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PCMJ

Progress in Computing and Mathematics Journal

volume 1

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College of Computing, Informatics, and Mathematics
Universiti Teknologi MARA Cawangan Melaka, Kampus Jasin
77300, Merlimau, Melaka Bandaraya Bersejarah

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EDITORS

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PREFACE

Welcome to the inaugural volume of the **Progress in Computing and Mathematics Journal (PCMJ)**, a publication proudly presented by the College of Computing, Informatics, and Mathematics at UiTM Cawangan Melaka.

This journal represents a significant step in our commitment to fostering a vibrant research culture, initially providing a crucial platform for our undergraduate students to showcase their intellectual curiosity, dedication to scholarly pursuit, and potential to contribute to the broader academic discourse in the fields of computing and mathematics. However, we envision PCMJ evolving into a beacon for researchers both nationally and internationally. We aspire to cultivate a space where groundbreaking research and innovative ideas converge, fostering collaboration and intellectual exchange among established scholars and emerging talents alike.

The manuscripts featured in this first volume, predominantly authored by our undergraduate students, are a testament to the hard work and dedication of these budding researchers, as well as the guidance and support provided by their faculty mentors. They cover a diverse range of topics, reflecting the breadth and depth of research interests within our college, and set the stage for the high-quality scholarship we aim to attract in future volumes.

As editors, we are honored to have played a role in bringing this journal to fruition. We extend our sincere gratitude to all the authors, reviewers, and members of the editorial board for their invaluable contributions. We also acknowledge the unwavering support of the college administration in making this initiative possible.

We hope that PCMJ will inspire future generations of students and researchers to embrace research and innovation, to push the boundaries of knowledge, and to make their mark on the world of computing and mathematics.

Editors
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FADTRACK: DEVELOPMENT OF VEHICLE TRACKING SYSTEM USING GPS

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Abstract

An increasing reliance on personal vehicle on our day to day live has made losing it a devastating event that have increasing chance to occur due to rampant crime rates. A vehicle can be lost due to a variety of incidents, including theft, unauthorised use, or misplacing. The problem raises the possibility that our vehicle will be lost and that there won't be any hint that it may be found again. This project objective to develop a vehicle tracking using GPS with out-of-range notification. This integrated system will enable real-time monitoring and tracking of assets within an area. By leveraging IoT connectivity, the system will provide accurate location information of assets through geofencing which using ESP 8266 and GPS module. Four experiments were conducted in this project, functionality testing (connectivity testing, GPS testing and alert triggering testing) and network performance testing. The result show that FADTrack system work better in open spaces, the system consistently achieves efficient alert notification with delays consistently under 30 seconds. The shorter delay times, such as 20 seconds at 80 meters in open areas. While building areas, where errors occur at longer distances (80 meters and 100 meters). The recommendation for future studies is to get a better GPS signal module to make this system can be useful anywhere even in the area around the obstruction.

Keywords: FADTrack, GPS, tracking system, geofencing, alert, notification.

INTRODUCTION

According to the Vehicle Theft Reduction Council of Malaysia (VTREC), an average of 20 vehicles were reported stolen daily in 2020, highlighting the urgency of addressing car security (paultan.org, 2021). This issue is particularly acute for individuals living in high-rise flats or flats, where vehicles are more vulnerable to theft. Traditional security measures like car alarms have limitations, prompting the need for advanced monitoring systems like FADTrack, which utilizes IoT technology to track vehicles in real-time (Alrifaie et al., 2018). The Internet of Things (IoT) facilitates the seamless exchange of data between interconnected devices, enabling real-time monitoring and proactive response to security threats (Kim et al., 2017). Wireless networks play a crucial role in IoT connectivity, allowing devices to communicate effectively with the internet and facilitating remote control and monitoring (Ferrag et al., 2017). By incorporating IoT and wireless network technologies, FADTrack revolutionizes vehicle monitoring and management by providing real-time tracking, geofencing, and intelligent alarm features. The aim of the FADTrack project is to develop an integrated IoT-based system that utilizes GPS and geofencing technology to track vehicle positions in real-time and address notification delays (Alrifaie et al., 2018). By leveraging IoT connectivity, the system offers accurate location tracking and proactive alerts when vehicles enter or leave designated zones, thereby enhancing overall road safety and reducing incidents of theft or misplacement. Through continuous monitoring and analysis of sensor data, FADTrack ensures early detection of potential problems, quick crisis management, and improved driver safety.

