Telegram based GPS Tracker

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Abstract

Global Positioning System (GPS) tracking systems are critical in asset, vehicle, and person tracking yet many of the systems currently on the market are hampered by their high cost, accessibility challenges, and the proprietary nature of current tracking systems. This research presents a GPS tracking system via the Internet of Things (IoTs) using a widespread popular social media platform, Telegram. The study is on the application of a Telegram-based GPS tracking system that includes low-cost, portable and user-friendly features. Built around ESP8266 microcontroller and Neo-6M GPS module, the system makes use of the telegram bots to enable real-time information and location updates. Field tests were done in ten cities in Nigeria and the results tested the performance of the system in terms of distance, response time, and speed-accuracy. Results showed a consistent reading of speeds with a margin of error of ±0.2 km/h and low times in response at various arbitrary geographical locations. The system was found to be reliable, energy-efficient and intuitive, which demonstrated its potential as a-scala solution for real-time tracking in both urban and remote environments.

Keywords- GPS Tracking System; Real-Time Location Updates; Internet of Things; ESP8266 Microcontroller; Telegram Bot

I. INTRODUCTION

The progress of Artificial Intelligence (AI)is a major driver of change in the logistics industry, as it leads to substantial opportunities to increase operational efficiency, reduce costs, and utilize resources more efficiently. This shift is made possible by the implementation of a combination of sophisticated technologies, such as IoT, big data analytics, and cloud computing, which collectively enable the automation and smart management of logistical operations (Ye et al., 2025; Lou & Zhuo, 2025). Key needs in industrial environments include transparent real-time information, robust data security, and reliable identification techniques, which are integrated with advanced planning and analytical capabilities (Helo & Thai, 2024).

An emerging focus in modern logistics is on public transportation services. These are broadly classified into two models: systems that adapt to live user requests and those that use historical GPS data to predict and design routes (Siddique et al., 2024). Maintaining constant infrastructure availability, enabling seamless data exchange, and managing resources effectively are all dependent on the continuous monitoring of system performance metrics that indicate real-time usage (Dos Passos et al., 2024).

Within healthcare, the Internet of Things (IoT) is highly important for enabling a proactive mode of patient care through remote monitoring, which improves the patient and healthcare provider relationship (Puri et al., 2024). However, conventional means of monitoring are facing growing challenges regarding their performance, security, and competitiveness in the market (Musarat et al., 2024). A significant number of current systems are extremely expensive to implement and sustain (Heravi et al., 2024) or are built on

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closed platforms which limit their scalability and accessibility to users (Muhammed & Saeed, 2025). Although specialized solutions have been created, attaining a balance of low cost and comprehensive capabilities remains a significant challenge (Lago et al., 2024).

In view of these limitations, this current study suggests a less-complicated and low-cost GPS tracking system using the popular Telegram messaging application. The infrastructure of Telegram provides an adaptable and decentralized foundation for building an intuitive and multi-use tracking tool. This system involves using Telegram bot applications linked with a GPS system to provide real-time location data, historical route tracking, and geofencing functions without requiring expensive dedicated hardware or customized mobile applications. This strategy contributes to the modernization of monitoring technology by using inexpensive parts and an intuitive design, thereby improving GPS usage in industrial and transportation contexts.

II. RELATED WORKS

Research and development over the last two decades have resulted in various systems for location tracking that vary from systems using Global System for Mobile Communication (GSM) to those based on the Internet of Things (IoT). In 2024, Yazid and Othman proposed a small wearable device to help the visually impaired navigate by sensing real time obstacles using an ultrasonic sensor measuring distance ranging from 2 to 300 cm. That same year, Maukana and Misbah (2024) were able to enhance motorcycle safety by using the newly introduced features of the sensors-RFID (Radio Frequency Identification) and ESP32 microcontroller. Both systems combined enable connectivity while the ESP32 processes the graphics data and sends the GPS location alerts to be used to the user.

