A Novel approach to track location of GNSS receiver using Satellite Navigation

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Abstract

A network of satellites called the Global Navigation Satellite System (GNSS) sends essential positional information to GNSS receivers via signals they emit from space. In turn, these receivers take in and evaluate information from several NMEA words to determine longitude and latitude. Using a GSM modem and SMS connection, the collected geographical data is then used to track the end user's location in real time.

The system's functions are controlled using an Arduino board. Depending on what the user needs, this microcontroller gives the buzzer and GNSS module distinct orders. These elements come together to create a complete system for accurate tracking and placement.

Keywords: NMEA, Arduino, GNSS

1. INTRODUCTION

Now a days, the use of Android based Smartphone's is increasing day by day. As these Smartphone's are providing various unique facilities, more and more people are getting attracted to them. Thus here, including best possible features and resources has become the need of the day. Moreover, GNSS there by device which offers an outstanding services of getting respective location. This facility is helpful in developing application which can track locations of every activity of end while is outside the home. In end tracking system clients able to trace the activities of their end through Android Smartphone. The activities such as real time location (on Google Maps).

2. LITERATURESURVEY

Chi, et al described that Global navigation satellite systems (GNSS) provide many more satellites than ever before. However for applications extremely sensitive to power consumption, not all satellites can be incorporated into the measurement vector, either because of the sheer computation overload or for purpose of power saving. These applications include but are not limited to unmanned aerial system (UAS), flying cars, and asset tracking. Thus, satellite selection methodology should be used to obtain subset satellites with good geometry. Recently, a down date method proposed in receiver autonomous integrity monitoring (RAIM) can be used for reference in satellite selection, although RAIM and GNSS positioning are quite different. In this paper, a DOP-based ultra-rapid satellite selection methodology, the direct satellite selection (DS) method, is proposed according to the down date method.
Swaszek, et al. described that receivers convert the measured pseudo ranges from the visible GPS satellites into an estimate of the position and clock offset of the receiver. For various reasons receivers might only track and process a subset of the visible satellites. It would be desired, of course, to use the best subset. In general selecting the best subset is a combinatory problem; selecting m objects from a choice of n allows for n-potential subsets.

And since the GDOP performance criterion is nonlinear and non-separable, finding the best subset is a brute force procedure; hence, a number of authors have described sub-optimal algorithms for choosing satellites

Swaszek et al Code phase Global Navigation Satellite System (GNSS) positioning performance is often described by the Geometric or Position Dilution of Precision (GDOP or PDOP), functions of the number of satellites employed in the solution and their geometry. This paper develop slower bounds to both metrics solely as functions of the number of satellites, effectively removing the added complexity caused by their locations in the sky, to allow users to assess how well their receivers are performing with respect to the best possible performance. Such bounds will be useful as receivers sub-select from the plethora of satellites available with multiple GNSS constellations. The bonds are initially developed for one constellation assuming that the satellites are at or above the horizon.

3. OBJECTIVES

The problem at hand involves the development of a system that efficiently integrates Global Navigation Satellite System (GNSS) data with GSM and SMS technology for real-time location tracking and user interaction. The primary objective is to design a robust and user-friendly solution that can accurately parse GNSS data, extract latitude and longitude from multiple NMEA sentences, and utilize this information in conjunction with a GSM modem to facilitate communication via SMS. Additionally, the system should be capable of receiving and executing user-defined commands from an Arduino microcontroller to trigger specific actions, such as controlling a buzzer or customizing GNSS behavior.

This article aims to address several key challenges, including data parsing, real-time data synchronization, error handling, and user command execution, all while ensuring optimal power consumption and reliability. The successful implementation of this systemhasthepotentialtoprovideaccurateandaccessiblelocationtrackingservices for various applications, including vehicle tracking, asset monitoring, and personal navigation.

Real-Time Location Visualization: The primary objective is to create a real-time location visualization system that reads and interprets NMEA data from a GNSS receiver and plots the receiver's location on a map. This provides a convenient way to monitor the receiver's position as it receives satellite signals.