LITERATURE REVIEW

The literature review explores the implementation of wireless networks, including Wi-Fi and cellular networks, play pivotal roles in modern connectivity. They enable seamless data transmission via radio waves, supporting a wide range of applications in residences, workplaces, and public areas. Wi-Fi, governed by IEEE standards like 802.11, facilitates wireless local area networks, offering mobility and flexibility. Cellular networks segment the world into discrete cells serviced by base stations, facilitating wireless communication for mobile devices. Advancements in both technologies, driven by continuous technical improvements, bolster the Internet of Things (IoT) ecosystem and ensure global connectivity and communication.

Moreover, The Internet of Things (IoT) encompasses billions of interconnected physical objects, allowing them to collect and exchange data (Steve Ranger, 2020). IoT devices range from small sensors to industrial machinery, all equipped with various sensors gathering information about their surroundings (Feng et al., 2020). These devices often rely on wireless connectivity, with platforms like the ESP8266 enabling cost-effective Wi-Fi connection for IoT applications (Mesquita et al., 2018). Additionally, GPS modules like the u-blox NEO-6M provide precise location data for navigation and tracking applications (Kanani & Padole, 2020). Programming these IoT devices is made easy through platforms like the Arduino IDE, which supports microprocessors like the ESP8266 and simplifies code authoring and uploading (Arduino.cc, 2023).

Satellites orbit celestial bodies like Earth, enabling diverse applications in satellite communications (Kodheli et al., 2021). Through electromagnetic waves, satellite communication facilitates global data exchange, empowering various sectors from news gathering to navigation (Sweeting, 2018). The Global Positioning System (GPS) exemplifies advanced satellite-based navigation, offering precise location data and aiding mapping endeavors (Ailsa Harvey, 2022). GPS receivers retrieve signals from satellites, utilizing trilateration to determine three-dimensional positions (Hribšek et al., 2021). Trilateration, based on signal transmission durations, ensures accurate location estimation, crucial for navigation, emergency response, and scientific research (GISGeography, 2022). The integration of space, control, and user segments in satellite telemetry enhances mobility studies and ecological monitoring (Hribšek et al., 2021). Ultimately, satellites revolutionize modern life, providing indispensable tools for navigation, communication, and environmental understanding (Digital Trends, 2022).

METHODOLOGY

The technique and the tactics employed to conduct the study will be the major focus of this chapter. Additionally, it will describe how the research developed. To further aid the intended audience in understanding the study, each action conducted is outlined with its own justification. A timeline of the research's milestones from start to finish is provided, illustrating any advancements and successes made.

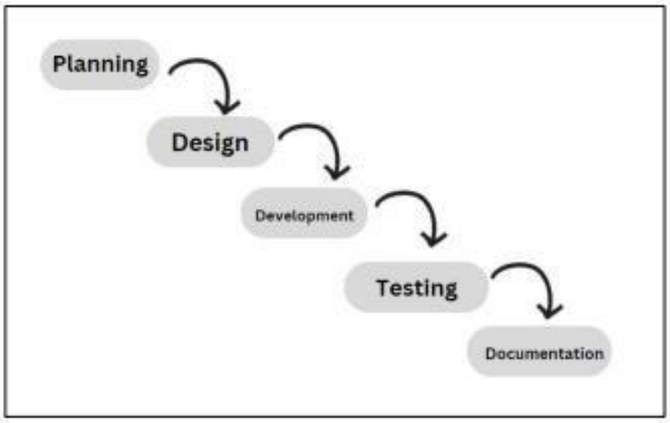

Figure 1: Waterfall Model

The feasibility study for the FADTrack System includes evaluating technological and operational viability. Assessing accessibility, compatibility, and the availability of technical resources determines technological feasibility. Operational feasibility examines integration into organizational or car environments, considering staff availability, training, and workflow impact. The research aims to address gaps in existing IoT solutions by combining ESP8266 with GPS modules for personalized border warnings. Design and development requirements outline system attributes, features, and functions, including hardware and software components, user interface design, data security, scalability, and testing procedures. These specifications guide the development process, ensuring a robust and efficient tracking system with precise monitoring capabilities and compliance with security guidelines.