Also contributing to this field, Santoso et al. (2025) developed a smart agriculture prototype for soybean farming that is based on NodeMCU and the Blynk app. Their design includes a soil moisture sensor, and a network time protocol module that enables viewership of the growing conditions, and in all, the system synchronise temporal information. Similarly, Banshiwal et al. (2023) executed a detailed review of vehicle tracking systems using GSM and GPS, and explained how the result of GPS data could be sent by SMS (Short Message Service) and be shown on a platform like Google Earth and Google Maps.

Pathak et al. (2024) produced "Smart Shield," a wearable health and GPS tracking health tool based on ESP8266 and Straitjack centrifugal force. Some of its features include an accelerometer for detecting falls, sensors for heart rate detection and SpO2 for blood hemoglobin measurement. The device triggers real-time GPS warnings via Telegram messages to pre-selected contacts when an emergency and/or unusual health event occurs. Similarly directed at safety, Naveen and Managuli (2023) developed an accident detection system with accelerometers and flame sensors to detect the occurrence of a crash. Their solution, based on NodeMCU and Neo-6M GPS modules, sends precise location through Telegram. Also, the system can accommodate continuous monitoring with the aid of Google Maps.

Spinning off from simple tracking, Sandhya et. al. (2024) designed a sophisticated vehicle tracking system using ESP32 and GSM SIM808 integrated modules. Their system can monitor the following: fuel consumption amount, distance between vehicles, vehicle's speed and the number of passengers. Meanwhile, Casanova et al. (2025) discussed leaps forward in navigational technologies that are tailored for the visually impaired, including the use of precise GPS, ultrasonic sensors, Bluetooth usage and haptic feedback in wearable technology.

For locations at which the GPS signals are weak, Song et al. (2016) developed a two-tiered algorithm using an Extended Kalman Filter (EKF) that combines the information from an RFID sensor with that collected from drivers via autonomous steering sensors such as accelerometer, odometer, compass and gyroscope, to estimate pertinent parameters. In addition, Nur (2025) has helped in the creation of a hybrid positioning system based on the GPS, Wi-Fi, Bluetooth, and RFID. In their structure, they used the concept of geometric modeling, probabilistic analysis and machine learning to boost the location accuracy in different fields like healthcare and transportation. These systems should be able to be adjusted to new contexts, and process sensor data in real-time which defines their effectiveness.

III. METHODOLOGY

The two core functional layers, both tightly integrated in the Telegram-based GPS Tracking System, are the hardware architecture, which handles data acquisition and physical operations, and the software architecture, which manages communications, data formatting, and user interaction through the Telegram interface. Figure 1 provides a clear representation of how these various subsystems are assembled to fulfill the intended tracking objectives.

A. Hardware Components

The hardware layer is responsible for gathering GPS data, handling power, and managing alerts. It consists of the following key components:

i. ESP8266 Microcontroller
This is used to control the tracking mechanism and provides WiFi connectivity for real-time monitoring and data logging. Its functions include: acts as the brain of the system; enables Wi-Fi connectivity and communication with the Telegram servers; Interfaces with the GPS module via serial communication; controls the buzzer using GPIO pins, and implements the logic for geofencing, battery status monitoring, and alert conditions.

ii. Neo-6M GPS Module
The Neo-6M GPS module is primarily responsible for acquiring real-time location data (latitude, longitude, altitude, and speed), and communicating with the ESP8266 via a serial protocol.

iii. 4.2V 1300mAh Lithium-Ion Battery
The 1300mAh Li-ion battery powers the entire GPS tracking system. It was selected to balance capacity and portability, providing several hours of continuous operation.

iv. Battery Management System (BMS)
The BMS role includes: protecting the battery from overcharging, over-discharging, and short circuits; ensuring safe and efficient power delivery to all components and extending battery life as well; and preventing hardware damage.

v. Buzzer
This component provides audible alerts for critical events and enhances usability in field scenarios. It is triggered by the ESP8266 microcontroller under specific conditions, such as low battery or geofence breaches.

