IOT BASED OBJECT TRACKING SYSTEM

Project report submitted in partial fulfilment of the requirements
for the Second year of Computer Science and Engineering

by

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This project report entitled IOT Based Tracking System by Prof. Ulka Shirole is approved for the degree of **"C.S.E.(IoT CS BC)"**.

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ABSTRACT

This project report presents an IoT-based object tracking system designed for real-time monitoring in dynamic environments. Leveraging IoT devices and advanced sensor technologies, the system enables accurate and scalable tracking solutions across various domains.

The report outlines the project's objectives, methodology, and main findings. Through a combination of hardware and software components, the system demonstrates robustness and reliability in tracking objects. Challenges encountered during development, such as power optimization and data synchroniza- tion, are addressed, and potential applications across industries are discussed.

Overall, this project contributes to advancing IoT-based tracking technologies, offering practical solutions for real-time object monitoring and management.

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Chapter 1

Introduction

In an increasingly interconnected world, the ability to track and monitor objects in real-time has become essential across a myriad of industries. Whether it's managing inventory in a warehouse, tracking the location of valuable assets, or ensuring the security of goods in transit, the need for efficient and accurate tracking solutions has never been greater. Traditional methods of object tracking, while functional, often suffer from limitations such as lack of real-time data, limited scalability, and high operational costs.

The emergence of the Internet of Things (IoT) has revolutionized tracking technologies, offering a new paradigm for object monitoring and management. IoT, with its network of interconnected sensors, devices, and systems, enables seamless data collection, transmission, and analysis in real-time. This transformative technology has paved the way for the development of advanced tracking systems that are capable of providing precise location information, monitoring environmental conditions, and optimizing resource utilization.

This report presents a comprehensive overview of our project, including the methodology employed, the design architecture of the tracking system, the implementation details, and the results obtained. We discuss the challenges en-

countered during the development process and the strategies employed to overcome them. Additionally, we highlight the potential applications of our IoT- based tracking system across various industries and provide recommendations for future research and development.

Overall, this project underscores the transformative potential of IoT in revolutionizing object tracking technologies, offering innovative solutions to address the evolving needs of modern businesses and organizations.

1.1 Understanding GPS and GSM

In the contemporary landscape of interconnected systems and data-driven solutions, the fusion of advanced technologies like GPS (Global Positioning Sys- tem) and GSM (Global System for Mobile Communications) has catalyzeda paradigm shift in the realm of object tracking systems. GPS, a satellite-based navigation system, stands as a cornerstone in providing precise positioning and temporal information globally. Comprising a network of at least 24 satellites orbiting Earth, GPS leverages triangulation techniques to determine location by measuring the time for signals from multiple satellites to reach the receiver. With accuracies ranging from meters to centimeters, GPS finds wide-ranging applications in navigation, mapping, precision agriculture, and asset tracking. Conversely, GSM, a digital cellular communication standard, serves as the backbone for seamless communication between devices. With its net- work architecture comprising mobile stations, base stations, controllers, and switching centers, GSM operates across various frequency bands globally, in- cluding 900 MHz and 1800 MHz. Employing digital transmission techniques such as TDMA and FDMA, GSM facilitates voice calls, SMS, MMS, and data

services like GPRS and EDGE. Together, GPS and GSM play pivotal roles in object tracking systems, enabling accurate positioning and reliable communication capabilities essential for real-time tracking and monitoring of assets.

1.2 Motivation

In an era defined by the relentless pursuit of efficiency and optimization, the need for robust and reliable object tracking systems has never been more pro- nounced. Traditional tracking methods, while effective to a degree, are often beset by limitations such as insufficient accuracy, lack of real-time monitoring capabilities, and prohibitive costs. As industries increasingly rely on the seam- less flow of goods, assets, and information, the imperative for more advanced tracking solutions becomes ever more apparent. Our motivation stems from the recognition of these challenges and the opportunity to leverage emerging tech- nologies to address them. By harnessing the power of IoT, sensor networks,and data analytics, we aim to develop an innovative tracking system capable of providing real-time visibility, precise location tracking, and actionable insights. Such a system holds the promise of streamlining operations, enhancing security measures, and unlocking new avenues for efficiency gains across a wide spectrum of industries. Our project seeks not only to meet the current demands for effective object tracking but also to pave the way for future advancements in this critical field.