Next, for the design phases the system's general design and functionality are developed at this essential step, ensuring that the system satisfies the stated criteria. The hardware, software, connection protocols, user interface, data processing algorithms, and security measures must all be carefully considered during this phase. The result of the design phase is a thorough design document that acts as a guide for the next phases of development, implementation, and testing, aiding in the creation of a well-organized and useful system.

The work breakdown structure (WBS) of project management is a method for completing a difficult, multi-step project. It is a tactic for breaking up large tasks into smaller ones in order to finish them more swiftly and efficiently. Every technique summary from WBS will be displayed visually on figure 2 below.

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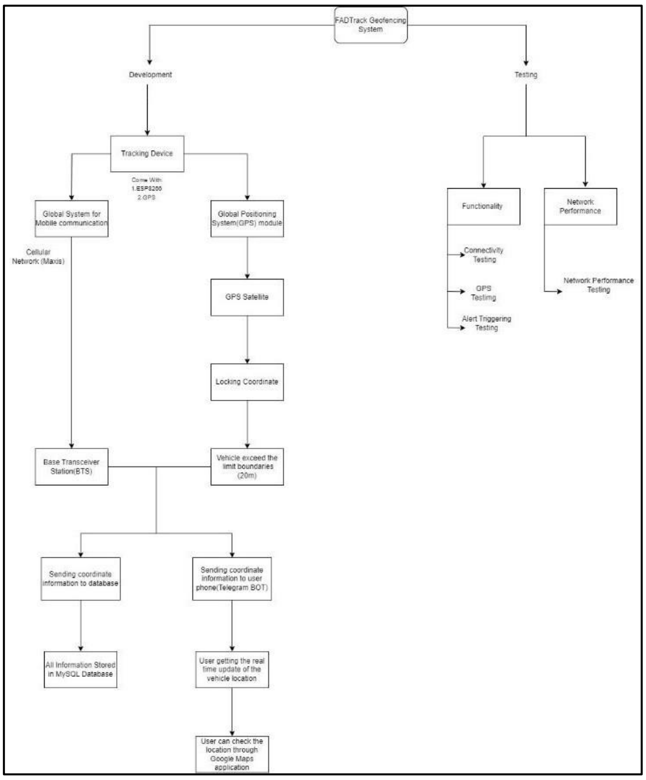

Figure 2: Work Breakdown Structure

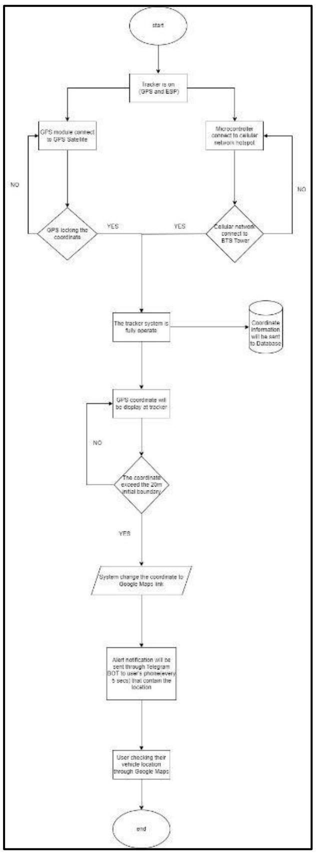

Figure 3 : System Flowchart

The sequential processes needed to operate a tracking system are shown in the flowchart (figure 3). The system starts by initializing and configuring the required parts. The next step is to read sensor data, which can provide details about an object's real time location. The necessary information for tracking and monitoring is subsequently extracted from the data through processing. The location or item is continually tracked by the system, which updates its location in real-time. It determines if the object is inside the geofenced or preset bounds. The system creates an alert and notifies the appropriate persons if the object is outside the boundaries. The tracking information is recorded and saved for further use and analysis. On a user interface, the real-time tracking data is shown, giving a visual depiction of the object's motions. This cycle is repeated until the system achieves its conclusion. The important procedures involved in tracking an objector location, monitoring boundaries, creating warnings, and presenting real-time tracking information are shown in this flowchart, which gives a visual depiction of the systems.