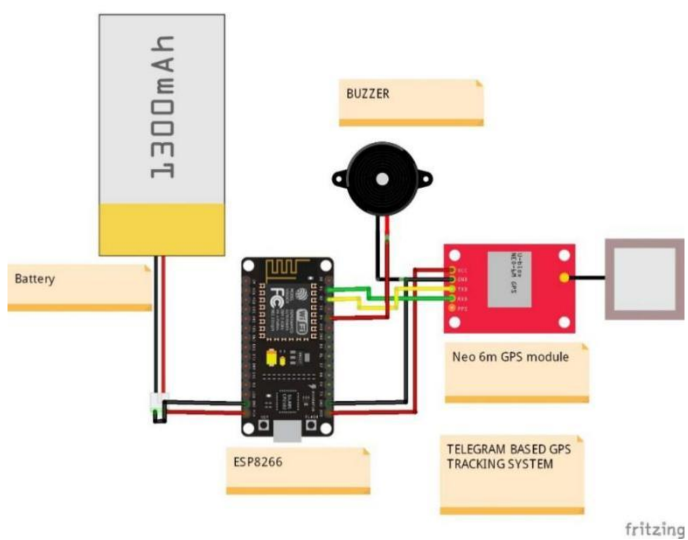

Figure 1. GPS Monitoring System Components.

B. Software Components
The software layer is developed around the Telegram Bot API (Application Programming Interface), which enables effective communication between the hardware and the user. The key components are:

i. Telegram Bot
The bot was created using BotFather within the Telegram application. Using the API, the bot receives location updates from the ESP8266 microcontroller via HTTPS requests. Formatted messages containing coordinates, timestamps, and alerts are sent to the user's Telegram chat, while various commands (such as activating the buzzer) are received from the user.

ii. Firmware on ESP8266
A lightweight firmware based on Arduino-compatible C/C++ was developed to parse GPS information. It was formatted for Telegram with respect to the study's purpose, and as well, it manages the Wi-Fi connection along with error handling.

C. System Operation

The system operates through a combination of hardware and a user interface to track a device's location. The user interface is the Telegram messaging application, through which a person can send commands and receive location data. The heart of the system is the ESP8266 module, which accepts commands from Telegram and interacts with a GPS tracker to retrieve data. The sequence of operation of the system is given below:

i. Initial Setup: First, the user needs to on a mobile hotspot or a MiFi device. This forms a network where the ESP8266 module connects. The phone of the user also needs to have a cellular network to transmit commands via the Telegram application interface.

ii. Command Prompt: The user enters a command prompt (e.g. a request of the location) via the Telegram app. This command is sent via the internet to the ESP8266 module.

iii. Data Retrieval: Upon receiving the command, the ESP8266 module requests information from the GPS tracker. The GPS tracker then acquires data such as longitude, latitude, and altitude.

iv. Information Transmission: The ESP8266module then transmits the obtained information back to the user through the Telegram app.

v. Location Visualization: The data received by the Telegram app includes a map link. The user can click this link to view the exact location of the tracked device on a map.

vi. Navigation: Once the map link is opened, the user can begin navigation, and the application will provide directions to the location of the tracked device.

vii. Buzzer Activation: If the user reaches the destination but is unable to locate the item, they can send a command to activate a buzzer on the device.

The system was housed in a small enclosure to facilitate deployment during field work as shown in Figure 2. It was tested in urban and semi-urban areas in Abeokuta, Ibadan, Abuja, Kano, Port Harcourt, Enugu, Maiduguri, Jos, Kaduna and Ilaro with GPS data recorded at periodic intervals.

Figure 2: The Developed GPS Tracker Prototype

IV. RESULT AND DISCUSSION

To test the performance of the tracking system, the GPS tracker was installed in vehicles that were driven around different cities in Nigeria. Distances were measured with reference to Ikeja, Lagos, as the origin point. Additionally, response time was measured as the time difference between sending a location request to the server via the Telegram system and receiving the corresponding GPS data. Finally, speed readings from the GPS tracker were compared to the vehicle's dashboard speedometer to determine accuracy. Figures 3 and 4 show the Telegram interface used in the system, illustrating how users interact with the bot by issuing commands such as /start or /all to retrieve GPS data. The bot replies with the coordinates, speed, and a formatted, clickable Google Maps link to view the location. This interface was found to be intuitive and reliable, even for non-technical users.