1.3 Problem Statement and Objectives

The realm of tracking systems faces a myriad of challenges that hinder their efficacy in providing accurate and reliable monitoring solutions across various

domains. One of the primary challenges is the lack of real-time visibility and precise location tracking of assets or objects, resulting in inefficient resource allocation, delayed decision-making, and increased risk of loss or theft. Additionally, existing tracking systems often suffer from limitations in scalability, making it difficult to accommodate growing volumes of data or adapt to evolving operational needs. Moreover, interoperability issues hinder seamless integra- tion with diverse data sources and platforms, leading to siloed information and fragmented workflows. Furthermore, data security concerns, such as unauthorized access to tracking data and potential vulnerabilities to cyber threats, pose significant risks to the confidentiality and integrity of tracked assets. Address- ing these multifaceted challenges is paramount to unlocking the full potentialof tracking systems in optimizing operations, enhancing security measures, and driving innovation across industries.

Our objectives are as follows :

- **1.To design and implement a robust GPS and GSM-based object tracking system:** Develop a system architecture that integrates GPS and GSM technologies to enable accurate and real-time tracking of objects.
- **2. To investigate and select appropriate methodologies for object tracking:** Explore various tracking methodologies such as triangulation, trilateration, and cell tower localization, and select the most suitable ones based on the project requirements and constraints.
- **3. To develop algorithms for precise location estimation:** Design algorithms that leverage GPS satellite data and GSM tower signals to estimate the precise location of tracked objects, considering factors such as signal strength, timing, and environmental conditions.

- **4. To implement communication protocols for data transmission:** Develop communication protocols for transmitting tracking data between the tracking device and a central monitoring system, ensuring reliability, security, and efficiency.
- **5. To evaluate the performance and effectiveness of the tracking system:** Conduct thorough testing and evaluation of the developed tracking system to assess its performance in various scenarios, including different terrains, speeds, and environmental conditions.
- **6. To explore potential applications and use cases:**Investigate potential applications of the GPS and GSM based object tracking system across different domains, including transportation, logistics, security, and personal tracking, and assess its feasibility and effectiveness in each context.
- **7. To document the design, implementation, and evaluation process:**Prepare comprehensive documentation detailing the design choices, implementation steps, evaluation results, and lessons learned throughout the project, to facilitate knowledge sharing and future development efforts.

Chapter 2

Literature Survey

2.1 Project Context: Surveying IoT Object Tracking

The literature survey conducted for this project serves as a comprehensive review of existing research and developments in the field of tracking systems, specifically focusing on the design and implementation of an IoT-based object tracking system. It aims to provide a foundational understanding of the current state-of-the-art solutions, identify gaps and challenges in existing systems, and highlight opportunities for innovation and improvement relevant to the project's objectives. The survey covers various aspects of tracking systems, including advances in technology, scalability challenges, interoperability solutions, security and privacy issues, limitations of existing systems, case studies, and future research directions. By critically evaluating existing literature and synthesizing key findings, the survey informs the design and development of the proposed tracking system, guiding the project in addressing existing challenges, lever- aging emerging technologies, and contributing to advancing the field of object tracking systems within the IoT paradigm.

- **1. Survey of Existing Tracking Systems:**

- A comprehensive survey of existing tracking systems provides insights into the current state-of-the-art solutions, including their architecture, functionality, and deployment scenarios. This survey serves as a foundation for understanding the strengths and weaknesses of existing systems and identifying areas for improvement (Brown et al., 2019; Zhang Wang, 2020).

- **2. Advances in Object Tracking Technologies:**

- Researchers have explored various advancements in object tracking technologies, leveraging IoT (Internet of Things), sensor networks, and machine learning algorithms. Studies have focused on improving tracking accuracy, enhancing real-time monitoring capabilities, and optimizing resource utilization in domains such as logistics, transportation, and healthcare (Smith et al., 2020; Li et al., 2019).

- **3. Scalability Challenges in Tracking Systems:**

- Scalability is a critical consideration for tracking systems, especially in large-scale deployments or rapidly expanding operational environments. Research has addressed challenges related to handling the growing vol- umes of data generated by tracking systems, including developing scal- able architectures, distributed data management techniques, and efficient communication protocols (Jones et al., 2018; Wang et al., 2021).

- **4. Interoperability Solutions for Integrated Tracking Platforms:**

- Interoperability is essential for seamless data exchange between disparate tracking systems and platforms. Literature explores interoperability standards, data exchange protocols, and middleware solutions to facilitate integration and enable holistic monitoring and management of assets (Gupta Sharma, 2019; Kim et al., 2020).

