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Advised by Dr. Lu and Dr. Ahn
October 4, 2017

EMG Security Monitoring System

Problem Statement

The current market for gesture based security systems focuses only on the use of cameras to detect user movement. These systems require heavy processing and restrict the user to gesture only in the field of view of the cameras. To address these issues, this project proposes a surface electromyography (sEMG) controlled security system.

Electromyography (EMG) is a technique for monitoring electrical signals produced by the movement of muscles. sEMG allows for accurate measurement of muscle activity without the need for intrusive or bulky measurement tools. sEMG requires only an electrode placed on the surface directly above the target muscle. When placed on an arm, sEMG can detect not only the activity of the arm, but also that of the user's hand.

The ideal use case of an sEMG security monitoring system is in small businesses that do not have a dedicated security department. In these businesses, security monitoring is a secondary responsibility of a worker. For example, in convenience stores the cashier is responsible for checking out customers while also watching a security monitor to prevent theft. Often, there is just one monitor displaying camera feeds from all around the store. In such cases, it can be difficult to clearly see what is happening around the store.

In this project, the user's gesture is captured via a Myo Gesture Control Armband. It houses eight electrodes for sEMG as well as an inertial measurement unit (IMU).

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Functional Description

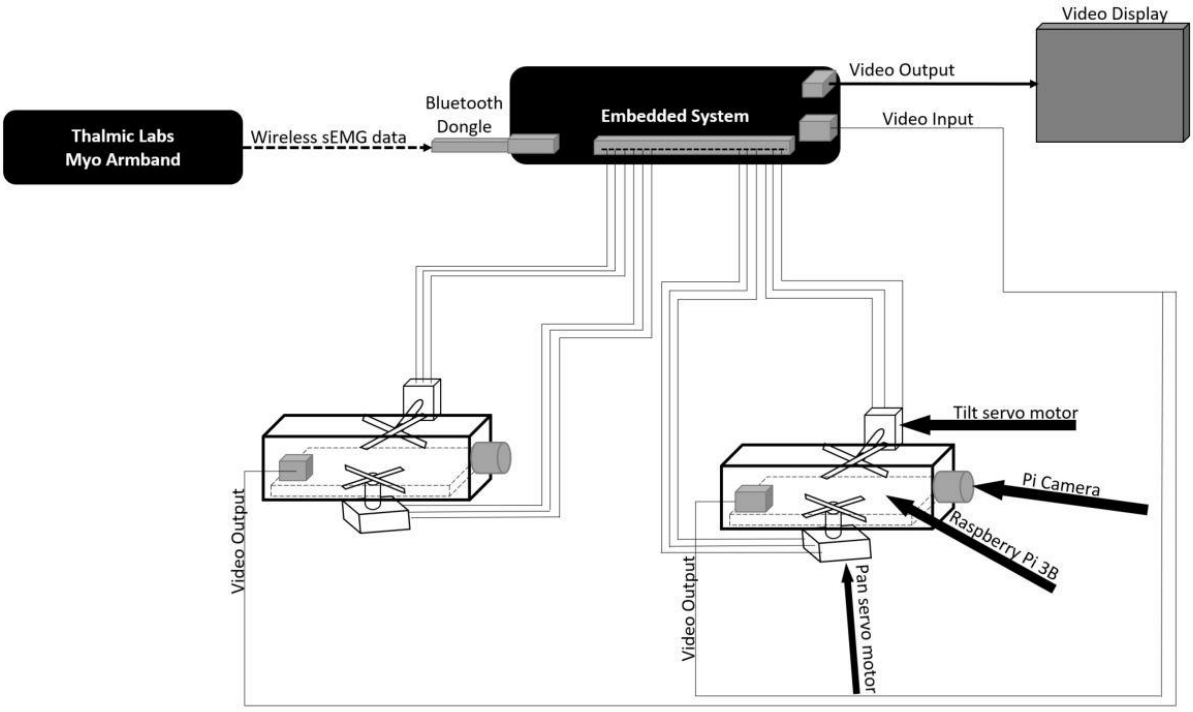

Figure 1: Rough Diagram of System

A Myo Armband is worn by a user, giving him/her hands-free control of a video camera system. The user has control of pan, tilt, and camera selection. The system utilizes sEMG and inertial signals from the armband to control the system. The armband wirelessly sends data to an embedded system. The system is responsible for signal processing and control of the video monitoring. In addition, two servo motors are used to rotate each camera. Communications are setup to transmit information between the Raspberry Pi boards, servo motors and the embedded system.

Myo Gesture Control Armband

The HMI, sEMG armband chosen for this project was designed by Thalmic Labs. It uses eight sEMG sensors as well as a nine-axis IMU to detect hand and arm movement. Data is sent in real-time via Bluetooth to an embedded system. While the raw data is available from the armband, the designers have integrated signal filters into the armband to transmit a signal free of any significant noise. This project will utilize the filtered sEMG signal to focus on the gesture recognition algorithms and their accuracy.

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Embedded System

The embedded system is the heart of the sEMG Security Monitoring System. It receives the armband signal via a Bluetooth dongle. This signal is then processed by our proven algorithms to identify the gestures made by the user. The embedded system also generates a PWM signal, based on the gesture input, which controls the pan/tilt servo motors. The Raspberry Pi boards transmit the video signals to a communication network where the embedded system will be able to receive the video signals. Based on the user input, the embedded system will transmit the desired video signal to a display for the user to see.

Servo Motors

The system includes two pairs of servo motors (per camera). The motors are attached to the case that houses the Raspberry Pi and the camera. The motors are hardwired to the embedded system, which will provide the PWM signals that control their position. By incorporating two motors to the camera mount, the user is able to control both the horizontal and vertical angle of the camera.

Raspberry Pi and Camera Assembly

There are two Raspberry Pi 3B computers, each with an attached camera. They process the video and send it to the embedded system across the communication network. The Pi cameras connect directly to the Raspberry Pi 3b and have the ability to stream live video in 1080P, while also recording to an SD card.

Monitor

The monitor has three different display modes, one to show both camera feeds at the same time and a full screen mode for each camera. The video feed is sent to the monitor from the embedded system. The selection of display mode is based on the gestures made by the user.