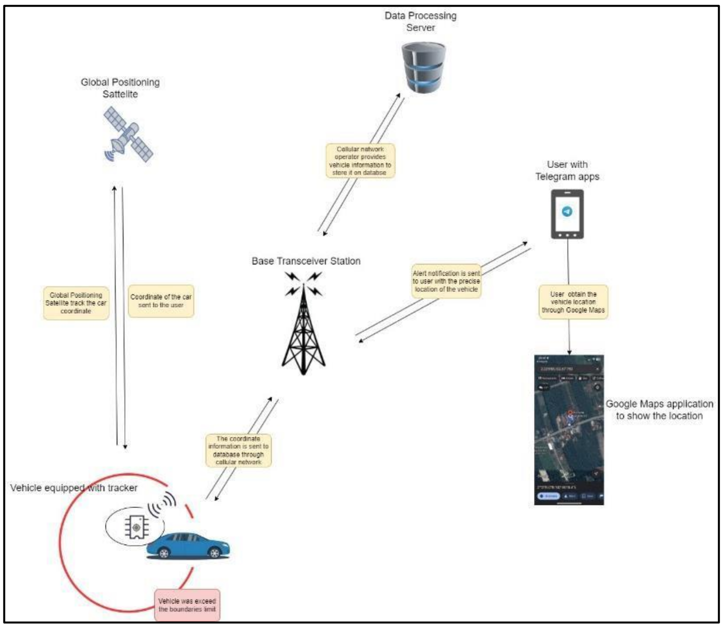

Figure 4: System Architecture

The system architecture diagram, as detailed in Figure 4 offers an extensive insight into the structure and organization of the FADTrack system. The illustration delineates key components of the system, encompassing theESP8266 microcontroller (control unit), GPS module as tracker. It shows how the tracker work, by receiving signal from the GPS satellite, and from the data, the receiver will notify by alert notification while database store the information, all this process will go through cellular network.

The part of the software development life cycle (SDLC) when the actual coding, programming, and implementation of the system take place based on the design requirements is referred to as the "development phase" in the FADTrack geofencing system. It entails writing code, integrating components, and creating the essential software features to turn the design concept into a functioning system. To guarantee that the system satisfies the given geofencing criteria efficiently and reliably, communication between the hardware and software development teams, rigorous testing, and an organized approach to code development and integration are essential throughout the development period.

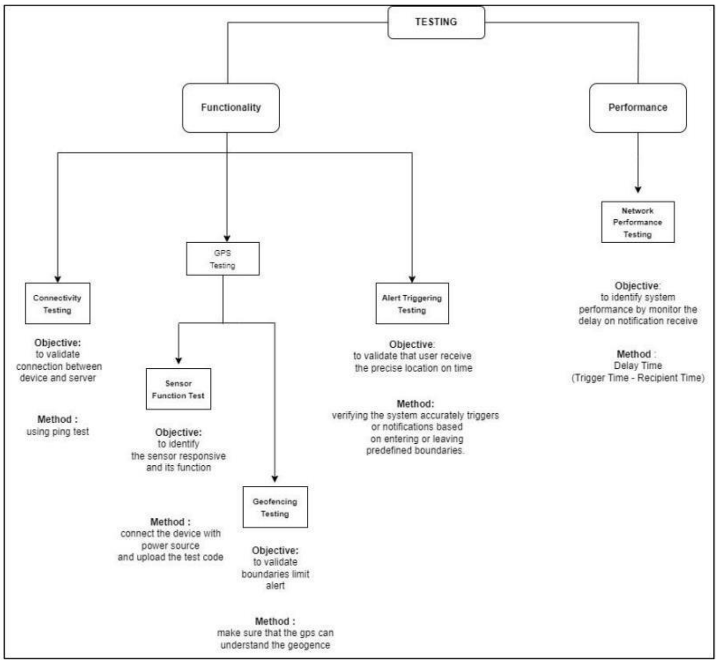

Figure 5: Testing Plan

All the testing are concluded on the figure 5. Before the system is made available for public use, problems, flaws, or inconsistencies are found, recorded, and fixed by developers during the testing phase. Thorough testing guarantees that the system meets user requirements and expectations while operating securely, precisely, and dependably.

RESULT AND DISCUSSION

This section will discuss and analyze the FADTrack functionality testing and experimental results. This analysis's primary goal is to assess how well the system detects boundaries and sends notifications precisely on time. It seeks to provide insight into the system's overall performance by shedding light on user-centric elements, notification delay times, and dependability.