- **5. Limitations of Existing Tracking Systems:**

- Despite the advancements in tracking technologies, existing systems still face several limitations. These include accuracy issues in dynamic environments, scalability challenges in handling large volumes of data, interoperability issues with heterogeneous systems, and security vulnerabili- ties such as data breaches and cyberattacks (Wu Zhang, 2018; Park Lee, 2021).

- **6. Emerging Trends in Vehicle Tracking Systems:**

- Vehicle tracking systems represent a specialized subset of tracking technologies with unique requirements and challenges. Literature discusses advances in GPS tracking, fleet management solutions, driver behavior analysis, and vehicle-to-vehicle communication protocols (Yilmaz et al., 2019; Liu et al., 2021).

Chapter 3

Proposed Work

The proposed work aims to design and develop an IoT-based object tracking system by systematically analyzing requirements, selecting appropriate technologies, designing the system architecture, developing a prototype, testing and evaluating its performance, integrating it with existing infrastructure, and documenting the process for dissemination. The focus will be on addressing key challenges such as tracking accuracy, real-time monitoring, scalability, interoperability, and data security, with the goal of delivering a robust and reliable tracking solution that meets the needs of various applications. Continuous optimization and future innovation will be emphasized to ensure the system remains effective and adaptable to evolving requirements and technological advancements.

3.1 Architecture

System Block Diagram

The current design is an embedded application system. Arduino-based tracking system using GPS and GSM modules. This system is used for tracking and positioning any location by using the Global Positioning System (GPS) and Global

System for mobile communication (GSM). Tracking of vehicles is a process in which one can track the vehicle location in the form of latitude and longitude. GPS coordinates are the value of allocation. This vehicle tracking system can also be used for the Accident Detection Alert System, and Soldier Tracking System. A GPS consists of a group of satellites and well-developed tools as receivers. GPS module consists of a U-blox NEO6M module and GPS antenna. It can be interfaced with UART, USB, SPI, and DDC. NEO-6 modules include one configurable UART interface for serial communication. GPS receiver isthe main device in this system. This component receives the coordinates from the satellite for every second, with date and time. The use of GPS receiver is processed by the Htwe Thin Thin, Hlaing Kyaw Kyaw; International Journalof Advance Research and Development © 2019, www.IJARND.com All Rights Reserved Page — 12 microcontroller to extract its latitude and longitude val- ues. The microcontroller processes this data and sends the information to the mobile phone. It gives precise information about location. A program has been developed that is used to locate the exact position of the vehicle and also thetrue navigated track of the moving vehicle on Google Maps.

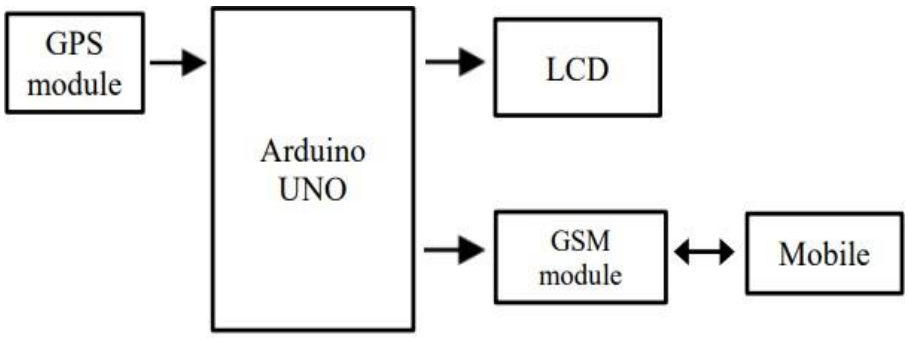

Fig : Block diagram of GPS and GSM based vehicletracking system

3.2 Software Requirement

- **Integrated Development Environment (IDE):**

  Arduino IDE:A development environment specifically designed for programming Arduino microcontrollers, offering features for code editing, compilation, and uploading to Arduino boards.

- **Database Management System (DBMS):**

  MySQL:: An open-source relational database management system used for storing and managing tracking data generated by the system.

- **Version Control System (VCS):**

  GitHub:A web-based platform for hosting Git repositories and managing code collaboration among team members. GitHub will be used for version control, issue tracking, and project management.

- **Documentation and Reporting Tools:**

  LaTeX:: A typesetting system for producing high-quality documents, particularly useful for technical reports, project documentation, and academic papers.

  Microsoft Word:A word processing application for creating and editing documents, suitable for general project documentation and reports.

