

Problem Statement

The amount of time it takes for a fallen senior citizen to receive help after a fall is considerable. The current available solutions are not adequate in the event of a senior citizen being unconscious.

Our Solution

The solution that was decided was to design a self-activating alert system which provides both pre and post fall data analytics.

Motivation and Significance

- Falls present a very serious issue for senior citizens with one fifth of all falls causing a serious injury[1].
- Annually 2.8 million people are seen in the emergency room for falls; 800,000 of them will need to be hospitalized for injuries received from that fall.
- Additionally, these falls cause serious injuries to senior citizens as 95 percent of hip fractures are caused from falling. These falls could also cause some sort of traumatic brain injury[1].
- Medical devices, such as Life Alert, naturally assumes the user knows that they are wearing the device, and hence have the ability to interact with it.
- Every 11 seconds an elderly person is treated in a hospital due to a fall, and every 19 minutes an elderly dies from a falling incident.

Project Hierarchy Diagram

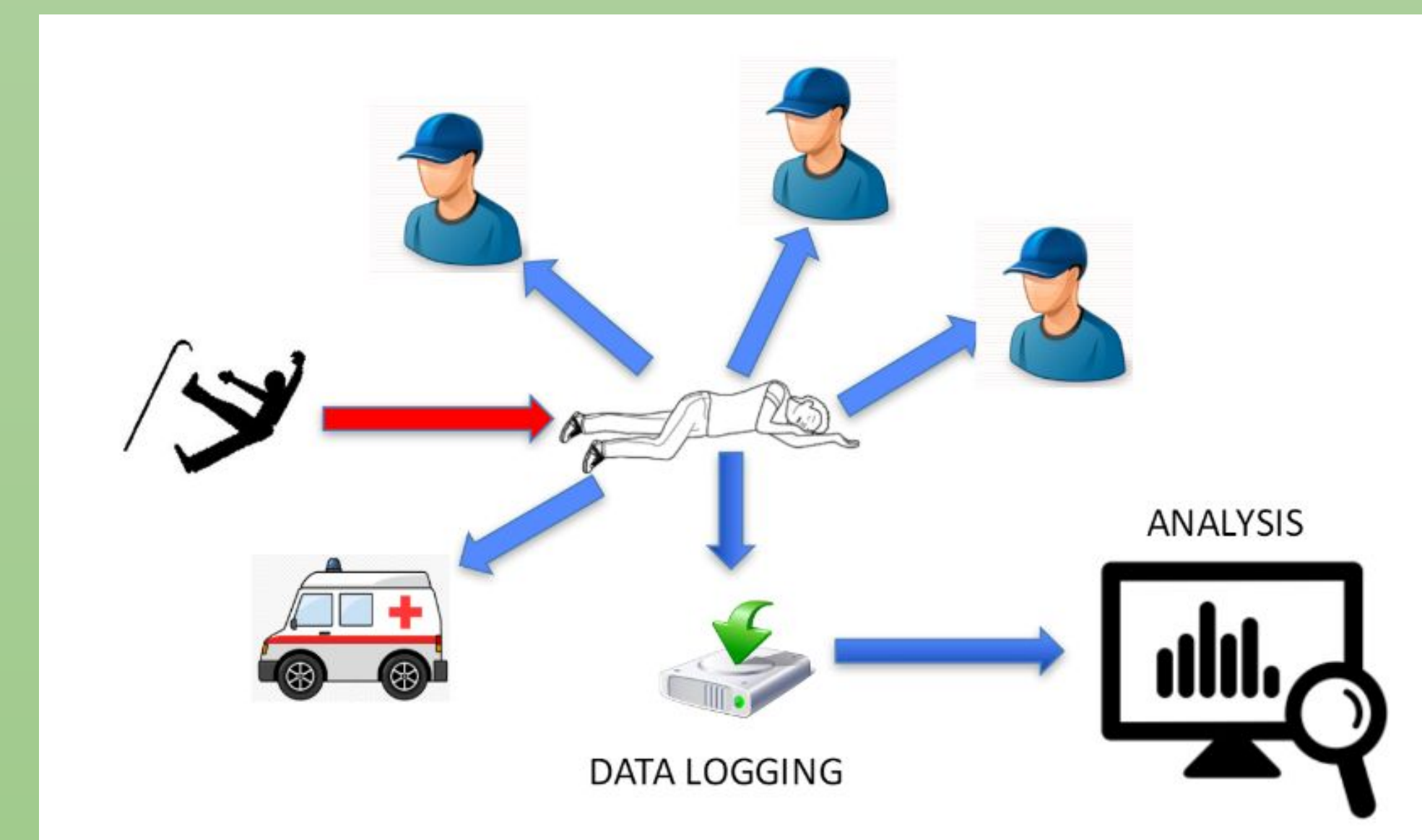
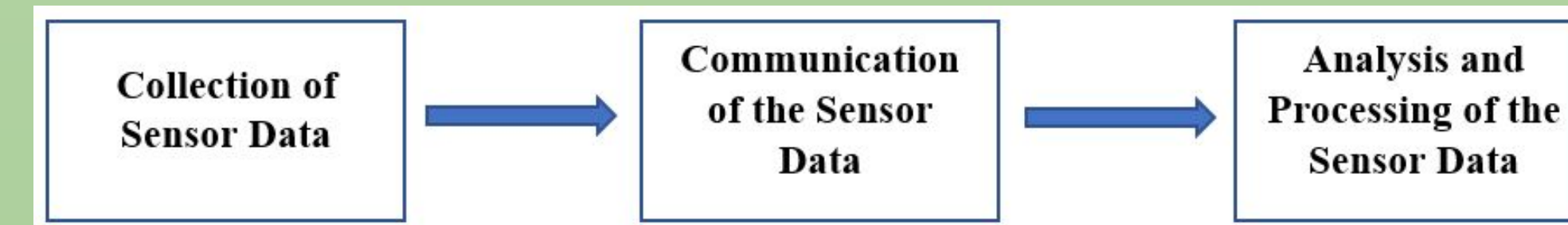