Signal Quality Assessment: Implement functionality to assess the quality of the received GNSS signals. Identify signal strengths, satellite constellations in view, and signal-to-noise ratios to understand the reliability of the data.

4. ANALYSIS

Existing Methodology

This project involves leveraging live NMEA data from a GNSS receiver to create real-time location visualization. It begins with selecting an appropriate GNSS receiver and establishing a connection with the GNSS receiver, followed by U-Blox NEO GNSS module as shown in figure1 reading the NMEA sentences in real-time.

Parsing these NMEA sentences allows us to extract critical location information, such as latitude, longitude, and timestamp data. We then utilize mapping libraries, which are already available in the MATLAB software to plot the location on a map, ensuring error handling for data integrity; we provide a user-friendly interface for smooth interaction.

Fig4.1GNSSNEO6MMODULE

Limitations of Existing Methodology

The existing methodology described leverages live NMEA data from a GNSS receiver to create real-time location visualization. It involves selecting an appropriate GNSS receiver, parsing NMEA sentences, and using MATLAB mapping libraries for location plotting. While this method may work well for certain applications, it has several limitations when compared to the proposed methodology for tracking end using GPS and SMS:

a. Hardware Dependency:

- The existing method relies on a dedicated GNSS receiver, which may not be readily available to all users. This hardware dependency can limit its accessibility and practicality.

b. Software Complexity:

- The methodology involves using MATLAB software and mapping libraries, which might require users to have specialized software and expertise. This complexity can be a barrier for some users, especially client s who are not tech-savvy.

c. Cost:

- Acquiring a GNSS receiver and using specialized software like MATLAB can incur additional costs. In contrast, the proposed method primarily utilizes smart phones, which are more common and cost-effective.

d. Real-Time Tracking:

- The existing method may not be suitable for real-time tracking, as it focuses on data visualization rather than immediate communication and tracking. This limitation is significant for applications like end tracking, where real-time information is crucial.

e. User Interface:

- The existing method does not emphasize a user-friendly interface. In contrast, the proposed method aims to provide a simple and easy-to-use solution for client s, which is particularly important in a end tracking scenario.

f. Data Integrity:

- While the existing method mentions error handling for data integrity, it does not provide details on how this is achieved. The proposed method likely includes features to ensure data accuracy and reliability for end tracking.

g. Accessibility:

- The existing method does not specify the accessibility and availability of GNSS data everywhere. In contrast, the proposed method primarily relies on GPS and SMS, which are more widely available technologies, making it suitable for a broader range of scenarios.

h. Compatibility:

- The existing method does not address compatibility with different devices, whereas the proposed method is designed for Android smart phones, which are commonly used by both clients and endren.

i. Limited Application:

- The existing method is not explicitly designed for end tracking but is a more general approach to location visualization. The proposed method, on the other hand, is specifically tailored to address the needs of client s for tracking their endren's locations.

In summary, the existing methodology has limitations in terms of hardware dependency, software complexity, cost, real-time tracking, user-friendliness, data integrity, accessibility, compatibility, and the scope of its application when compared to the proposed methodology for end tracking using GPS and SMS. The proposed method aims to overcome these limitations to provide a more accessible and user-friendly solution for concerned client s.

Proposed Methodology

This work is designed for clients and endren. Both must have GNSS and GSM services enabled devices i.e., smart phone at the client side and the tracking module at end side that supports GNSS and SMS as a minimum. SMS is a basic service on any smart phones but GNSS can be found on new smart phones. The application is mostly to be used by client s to track down the end’s location.

A solution is proposed to solve the problem based mainly on GNSS and GSM technologies. It takes advantage of the two main rich features that is offered in Android platforms nowadays. Those features are location services, mainly GNSS, and basic telephony services, mainly SMS. The system proposed is based on a simple idea that is the use of SMS for communicating between the parties involved, client and end. It is designed in a simple way so that it will involve few elements and less user interaction. This way it will result in a system that is simple and easy to implement and use, making it more user-friendly. The architecture of the system proposed, consists of two sides. First is the client side which acts as a server for the system though it is not actually a server. It is basically an Android phone owned by the client of the end for tracking and monitoring. The client’s side uses SMS for communicating and receiving the alert messages and location co-ordinates from end module and maps to view the location of the end on a map.