To guarantee the smooth and dependable functioning of FADTrack, extensive connectivity testing, such as Network, Server, Telegram Bot Integration, Data Transmission, and Hardware-Specific Connectivity checks, must be carried out. These tests confirm that the system can operate in a variety of network environments. The result shown on Table 1 below.

Scenario	Description	Expected Outcome	Pass/Fail
Network Connectivity Test	Validate the device's connection to the internet network required for data transmission and alert notifications.	Stable and consistent network connection established.	PASS
Hardware-Specific Connectivity	Test communication between the GPS module and the microcontroller to ensure proper data transfer.	Reliable and accurate data transfer between components.	PASS
Database Connectivity Test	Simulate the transfer of geofencing data from the device to database server	complete transmission of data.	PASS
Telegram Bot Integration Test	Confirm integration and functionality of the Telegram bot responsible for sending alert notifications.	Telegram bot sends alerts promptly and accurately.	PASS

Table 1: Connectivity Testing

Next testing assessment makes sure the sensors like proximity or GPS sensors work as efficiently as possible to detect limits. Systematic testing may be used to verify the accuracy of sensor data, evaluate the system's response to changes in the environment, and check that notifications are correctly triggered by the system. The efficacy of FADTrack in delivering accurate and timely warnings is ensured by detecting and resolving any differences in sensor operation. This improves the system's overall performance and user confidence in a variety of environments.

Scenario	Description	Expected Outcome	Pass/Fail
Signal Acquisition	Acquire satellite signals and display GPS lock.	Finds signals quickly and locks on.	PASS
Position Fix	Verify accurate display of current latitude and longitude.	Shows accurate location	PASS
Signal Strength	Evaluate strength and consistency of satellite signals.	Strong and consistent signals for accurate tracking.	PASS
Data Refresh Rate	Check frequency of updated location information.	Updates at expected frequency with minimal delays.	PASS
Error Handling	Test module's response to signal loss and recovery capabilities.	Graceful handling of signal loss, quick recovery.	PASS

Table 2: Sensor Function Testing

. Furthermore, by measuring boundary accuracy, one can validate the accuracy of geofencing and make sure that alerts only go out when a user enters or leaves designated zones. Boundary Consistency assesses how well the system holds boundaries across time and under various circumstances. Dynamic Boundary Change evaluations guarantee that FADTrack manages geofence modifications in real time with skill. The system's capacity to appropriately manage and alert users when dealing with overlapping or adjacent borders is validated by many boundary tests that set within 10-50 meters.

Boundary Check: Verify the that when simulate movement along geofence limits, the system sounds an alert.

Distance (meters)	Outcome
10	Alerts trigger within 10 meters
20	Alerts trigger within 20 meters
30	Alerts trigger within 30 meters
40	Alerts trigger within 40 meters
50	Alerts trigger within 50 meters

Table 3: Boundary Check

Boundary Consistency: Monitor that alert triggers are consistent along every border point, keep an eye on the consistency of geofence boundary detection.

Distance (meters)	Outcome
10	Alerts trigger within 10 meters
20	Alerts trigger within 20 meters
30	Alerts trigger within 30 meters
40	Alerts trigger within 40 meters
50	Alerts trigger within 50 meters

Table 4: Boundary Consistency

Dynamic Boundary: Test how well the system adapts to dynamically changing geofence bounds and make sure it does so accurately.

Distance (meters)	Outcome
10	Accurate within 10 meters
20	Accurate within 20 meters
30	Accurate within 30 meters
40	Accurate within 40 meters
50	Accurate within 50 meters

Table 5: Dynamic Boundary

Next, this assessment makes sure that when preset boundaries are crossed, the system swiftly and accurately triggers notifications. Through a variety of scenario simulations and behavior assessments, this testing ensures that FADTrack reliably provides timely notifications without needless delays or false alarms. It increases user confidence in the system's capacity to deliver trustworthy notifications in practical scenarios by validating the correspondence between the identified boundary events and the accompanying warnings.

