an APRS telemetry station, due to the AX.25 packet protocols and its compatibility with Arduino, with customize transmission data packets. This Hamshield based APRS telemetry station also would be more cost effective compared to consumer-grade equipment. Multiple nodes and digipeaters can expand the propagation of the warning signals and increase their effectiveness. Overall, these commercially available component-based systems that operate on open-source code can be expanded upon and researched for their novelty in solving amateur radio problems.

References

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