Thus, it requires telephony and internet services to be enabled in the client’s phone for the system to function. The Second is the end side which acts as a client for the system. The end side is a traceable module consists of GSM and GNSS devices. The end side uses SMS for communicating with the client side and location services, GNSS or Network, to get the location of the end in form of coordinates. On the end side, telephony and location services must be enabled and up running on the end side for the system to work. Where else the client side might need internet connectivity only for the map to show. On the client side, there is an Android phone with an application for monitoring end location.

System Architecture

The antenna receives the GNSS signal when it receives the command from NEO 6M GNSS module. The GSM SIM 900A modem receives an AT command and then the Arduino nano works according to the command, i.e., if the command states to track the location of end user then it notifies the GNSS module or if the command is to make sound, the buzzer is activated. figure 4.2 represents the block diagram of proposed research.

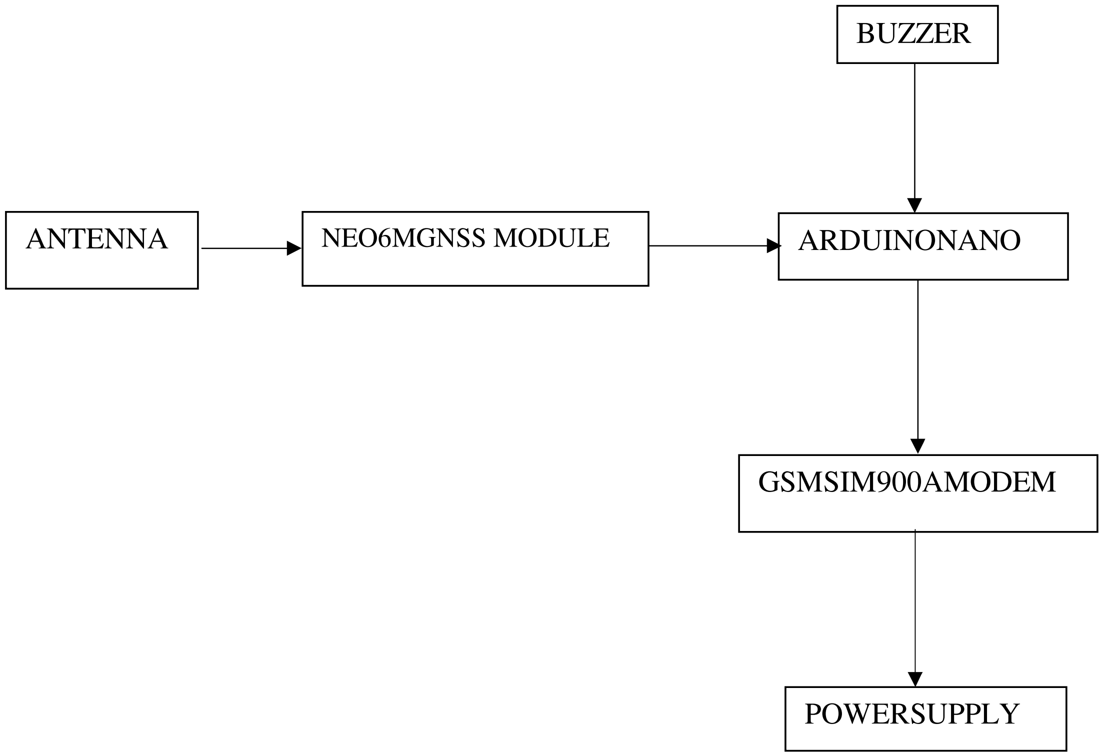

Fig 4.2 BlockDiagram

Flow Diagram of Proposed Methodology

The proposed method aims to help locating their items on the go activity. GNSS is used along with one of the basic service of a smart phone is SMS. An application at the client side will allow clients to send a location request to an end side then retrieve the location from the request reply and shows it on a map. On the other hand, the tracking device at the end side gathers the necessary information such as GNSS coordinates which are in the form of latitude and longitude. And time are gathered and sent to the client's smart phone that is pre- registered on the application. The communication between the client side and the end applications is done using Short Message Service (SMS). SMS offers the system unique features. It will allow the system to work without the need of internet connection thus allows the application to be implemented on smart phones that do not support GPRS. The system sends the location of end's smart phone to client's smart phone when the client's wishes to check on the end.Figure 4.3 represent the flow chart of proposed design.

