

ABSTRACT

Individuals with Down Syndrome are at high risk of disorientation due to cognitive and communication limitations. These challenges can lead to emergency situations such as getting lost or being unable to ask for help. Based on interviews with parents of individuals with Down Syndrome, incidents of disorientation have occurred and caused significant concern. Therefore, a system capable of real-time movement monitoring is needed as a mitigation solution. The main problem addressed in this study is the lack of a tracking device that can monitor the location and physical activity of individuals with Down Syndrome securely, efficiently, and accessibly via a mobile application.

The proposed solution is to design and develop an Internet of Things (IoT)-based tracking system using GPS sensors, the MPU6050 accelerometer, the DHT22 temperature and humidity sensor, and an ESP32 microcontroller. The system transmits data in real-time using the MQTT protocol over a cellular network through the SIM7600G module, and displays the data through a cross-platform mobile application developed with Flutter. To predict physical activity, a Support Vector Machine (SVM) model is used, while data security is ensured with AES-GCM encryption so that only authorized parties can access the user's information.

The developed IoT-based GPS tracker system successfully fulfilled the primary research objective, which is to monitor the movement of individuals with Down Syndrome in real time. The system reliably reads and transmits sensor data using the MQTT protocol, with latency and power consumption remaining within acceptable limits for daily monitoring. The Support Vector Machine (SVM) model with a window size of 5 achieved the highest classification accuracy of 82.8% in activity prediction. Data security is guaranteed through AES-GCM encryption with processing times under 0.5 milliseconds, and payloads were confirmed unreadable in Wireshark tests. The mobile application demonstrated stable performance with an average latency of 2 seconds, and received positive feedback from 64 respondents, scoring above 4.8 in UI/UX evaluation. These results indicate that the system meets the technical specifications and has been well received by end users.

Keywords: *AES-GCM, Down Syndrome, IoT, MQTT, SVM*