Figure 1a. and1b. Design Process

System Overview

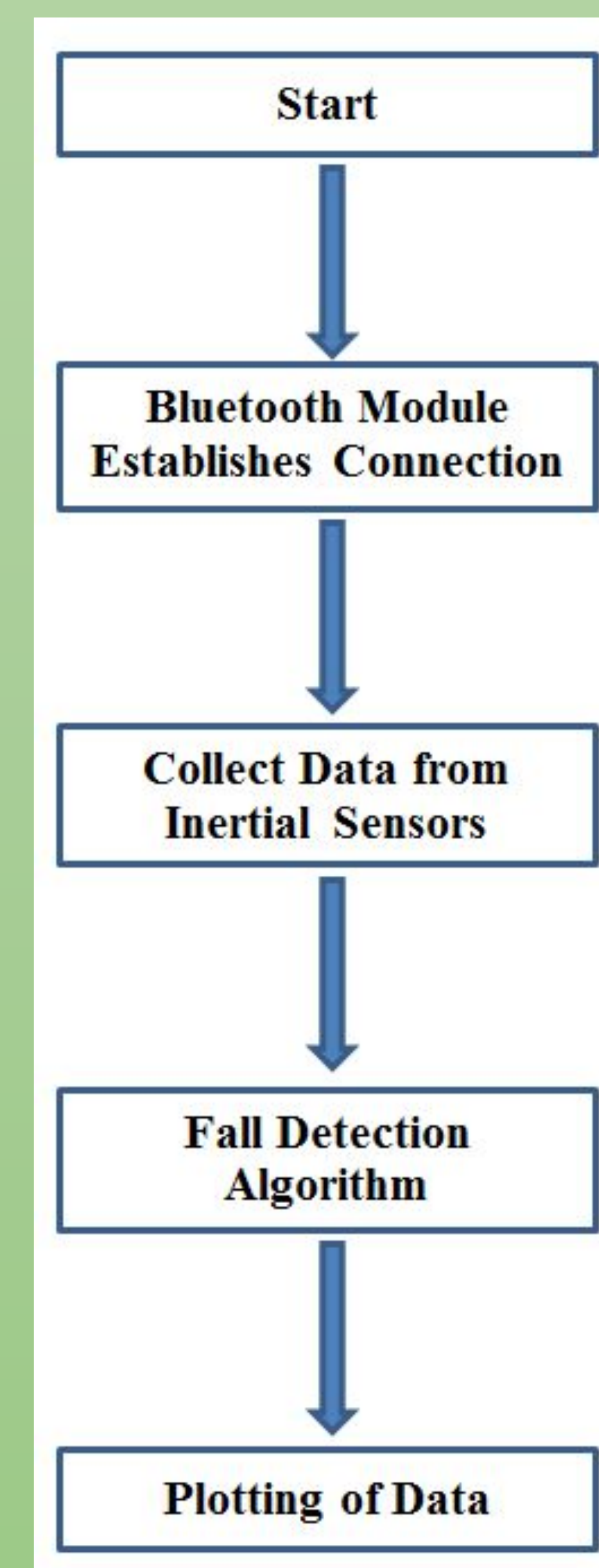


Figure 2. System Flow Chart

Design Constraints

- Develop a compact, dependable, self-activating system
- Write device drivers that will accurately detects falls and eliminates false positives
- Minimizes energy consumption
- Maximizes battery life of the device

Design Approach

- Fall Detection Algorithm:**
 - Determines that the acceleration of the data is higher during a fall
 - Determines that the fallen person is at rest after the fall
 - Monitors the acceleration of the data
 - Determines experimentally the optimal parameters to be used
- Saving Data:**
 - Data is saved onto a microSD card
 - Format for data that is saved is time, accelerometer, gyroscope, magnetometer
 - Logs data of before, after and during of the fall

Raw Data

Time (ms)	ACC_X	ACC_Y	ACC_Z	MAG_X	MAG_Y	MAG_Z	GYP_X	GYP_Y	GYP_Z
63391583	-53.0	-232.0	41.0	278.0	-512.0	221.0	-14.0	32.0	-9.0
63391635	-54.0	-231.0	41.0	279.0	-529.0	221.0	-14.0	32.0	-9.0
63391649	-54.0	-231.0	40.0	280.0	-510.0	220.0	-15.0	33.0	-9.0
63391651	-53.0	-231.0	41.0	281.0	-513.0	219.0	-14.0	33.0	-9.0
63391685	-55.0	-231.0	41.0	278.0	-511.0	219.0	-14.0	33.0	-9.0
63391688	-54.0	-230.0	42.0	280.0	-514.0	220.0	-15.0	32.0	-9.0
63391725	-53.0	-231.0	41.0	280.0	-509.0	220.0	-14.0	32.0	-9.0
63391730	-53.0	-232.0	41.0	274.0	-516.0	224.0	-15.0	31.0	-9.0
63391797	-54.0	-231.0	41.0	283.0	-509.0	220.0	-14.0	31.0	-9.0
63391799	-53.0	-230.0	42.0	283.0	-511.0	220.0	-13.0	32.0	-9.0
63391800	-54.0	-230.0	41.0	281.0	-513.0	222.0	-15.0	32.0	-9.0
63391849	-53.0	-232.0	42.0	280.0	-514.0	222.0	-16.0	32.0	-9.0
63391863	-53.0	-230.0	41.0	278.0	-535.0	222.0	-13.0	32.0	-9.0
63391865	-53.0	-231.0	42.0	279.0	-512.0	221.0	-14.0	32.0	-9.0