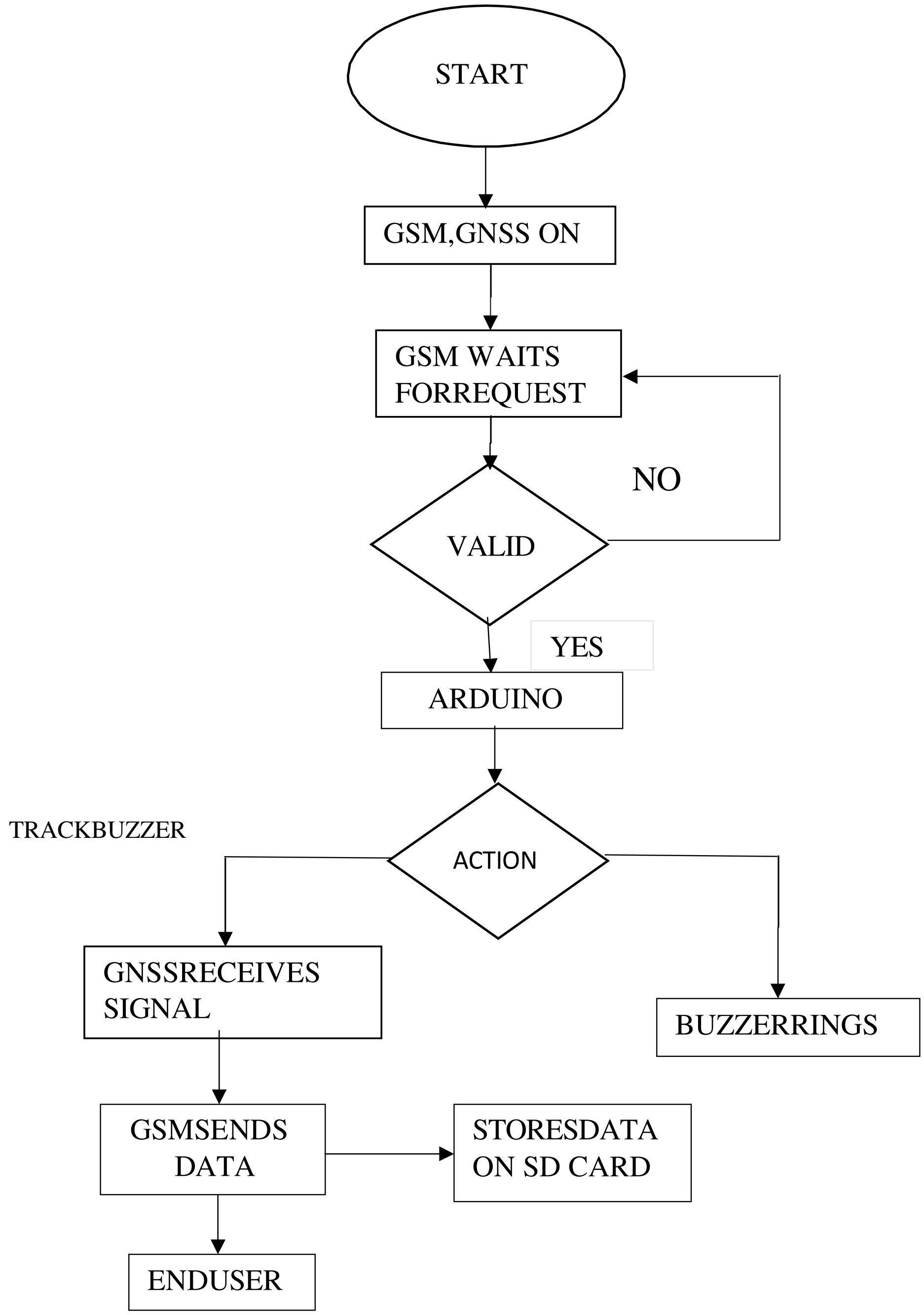

Fig 4.3FlowDiagram

5. RESULTS

Existing Methodology Results

Fig 5.1, 5.2, 5.3 represents the results of day1, 2 and 3 with internet services. it is displayingthelocationparameterslikelatitudeandlongitudeofcertainlocation.but the constraint is to have internet facility.