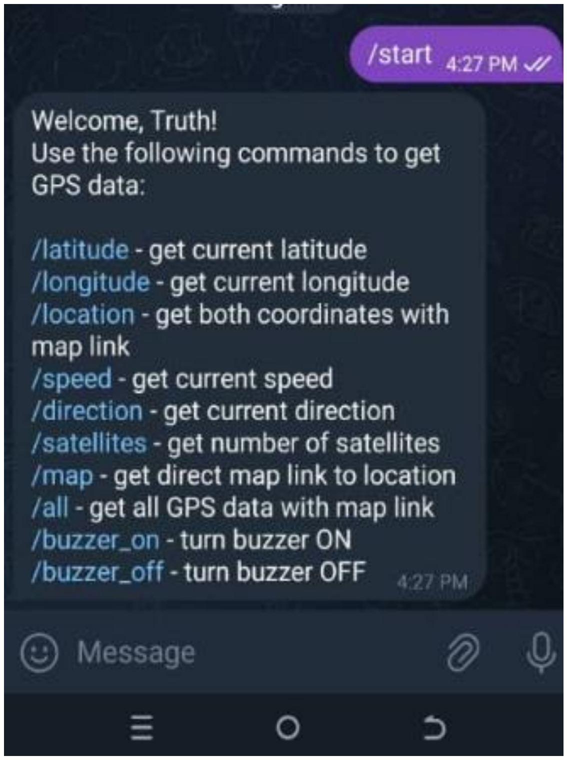

Figure 3: Telegram Interface of the GPS Tracker (/start)

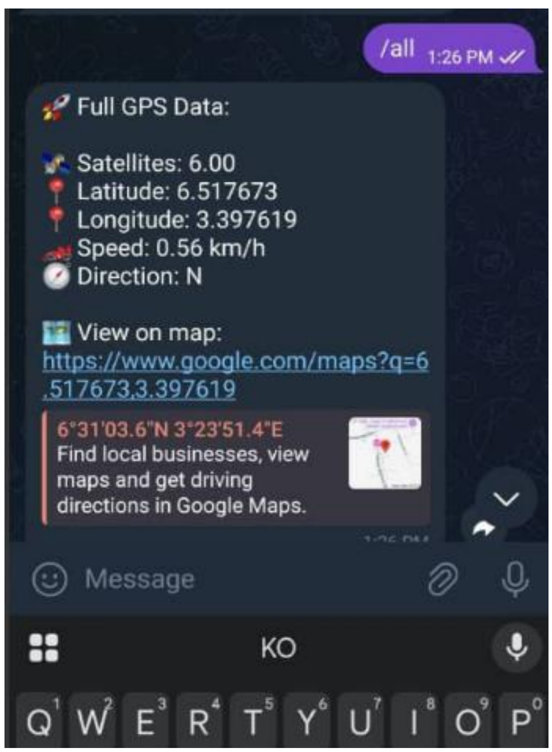

Figure 4: Telegram Interface of the GPS Tracker (/all)

More elaborately, the developed GPS module successfully sent location data to the Telegram bot, which then formatted and delivered the coordinates, speed, and response time to the user. The accuracy of the location reports was validated by comparing the GPS coordinates to known city centers using Google Maps. To assess the performance of the Telegram-based GPS tracking system, performance measures were selected out of the dataset retrieved in 10 cities of Nigeria. Metrics were distance travelled, speed and response time measures. The data obtained was summarized in Table 1 with distance travelled, response time, speed and geographic coordinates of each location.