Figure 3. Transmitted Raw Data

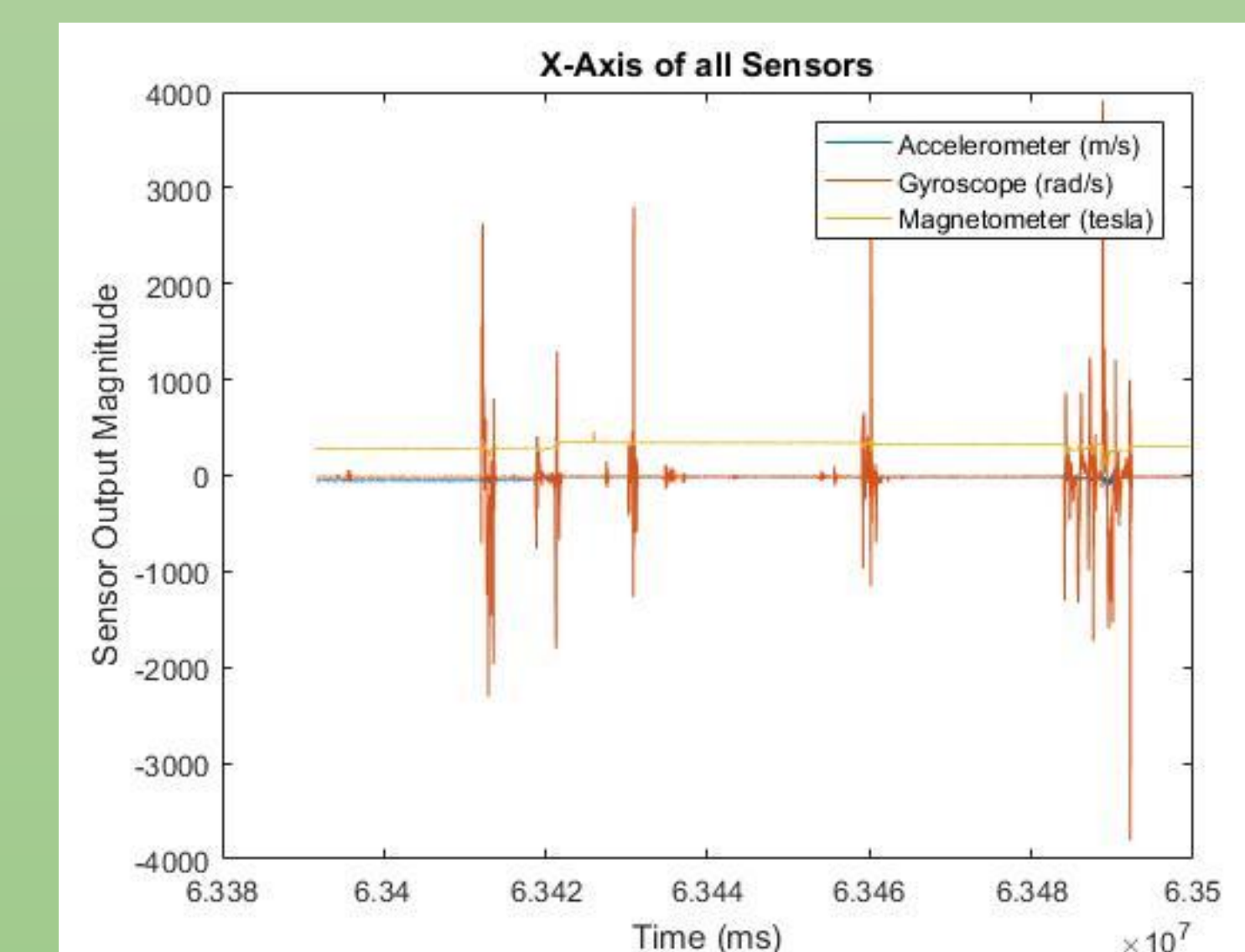


Figure 4. X-Axis of All Sensors

The figure shows the raw data of the X-axis of all three sensors. Each spike is a potential fall from the device being dropped. The X-axis of this figure is in time and Y-axis is the output of the sensors. The blue line represents the accelerometer, the orange line represents the gyroscope, and the yellow line represents the magnetometer.