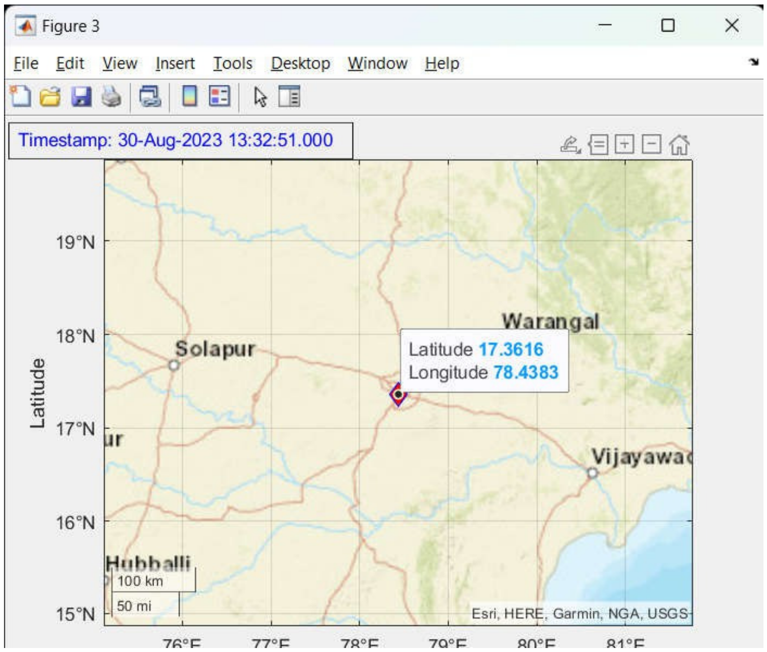

Fig 5.1 Resultat Day1

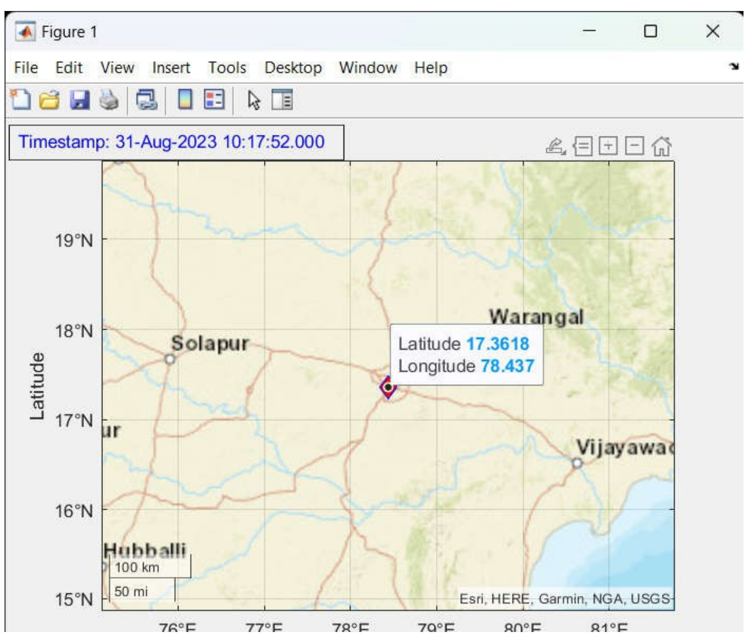

Fig 5.2 Resultat Day2

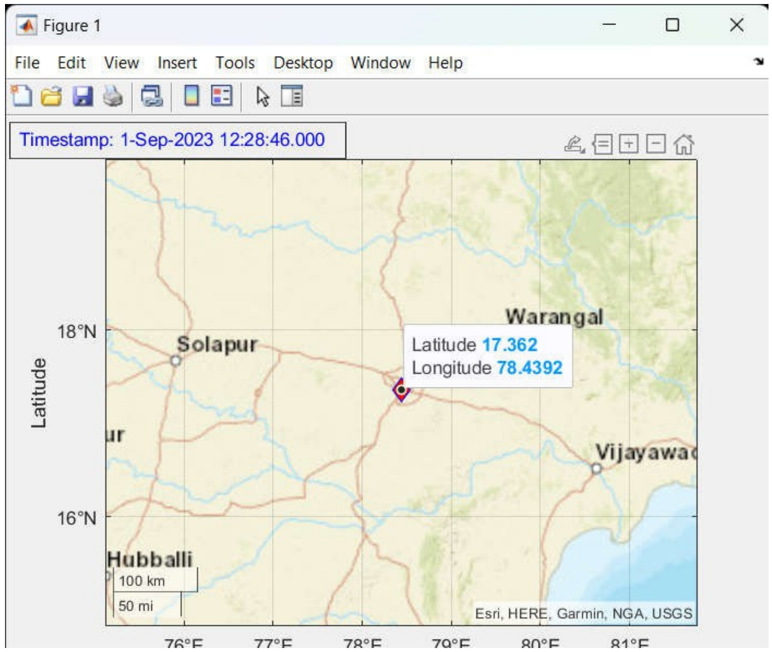

Fig 5.3 Resultat Day3

Proposed Methodology Results

Fig 5.4 represents the results of proposed methodology without internet service.