Scenario	Description	Expected Outcome	Pass/Fail
Geofence Entry Alert	Trigger geofence entry and verify if the user promptly receives the alert.	Immediate alert notification upon entering the geofence boundary	PASS
Geofence Exit Alert	Trigger geofence exit and confirm the user receives the exit alert.	Immediate alert notification upon leaving the geofence boundary	PASS
Accuracy Alert	Check if the received location in the alert matches the actual position.	Accurate display of user's precise location in the alert	PASS
Network Variability	Test under varying network conditions to validate consistent alert delivery.	Alerts consistently delivered despite network fluctuations	PASS

Table 6: Alert Trigger Testing

Last testing, two experiments will be conducted at the various places and different environments. The first experiment will be held at my college, Tun Sri Lanang A/B at UiTM Jasin which the environment is on building area. The second place of experiment will be held at my hometown, Bukit Gambir, Tangkak. The environment for this experiment is two different environments chosen to make analysis on how the delay responsive for alert notification in different environments situation. These experiments will determine the delay time by calculating trigger time when the GPS exceeds the boundary and recipient time when the receiver receives the alert message. The delay time will be recorded by using these times information. These experiments were repeated twice to ensure reliability and accuracy.

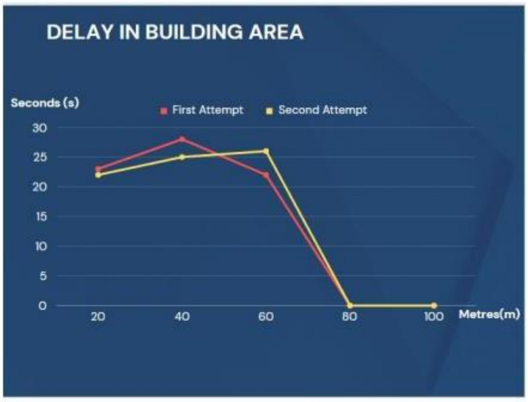

Figure 6: Delay Result in Building Area

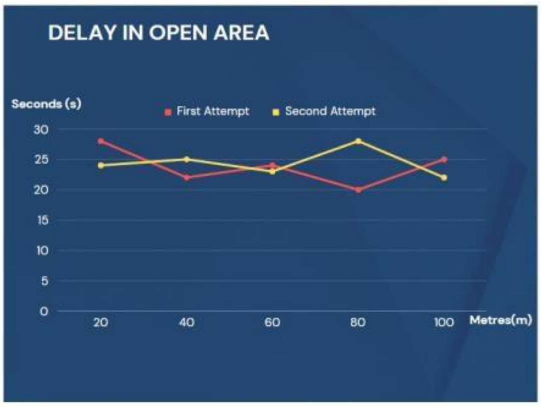

Figure 7: Delay Result in Open Area

CONCLUSION

As a conclusion, FADTrack was successfully developed and had met the aim and objectives for making the prototype of tracking system for vehicle security. The objective of this project is to develop a vehicle tracking using GPS without-of range notification. Research was conducted and vehicle owner find problems on how to provide high security on their vehicle because the tracking system that selling market right now is expensive. Owner who is their vehicle not come with tracking system cannot be notify if their car is moving from their location without permitted, with this system owner can get it in cheaper price. This system can help to reduce the cases of vehicle stolen that happened in our country, it may not avoid the stealing activity, but it might find the location after being stole which can find back our vehicle and the stealer can be caught.

REFERENCES

Ailsa Harvey, M. W. (2022, December 6). *GPS: Everything you need to know about the space-based technology keeping us on track*. Space.Com. https://www.space.com/gps-what-is-it

Alrifaie, M. F., Harum, N., Fairuz, M., Othman, I., Roslan, I., & Shyaa, M. A. (2018). Vehicle Detection and Tracking System IoT based: A Review. *International Research Journal of Engineering and Technology*, 1237. www.irjet.net

Arduino.cc. (2023, May 16). *What is Arduino?* Arduino.Cc. https://docs.arduino.cc/learn/starting-guide/whats-arduino

Chen, M., Challita, U., Saad, W., Yin, C., & Debbah, M. (2019). Artificial Neural Networks-Based Machine Learning for Wireless Networks: A Tutorial. *IEEE Communications Surveys and Tutorials*, *21*(4), 3039–3071. https://doi.org/10.1109/COMST.2019.2926625

Ferrag, M. A., Maglaras, L., Argyriou, A., Kosmanos, D., & Janicke, H. (2017). *Security for 4G and 5G Cellular Networks: A Survey of Existing Authentication and Privacy-preserving Schemes*. http://arxiv.org/abs/1708.04027