Table 1: GPS Tracker Data Collected at Different Locations

DISTANCE(KM)	RESPONSE(Sec)	SPEED(Km/h)	LONGITUDE	LATITUDE	CITY/STATE
70.5	130	120.83	3.3481	7.1608	Ogun (Abeokuta)
113.3	173	23.61	3.947	7.3775	Ibadan (Oyo)
533.4	113	163.33	7.4951	9.0579	Abuja (FCT)
833.6	173	172.64	8.5919	12.0022	Kano
446.3	146	109.09	7.0336	4.8242	Port Harcourt (Rivers)
457.4	157	104.5	7.5139	6.4483	Enugu
1223.5	83	52.7	13.15	11.8333	Maiduguri (Borno)
709.5	169	150.03	8.8583	9.8965	Jos (Plateau)
626.6	86	28.04	7.4284	10.5061	Kaduna
247	67	13.64	5.6037	6.335	Benin City (Edo)
253.8	73	123.49	4.55	8.5	Ilorin (Kwara)
216	156	48.62	5.1931	7.2526	Akure (Ondo)
575.4	155	139.73	8.3389	4.9767	Calabar (Cross River)
751.1	91	21.23	5.239	13.0604	Sokoto
1046.6	146	145.95	12.4833	9.2	Yola (Adamawa)
0.5	2	0.56	3.397619	6.517673	Lagos(yaba)
80	1	0.2	3.010904	6.897881	Ogun(Ilaro)

The information that we have gathered gives us the overall device performance in 17 Nigerian cities, where we have found that there are differences in the distance covered, the time taken, and the speed accuracy. The longest intercity trips vary between 1200 km in Maiduguri and 0.5 km in Lagos based on the flexibility of the system to both small and large-scale movements. Response time is typically low with a few as fast as one second in Ilaro, and longer journeys like Abeokuta or Ibadan have delays of more than 130 seconds, pointing to network or signal effects. The speed results are consistent with vehicle speedometer and speed limits are high in Abuja and Kano (160 km/h and higher), whereas in developed cities such as Benin City and Lagos the data are very low (under 100 km/h). The geographic coordinates ensure proper positioning, including the centres of the cities and confirm the usefulness of the GPS module.

