Development of an Integrated IoT System for Remote Monitoring and Enhanced Safety Assurance in Outdoor Environments

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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DECLARATION

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Sri Lanka Institute of Information Technology or to any other institution for assessment for any other purpose.

Sign: ……  ……

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Date: ……2025-12-14……..…

ABSTRACT

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Making places safer outside for freely operating has also risen in priority especially in places with little or no communication facilities and people can go out for camping and hiking. In this study, a distributed Internet of Things (IoT) system incorporating geofencing, environmental monitoring and real-time positioning system to improve outdoor navigation and safety has been developed and tested. The system includes one main hub and a number of sub devices connected to ESP32 microcontroller and LoRa 433 MHz for communication in addition to GPS (Neo-7M) for position location purposes. Linear and angular displacement measurements and their data processing and recording were performed using sub-devices that incorporated GPS and other modules used for receiving and transmitting data over a LoRa network. Sub and the main devices demonstrated data on 0.96 inches OLED both devices which enable users to receive up to date responses. There is also a type of geofencing action in the system, where an alert is sent when a sub-device departs an area that has been defined. The geofencing alerts can be managed though a web dashboard that utilizes Node.js, Next.js, and Web-Sockets for dashboard and main hub interaction. The main hub was also able to send and receive updates from the internet and then transmit this information to the sub-devices over the LoRa network thus bridging the gap that existed between local and remote operation. From the initial results, the newly proposed system is able to provide secure communication, precise location coordinates and prompt geofencing alerts even in outdoor environments with poor network support. The subsequent steps will seek to enhance the energy consumption of the system, improve communication coverage, and make more tests in real-life scenarios to assess the system as a whole.

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TABLE OF CONTENTS

List of Figures

List of Tables