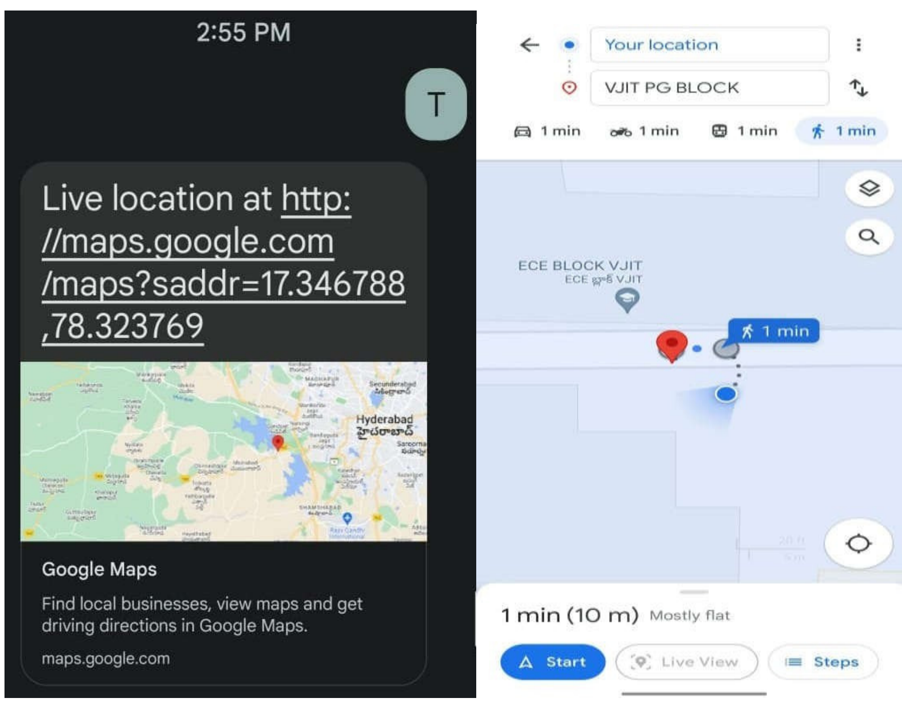

Fig5.4 SMS Display and Google Map Display

6. CONCLUSION AND FUTURESCOPE

Conclusion

The proposed solution offers a simplified and effective approach to address the critical need for real-time end tracking and monitoring. By harnessing the capabilities of GNSS and GSM technologies and exploiting the inherent features of Android platforms, the system provides a user-friendly means for clients to stay connected with and ensure the safety of their end.

This system offers several advantages, including ease of use, minimal user interaction, and efficient communication via SMS. Clients can access real-time location information of their end on a map, providing peace of mind and a sense of security. The project's architecture, consisting of both client and end sides, promotes a balanced interaction that ensures the end's safety and respects their privacy.

While the current implementation focuses on core features, there is considerable room for future development and enhancement.

Future Scope

The proposed system, which integrates GNSS and GSM technologies for end tracking and monitoring, shows great promise for further development and expansion. Here are potential avenues for future research and development:

1. Machine Learning Integration: Incorporate machine learning algorithms to enhance location prediction and anomaly detection, providing a more intelligent and predictive system.

2. Wearable Devices: Explore the integration of end-wearable devices, such as smart watches or GNSS-enabled wearables, to provide a more robust and convenient tracking solution.

3. SOS and Emergency Services: Enhance the system to include SOS features that allow end to send distress signals or request emergency services, improving safety measures.

4. Geo-Fencing and Alerts: Implement geo fencing capabilities to define safe zones and receive alerts when a end enters or leaves these predefined areas.

5. Multi-Platform Support: Develop dedicated applications for various platforms, including iOS, Android, and web, to reach a broader user base.