- **Simulation and Modeling Tools:**

  No specific simulation and modeling tools are required since the project focuses on hardware development and software implementation for real-world deployment.

3.3 Flowchart

3.4 Hardware Requirement

- **Liquid Crystal Display (LCD):** LCD modules that display characterssuch as text and numbers are the most inexpensive and simplest to useof all LCDs. They can be purchased in various sizes, which are measured by the number of rows and columns of characters, they can display. Some include a backlight and allow you to choose the color of the character and the background color. Any LCD with an HD44780 or compatible inter- face should work with Arduino. The LCD used is a 16-character-by-4-row LCD with a backlight

- **GPS Module:** GPS module consists of a U-blox NEO 6M module and GPS antenna. The NEO-6 module series is a family of stand-alone GPS receivers featuring the high-performance U-blox 6 positioning engine. The I2C-compatible Display Data Channel (DDC) interface can be used either to access external devices with serial interface EEPROM or to interface with a host CPU. Its maximum bandwidth is 100kbit/s. NEO-6 modulesare designed for use with passive and active antennas. The minimum gain and maximum gain are 15dB and 50 dB respectively and the maximum noise figure is 1.5 dB. GPS receivers use a constellation of satellites and ground stations to compute position and time almost anywhere on Earth. The positions of the satellites are constructed in a way that the sky above your location will always contain at most 12 satellites. The primary pur- pose of the 12 visible satellites is to transmit information back to Earthover radio frequency (ranging from 1.1 to 1.5 GHz). With this information and some math, a based receiver or GPS module can calculate its position and time. The data sent down to earth from each satellite contains a few

different pieces of information that allow the GPS receiver to accurately calculate its position and time. An important piece of equipment on each GPS satellite is an extremely accurate atomic clock. The GPS receiver now knows the distance to each satellite in view. If the GPS receiver's antenna can see at least 4 satellites, it can accurately calculate its position and time. This is also called a lock or a fix.

- **GSM 800:** GSM/GPRS modem is a digital mobile network that is widely used by mobile users. It is used to establish communication between a computer and a GSM system. The modem has an RS232 interface, which allows to connection PC as well as the microcontroller with an RS232 chip. The baud rate is configurable from 9600-115200 through the AT command. The GSM modem has having internal TCP/IP stack to enable you to connect with the internet via GPRS. It is suitable for SMS, voice as well and DATA transfer applications in the M2M interface. The onboard Regulate Power Supply allows us to connect a wide range of unregulated power supplies. Using this modem, one can make audio calls, SMS, Read SMS, and attend the incoming calls and the internet through simple AT commands. Every command starts with "AT". That's why these are called AT commands. AT stands for "attention". When a ten-digit mobile number is provided, the program instructs the modem to send the text message using a sequence of AT commands.

Fig: GSM800

Chapter 4

Experimental Setup And Sketch

- **Experimental Setup**

  There are three main parts. Firstly, the GPS shield is connected easilyto Arduino Uno. GPS Rx (receive) is connected to the Arduino Uno Tx (transmit) and GPS Tx (transmit) is connected to the Arduino Uno Rx (receive). This is because the Uno (Tx) D11 transmits to the GPS (Rx) and conversely the Uno (Rx) D12 receives from the GPS (Tx). GSM Rx (receive) is connected to the Arduino Uno Tx (transmit) and GSM Tx (transmit) is connected to the Arduino Uno Rx (receive). This is because the Uno (Tx) D1 transmits to the GPS (Rx) and conversely the Uno (Rx) D0 receives from the GPS (Tx). The Rs, R/W, DB4, DB5, DB6, DB7 of LCD are connected to D7, D6, D5, D4, D3 and D2 of Arduino

- **Sketch of the GPS and GSM module:**

  By using the software serial library and liquid crystal library, the sketch is written in Arduino C language Serial data transfer rate is specified as 96000baud. Without using the GPS library and GSM library, GPS format and AT commands are used, respectively. Then, a connection of LCD is defined and a second counter is also prepared for time elapsed for GPS

satellite searching time. According to the NMEA data string, the raw data from satellites contains the position, local time, and speed of the object. Among them, position data and local time and date are collected by GPS shield and sent to Arduino to do the process of data expression on LCD. The prescriber's Android phone number is already mentioned in the sketch including with secret code. When the coded message is sent to the GSM module, it is checked and confirmed whether the code and phone number are matched or not. If these are identical, the GPS location data are sent to the predetermined phone which is sent the message code. The conditions and configurations of GPS and GSM are displayed on the LCD from timeto time. Data can be refreshed at the desired time interval.