Figure 5: Telegram Interface of the GPS Tracker during a Speed Test

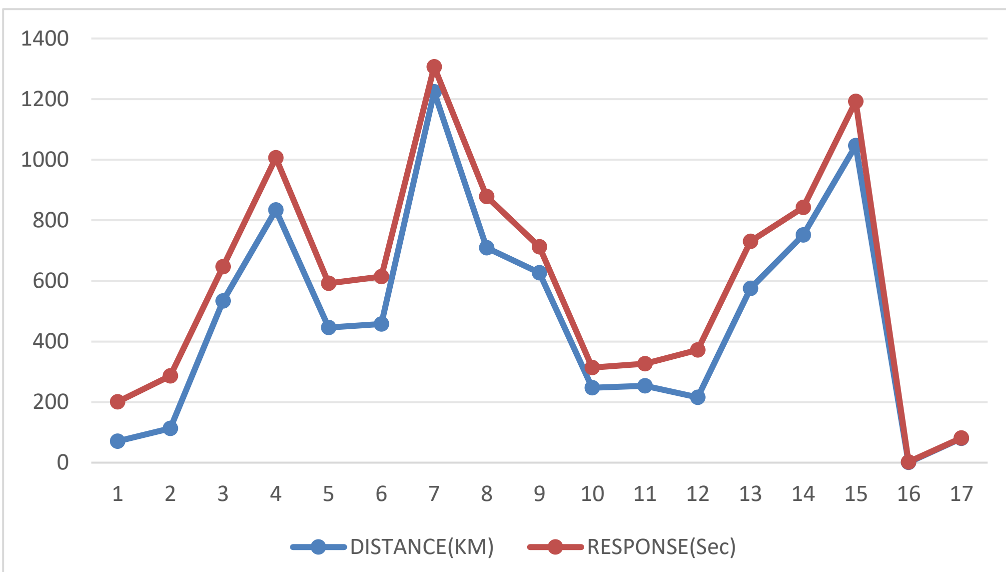

Figure 6: The System's Response Time vs Distance of Moving Vehicles

In Figure 6, there is no strict linear relationship, as instances like Maiduguri show low response times despite long distances, while short journeys like Abeokuta experience longer delays. This implies distance isn't a major factor; network latency and environmental factors play a bigger role, aligning with Ma et al. (2025) and Jimoh et al. (2025). The Lagos and Ilaro data points suggest the system can provide near-instantaneous updates, crucial for real-time tracking in densely populated cities. Middle-range distances like Enugu and Port Harcourt show average delays, indicating mixed performance in semi-urban locations. The variation in speeds demonstrates the tracker's ability to record dynamic vehicle motion. Uniform outcomes across terrains (e.g., Calabar, Sokoto) support the system's scalability. The chart highlights that while distance matters, connectivity quality is crucial for efficient data transmission, shown by clustered response times (130-170s) likely due to infrastructural constraints (Nigeria ranks 132nd/138th in infrastructure) (Otuoze et al., 2021). However, outliers with low delays demonstrate high responsiveness in optimal conditions.

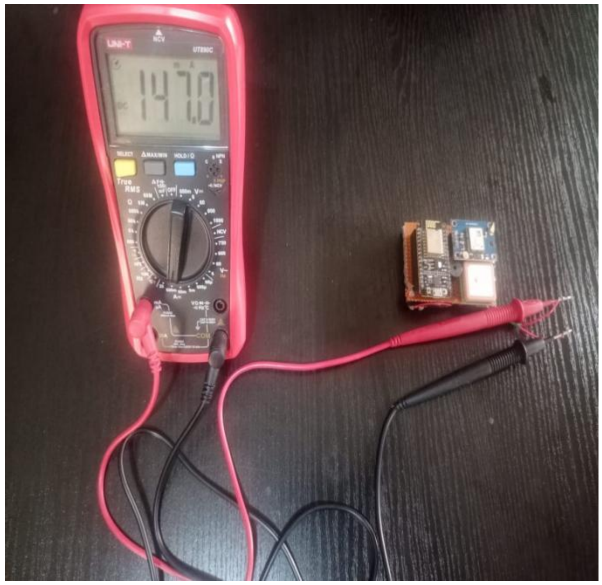

Figure 6: Measured Current of the Tracking System

Furthermore, we analyzed our device's energy usage and, after several tests, it reports a runtime of 8.8 hours, as our multimeter measured that our system draws 147mA during high-performance mode, i.e., continuous GPS acquisition and active Wi-Fi connection. Traveling across these specific states exposed the device to extreme variances in environmental conditions, from the humid, coastal atmosphere of Port Harcourt (which can affect RF propagation) to the arid, dusty heat of Maiduguri. The battery's ability to hold a charge for nearly 9 hours in these varying temperatures validates the thermal stability of the chosen 4.2V 1300mAh Lithium-Ion Battery. Transitioning the "Telegram based GPS Tracker" from a validated prototype to a mass-market commercial product requires a fundamental shift in engineering strategy. The current implementation, which relies on breakout boards, jumper wires, and generic enclosures, is suitable for pilot testing but insufficient for large-scale deployment. To scale, we must embark on: System Redesign, Component Procurement, and Regulatory Compliance. For instance, the current prototype relies on a mobile hotspot. Scaling requires replacing this dependency with an onboard cellular modem

V. CONCLUSION

The GPS Tracking System, which used Telegram, showed good performance with regard to many metrics such as positioning accuracy, consistency of speed, and time efficiency. Telegram integration offers a friendly and user-friendly interface, hence the system can be used with both technical and non-technical users. Field tests were able to confirm that the speed readings of the GPS module were very similar to those shown on the dashboard of the tested vehicles, and the system response time also remained very low, even at varying ranges. Such results confirm the reliability of the system in terms of real time tracking. However, there were also certain constraints, including battery life, and network delay, and weaker GPS signal coverage in obstructed conditions. These issues will be very important in improving the long-term feasibility and scalability of the system. In order to enhance the performance and scalability of the proposed Telegram based GPS Tracking System, some improvements are proposed based on the results obtained. To start with, the optimization of the power system by incorporating solar charging modules and a larger capacity battery would increase the operating time, particularly in off-grid or remote locations. Also, the ESP8266 firmware should be programmed with deep sleep features to save power when the device is not busy, which will save more energy.

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