6. Data Analytics and Reporting: Provide client s with detailed reports and analytics on their end's movements, helping them better understand routines and behaviors.

7. Privacy Controls: Strengthen privacy controls, allowing end to have more control over what data is shared and with whom, ensuring a balance between monitoring and privacy.

8. Community and Social Features: Introduce features that connect client s in local communities, allowing them to share safety tips, information about safe locations, and more.

9. Internationalization: Extend support for different languages and regions to cater toa global user base.

10. Battery Efficiency: Focus on optimizing battery consumption in end side devices to prolong battery life and usability.

11. User Feedback and Improvements: Continuously gather user feedback to refine the system's usability, user experience, and performance.

12. AI-Based Location Services: Investigate the integration of AI-driven location services to enhance accuracy and reliability in both urban and remote areas.

13. Collaboration with Educational Institutions: Collaborate with educational institutions to promote end safety and use the system for educational and safety awareness programs.

These future directions will ensure that the system remains at the forefront of end tracking and safety technology, addressing the evolving needs and preferences of client s and end while prioritizing safety and user privacy.

REFERENCES

1. Ariffin, Ahmad & Aziz, Hafizah & Othman, Kama. (2011). Implementation of GPS for location tracking. 77-81. 10.1109/ICSGRC.2011.5991833.

2. Chadil, Noppadol & Russameesawang, Apirak & Keeratiwintakorn, Phongsak. (2008). Real-time tracking management system using GNSS, GPRS and Google earth. IEEE. 1. 393 - 396. 10.1109/ECTICON.2008.4600454.

3. Chi, C., Zhan, X., Wu, T., & Zhang, X. 2019, Ultra-rapid direct satellite selection algorithm for multi-GNSS, In International Conference on Aerospace System Science and Engineering (Singapore: Springer), pp.11-25.

4. C. J. Hegarty, "GNSS signals — An overview," 2012 IEEE International FrequencyControl Symposium Proceedings, Baltimore, MD, USA, 2012, pp. 1-7, Doi: 10.1109/FCS.2012.6243707.