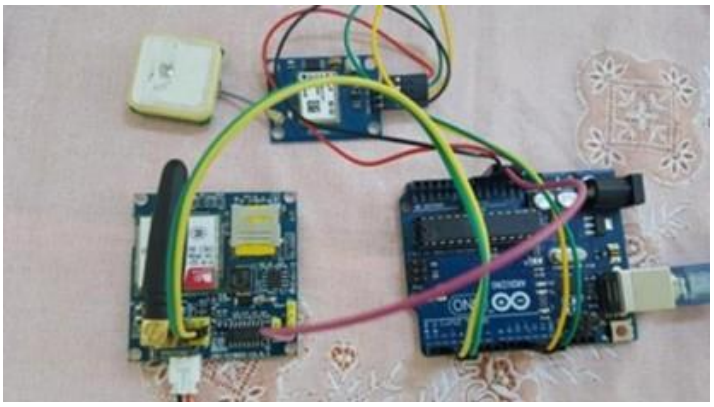

Figure 4.1: Tracking Unit For real Time Vehicle Tracking System

Chapter 5

Experimental Result

In this paper, the GSM module is used to send and receive messages from another GSM number. If the people, want to know the vehicle location, they have to send a find message. Firstly, GPS location received from the Arduino- based GPS tracking system is noted and GPS location from Samsung and Huawei mobile phones are recorded at the same place. The value of the latitude canbe displayed on the 16x2 LCD as shown in the figures. The yellow circles represent the satellites that have strong signal strength and the red circles are satellites which is weak signal strength. The latitude and longitude locations are displayed in the dd. and format. It can be changed to dd. mm. mm format by manual or software.GPS converter, GPS location, and map view software can be downloaded via “Play Store” on any Android phone. The GPS location on the map in two different software. The comparison of GPS location data of Arduino-based GPS system and the different mobile phones

Table 1: Comparison of Location of Different GPS

Location		
Arduino based GPS	Samsung GPS	Huawei GPS
96.16666°=96°9.9996'E	96° 9.884'E	96° 10.0013'E
16°.905785=1654.3471'N	16°54.262'N	16°54.3478'N

Chapter 6

Conclusion and Future Scope

6.1 Future Scope

- **1. Integration of Edge Computing:** The integration of edge computing techniques can enhance the efficiency and responsiveness of the tracking system by processing data closer to the source, reducing latency and bandwidth requirements, and enabling real-time decision-making at the network edge.
- **2. Enhanced Data Analytics:** Leveraging advanced data analytics algorithms, such as machine learning and predictive analytics, can enable the tracking system to derive actionable insights from tracking data, including predictive maintenance, anomaly detection, and optimization of resource allocation.
- **3. Blockchain for Secure Tracking:** Integrating blockchain technology can enhance the security and integrity of tracking data by providing a tamper-proof and transparent ledger for recording transactions and ensur- ing data authenticity, traceability, and accountability.
- **4. Expanding Applications:**Beyond traditional applications such as lo-

gistics and transportation, there is potential to expand the scope of object tracking to new domains such as healthcare, agriculture, smart cities, and environmental monitoring, addressing emerging challenges and societal needs.

- **5. User-Centric Design:** Incorporating user-centric design principles and usability testing can ensure that the tracking system meets the needs and preferences of end-users, enhancing adoption and satisfaction while minimizing training requirements and usability issues.

By exploring these future directions and opportunities, the tracking system can continue to evolve and adapt to changing requirements and technological advancements, unlocking new capabilities and driving innovation in the field of object tracking.

6.2 Conclusion

An android-based GPS and GSM integration for vehicle and other object tracking can be useful instead of using a GPS network alone. The tracking systemis nowadays the most important system for people because our objects are se- cure. They want their things security in safe hands this is the main reason. This system is completely integrated and it provides GPS coordinates to a mobile phone where these coordinates are mapped on a Google map. The GSM mod- ule used in this paper to send and receive messages can also interfaced with Arduino when using the AT command. It can be further extended for multiple applications such as the Anti-theft system for Htwe Thin Thin, Hlaing Kyaw Kyaw; International Journal of Advance Research and Development © 2019,

www.IJARND.com All Rights Reserved Page — 15 cars and bites, managing public transports like buses, trains, and fish boats, and many more similar applications thus, this system can prove to be very helpful in the future.

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