Preliminary Results

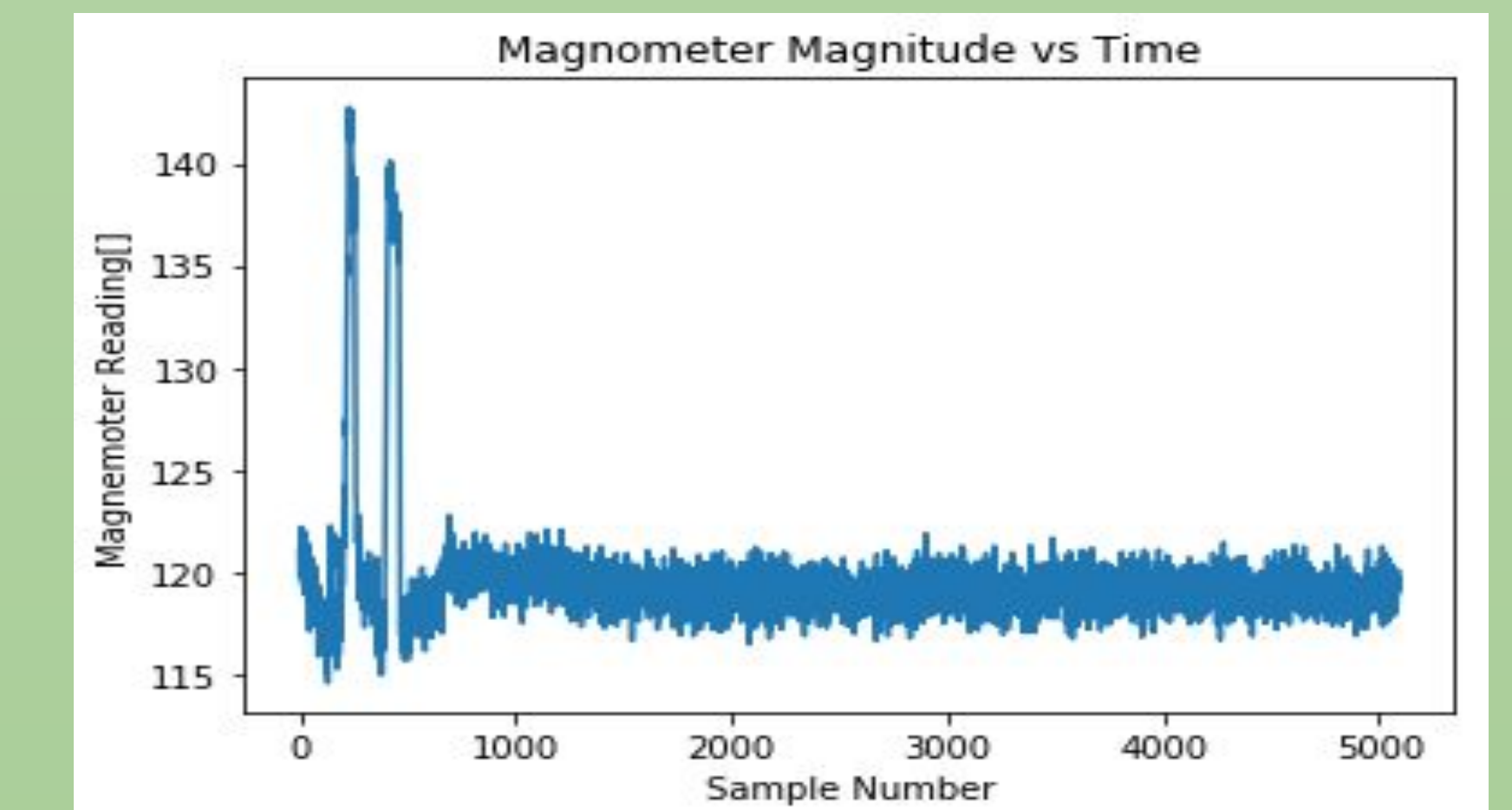


Figure 5. Magnitude of Magnetometer

The figure shows the magnitude of magnetometer plotted against time. Notice that there are two peaks at the beginning of the plot. Those two peaks represent where the fall has occurred.