5. Dalip, Vijay Kumar, GNSS and GSM Based Passenger Tracking System, InternationalJournalofComputerApplications(0975–8887)Volume100–No.2, August 2014.

6. Enge, Professor. (1994). The Global Positioning System: Signals,measurements, and performance. IJWIN. 1. 83-105. 10.1007/BF02106512.

7. Granbohm, H. & Wiklund, J.. (1999). GPRS - general packet radio service. 76. 82-88.

8. Gerbeth, D., Felux, M., Circiu, M.-S., & Caamano, M. 2016, Optimized selection ofsatellitesubsetsforamulti-constellationGBAS, InProceedingsofthe 2016 International Technical Meeting of The Institute of Navigation, Monterey, California, 25-28 January 2016, pp.360-367.

9. H. A. Abdallah Dafallah, "Design and implementation of an accurate real time GNSS tracking system," The Third International Conference on e-Technologies and Networks for Development (ICeND2014), Beirut, Lebanon, 2014, pp. 183-188, Doi: 10.1109/ICeND.2014.6991376.

10. ICAO, Annex 10 to the Convention of International Civil Aviation, Montreal, PQ, Canada, Jul. 2011, vol. I, Radio NavigationAids,Amendment 87.

11. Liu, M., Fortin, M.-A., & Landry, Jr., R. 2009, A recursive quasioptimal fast satellite selection method for GNSS receivers, Proceedings of the 22nd International Technical Meeting of the Satellite Division of the Institute of Navigation 2009 (ION GNSS 2009).

12. M. Ranjbar and M. R. Mosavi, “Simulated annealing clustering for optimum GPS satellite selection,” Int’l. Jour. Comp. Sci., vol. 9, no. 3, May 2012.

13. M. S. Phatak, “Recursive method for optimum GPS satellite selection,” IEEE Trans.Aero. Elect. Sys., vol. 37, no. 2,Apr. 2001, pp. 751-754.

14. McDonald, Mike & Keller, Hartmut & Klijnhout, Job & Mauro, Vito & Hall, Richard&Spence,Angela&Hecht,Christoph&Fakler,Oliver.(2006).Intelligent Transport Systems in Europe: Opportunities for Future Research. 10.1142/6281.

15. Mok, Esmond C. M. and Paul A Cross. “A Fast Satellite Selection Algorithm for Combined GPS and GLONASS Receivers.”*Journal of Navigation*47 (1994): 383 - 389.

16. P. Enge and P. Misra, "Special Issue on Global Positioning System," in Proceedings of the IEEE, vol. 87, no. 1, pp. 3-15, Jan. 1999, doi: 10.1109/JPROC.1999.736338.

17. Parkinson, B., and J. J. Spilker, Jr. (Eds.), Global Positioning System: Theory and Applications, Volume I, American Institute of Aeronautics and Astronautics, Washington, D.C., 1996.

18. R. Langley, “GLONASS: Review and update,” GPS World, vol. 8, no. 7, pp. 46-51, July 1997.

19. Shoaib, Mohd & Jain, Kamal & Haq, Mohd Anul & Shashi, Mesapam. Development and implementation of NMEA interpreter for real time GNSS data logging, 2013. 143-146. 10.1109/IAdCC.2013.6514210.

20. Swaszek, P. F., Hartnett, R.J.,&Seals, K. C. 2016, Multi-constellationGNSS: newboundsonDOPandarelatedsatelliteselectionprocess, InProceedingsofthe 29th International Technical Meeting of the Satellite Division of The Institute of Navigation(IONGNSS+2016),Portland,Oregon,12-16September2016, pp.228-235.

21. Swaszek, P. F., Hartnett, R. J., & Seals, K. C. 2017, Lower bounds on DOP, The Journal of Navigation, 70, 1041-1061.

22. Wei, M.,Wang, J., & Li, J. (2012).Anew satellite selection algorithm for real-time application.*2012 International Conference on Systems and Informatics (ICSAI2012)*, 2567-2570.