Fourati, F., & Alouini, M. S. (2021). Artificial intelligence for satellite communication: A review. In *Intelligent and Converged Networks* (Vol. 2, Issue 3, pp. 213–244). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.23919/ICN.2021.0015

GISGeography. (2022, May 31). *How GPS Receivers Work – Trilateration vs Triangulation*. GISGeography. https://gisgeography.com/trilateration-triangulation-gps/

Hribšek, I., Plećaš, M., Skorić, S., & Marinković, S. (2021). First description of movement and ranging behavior of the Griffon vulture (Gyps fulvus) from Serbia using GPS satellite tracking. *Archives of Biological Sciences*, *73*(2), 185–195. https://doi.org/10.2298/ABS201210013H

Josh Fruhlinger. (2023, January 3). *What is Wi-Fi and why is it so important?* NetworkWorld. https://www.networkworld.com/article/968819/what-is-wi-fi-and-why-is-it-so-important.html

Kanani, P., & Padole, M. (2020). Real-time Location Tracker for Critical Health Patient using Arduino, GPS Neo6m and GSM Sim800L in Health Care. *Proceedings of the International Conference on Intelligent Computing and Control Systems, ICICCS 2020*, 242–249. https://doi.org/10.1109/ICICCS48265.2020.9121128

Kim, D. H., Park, J. Bin, Shin, J. H., & Kim, J. D. (2017). Design and implementation of object tracking system based on LoRa. *International Conference on Information Networking*, 463–467. https://doi.org/10.1109/ICOIN.2017.7899535

Kodheli, O., Lagunas, E., Maturo, N., Sharma, S. K., Shankar, B., Montoya, J. F. M., Duncan, J. C. M., Spano, D., Chatzinotas, S., Kisseleff, S., Querol, J., Lei, L., Vu, T. X., & Goussetis, G. (2021). Satellite Communications in the New Space Era: A Survey and Future Challenges. In *IEEE Communications Surveys and Tutorials* (Vol. 23, Issue 1, pp. 70–109). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/COMST.2020.3028247

Larry Ciummo. (2023, January). *What is the basic function of a communication satellite?* https://www.quora.com/What-is-the-basic-function-of-a-communication-satellite

Lopez-Perez, D., Garcia-Rodriguez, A., Galati-Giordano, L., Kasslin, M., & Doppler, K. (2019). IEEE 802.11be Extremely High Throughput: The Next Generation of Wi-Fi Technology beyond 802.11ax. *IEEE Communications Magazine*, *57*(9), 113–119. https://doi.org/10.1109/MCOM.001.1900338

Mama, M. (2008). *Mathematical Modelling of The Global Positioning System Tracking Signals*. http://www.bth.se/tek/master

Mesquita, J., Guimarães, D., Pereira, C., Santos, F., Almeida, L., & Almeida, L. (2018). *Assessing the ESP8266 WiFi module for the Internet of Things Assessing the ESP8266 WiFi module for the Internet of Things Assessing the ESP8266 WiFi module for the Internet of Things*. www.cister.isep.ipp.pthttp://www.cister.isep.ipp.pt

Oluwayimika Kasumu, R., Rebecca Yinka, A., & Nkeiruka Queendarline, N. (2018). Telegram as a social media tool for teaching and learning in tertiary institutions. In *International Journal of Multidisciplinary Research and Development www.allsubjectjournal.com* (Vol. 5). www.allsubjectjournal.com

paultan.org. (2021, April 7). Vehicle thefts in Malaysia down by 37% in 2020. *Paultan.Org*. https://paultan.org/2021/04/07/vehicle-thefts-in-malaysia-down-by-37-in-2020-7400-cases-reported-last-year-compared-to-11675-in-2019/

Poushya, M., Rupasri, K., Supritha, N., Hema, K., & Tejaswini, R. (2018). *IoT Based Vehicle Theft Detection*.

Ramesh, P. L. N., Moorthi, M., Prathyusha Engineering College, IEEE Young Professionals., & Institute of Electrical and Electronics Engineers. (2018). *Fourth IEEE International Conference on Advances in Electrical, Electronics, Information, Communication and Bio Informatics : AEEICB-2018 : 27th & 28th February*.

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