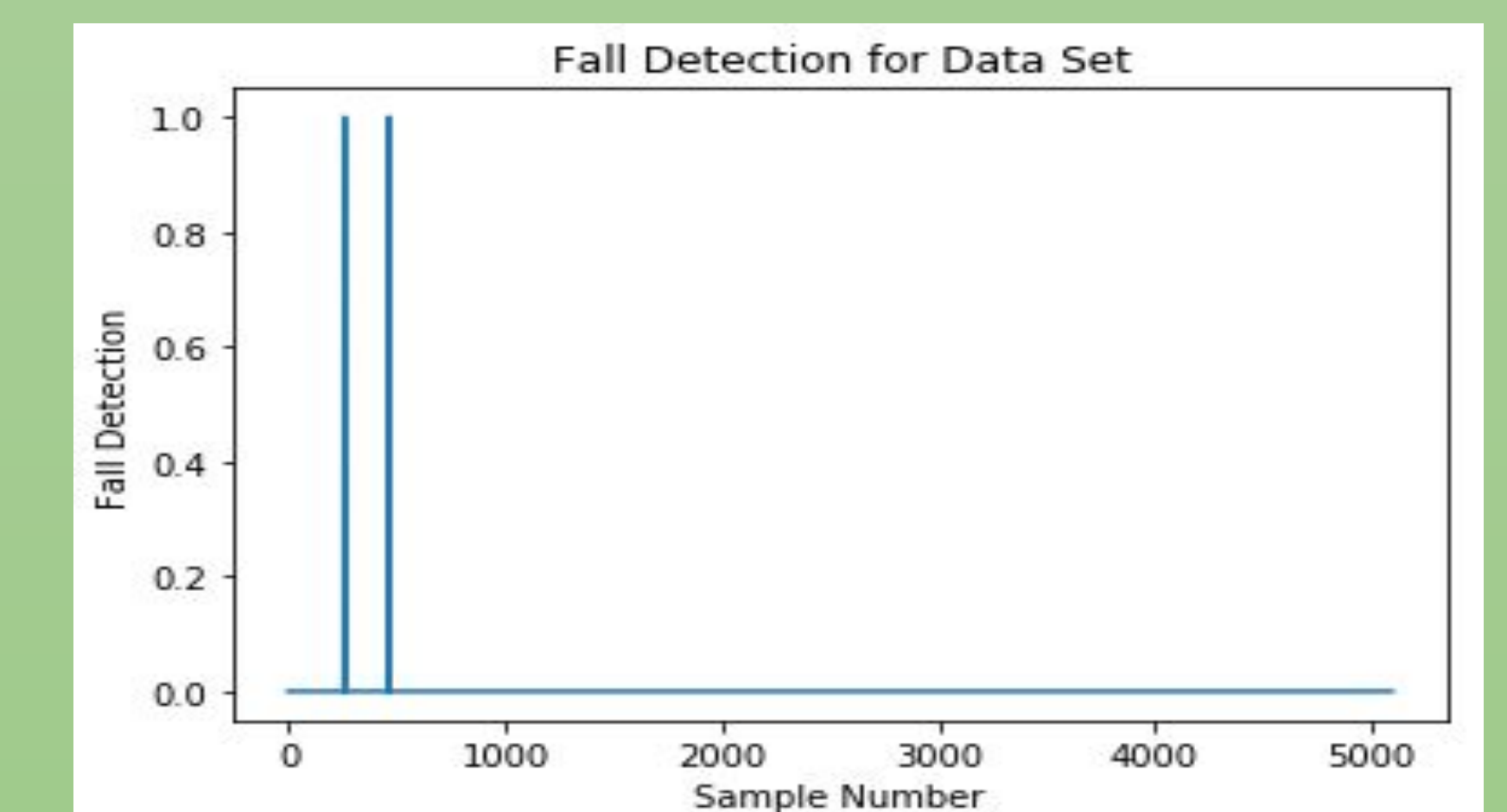


Figure 6. Fall Detection

The figure shows the detection of the falls with less noise in the signal. Notice that the two peaks are now straight lines that still represent the fall. When comparing Figures 5 and 6 it can be seen that the detection algorithm can find where a fall has occurred.

Conclusion

- Elimination of false positives in the fall detection algorithm
- Effectively allocate biometric data for future research
- Increased battery life
- Minimization of device size

References

[1] "Important Facts about Falls | Home and Recreational Safety | CDC Injury Center." [Online]. Available: <https://www.cdc.gov/homeandrecrationalafety/falls/adultfalls.html>. [Accessed: 16-Nov-2017].