Real-Time Fall Detection System

The aim of this project is to correctly detect the fall of a person and inform his/her caretaker by sending the message. It is done with the help of a waistband to which all the equipment is fixed. For this, 2 tri-axial accelerometers- one on the STM32F4 discovery board and an external MPU-6050, Zig-Bee transmitter and receiver modules and a buzzer are used. The STM32F4 Discovery board follows the SPI protocol to communicate with the onboard accelerometer (LIS3DH) while the MPU-6050 follows the I2C communication protocol. The Zig-Bee communicates with the microprocessor via the UART protocol.

The Zig-bee transmitter is connected to the STM board and the receiver is connected to the laptop on which the message can be observed through the XCTU. Once the power supply is provided to the equipment, both the accelerometers start collecting the values of acceleration in three dimensions. As the output data rate is set to 25Hz, 25 samples of data will be collected per second. For each sample, the SVM parameter is calculated simultaneously for both accelerometer values. SVM parameter is the square root of the sum of squared values of the accelerations in each direction per sample. Whenever the average of the two SVM values is observed to be greater than the threshold of 1800 mg, a **possible fall** message is sent to the caretaker. From then on, we need to confirm if it is an actual fall or not. For this, the SMA parameter is used. It is the mean of the body component of the accelerations along the three dimensions per each sample. First, the body components of accelerations are to be obtained. For this, the acceleration components are passed through a first-order IIR low pass filter to get the gravity component of the acceleration. This gravity component is subtracted from the actual values to get the body components using which SMA is found. SMA values are calculated separately for both the accelerometers and the average value is found per second (25 samples). The SMA average is calculated for 20 seconds. At any point, if the average value is greater than the threshold of 80 mg, it indicates that the person is moving. Hence it is not an actual fall. So, a **no fall** message is sent via UART and we stop calculating SMA and continue the steps in the main loop where we check for a possible fall. Even after 20 seconds, if the SMA threshold is not reached, then a **fall confirmed** message is sent and the buzzer goes on.

The threshold values are obtained from the multiple test cases that are implemented. This system was tested by a person performing various activities like walking, running, sit to stand, stand to sit, fall followed by inactivity for 20 seconds, fall followed by some activity, climbing stairs, walking on uneven surfaces. The system could give the desired output for all the activities. It has been observed that the efficiency can be improved by using a higher-order IIR filter, training the system to set the threshold automatically by considering the height and weight of the person wearing the device.

Considering the future scope of the presented equipment, a GSM module can be included in the place of the Zig-bee, which would enable the device to communicate over long distances. For improving the efficiency and speed of fall detection, onboard or external gyroscopes can also be deployed with the equipment. Better filtering techniques and behavioral learning algorithms may also be used.