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A REAL-TIME WEB INFORMATION SYSTEM BASED ON A GLOBAL POSITIONING SYSTEM FOR MONITORING ENVIRONMENTAL POLLUTION

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Abstract

This research will discuss monitoring pollution in waterways in real time based on GPS. A website-based information system is an essential factor for information media, not only database-based but can be communicated with GPS. GPS is a satellite system that can determine the point of an area with Longitude and Latitude parameters. The Global Positioning System is one of the parameters used in this study. Longitude and Latitude are the primary keys to getting the point in a particular area or point. In research, this location is used in sensor or environmental pollution monitoring. In this paper, we try to review the projects carried out and perform analysis, management, and governance on the server and local host. The program is made by developing the FrontEnd and BackEnd sides. Development can be done on Desktop-based programming and then extended to Mobile by manipulating and modifying programs using Javascript, JSON, and other building scripts for better performance and suitable for deployment on various platforms such as Mobile-based. This system is very efficient in determining various parameters, for example, the environmental pollution factor. From testing, the GPS data is not perfect, all data can be sent, but the accuracy of GPS data can reach 96%. This is due to data errors during uplinking and downlinking data.

Keywords: information systems; global positioning system; Environmental Monitoring, real-time, Longitude-Latitude

Abstract

Pada riset ini akan membahas pemantauan pencemaran pada saluran air secara realtime berbasis GPS. Sistem informasi berbasis *Website* merupakan faktor penting untuk media informasi, tidak hanya berbasis *database* tetapi dapat dikomunikasikan dengan GPS. GPS merupakan sistem satelit yang dapat mengetahui titik suatu daerah dengan parameter Bujur dan Lintang, Global *Positioning* System merupakan salah satu parameter yang digunakan dalam penelitian ini, dimana parameter Bujur dan Lintang merupakan kunci utama untuk mendapatkan suatu titik dalam suatu daerah atau titik tertentu, dalam penelitian ini merupakan lokasi yang digunakan dalam pemantauan sensor atau pemantauan pencemaran lingkungan. Dalam naskah ini, kami mencoba meninjau proyek-proyek yang telah dilakukan dan melakukan analisis, manajemen, dan tata kelola di server dan *localhost*. Program dibuat dengan mengembangkan sisi *FrontEnd* dan *BackEnd*. Pengembangan dapat dilakukan pada pemrograman berbasis Desktop dan selanjutnya diperluas ke Mobile dengan memanipulasi dan memodifikasi program menggunakan Javascript, JSON, dan skrip bangunan lainnya untuk kinerja yang lebih baik dan cocok untuk ditempatkan di berbagai platform seperti berbasis Mobile. Sistem ini sangat efisien digunakan untuk mengetahui berbagai parameter dalam sistem, misalnya faktor pencemaran pada suatu lingkungan. Dari pengujian data GPS belum sempurna, semua data dapat terkirim namun akurasi data GPS dapat mencapai 96%. Hal ini dikarenakan adanya kesalahan data pada saat proses uplink dan downlink data.

Kata kunci: sistem informasi; sistem penentuan posisi global; Pemantauan Lingkungan, Realtime, Bujur-Lintang

INTRODUCTION

Conventional systems carry out periodic checks using manual methods, for example, checking water conditions or water quality in areas full of pollution, for example, water pollution in crowded settlements. For example, every week, officers from the cleaning service and health services check the pH of water in areas such as sewers or water reservoirs adjacent to residential areas; this is done to determine the level of pollution that may occur in well water or air pollution. Preventive efforts are needed to overcome pollution, which uses conventional methods. In this research, automatic detection or real-time monitoring (Moushi et al., 2018) of pollution that occurs in certain areas is carried out using a combination of website-based (Hnatushenko et al., 2018) and realtime based technology (Benitez Cortes et al., 2019), (Adi et al., 2022), realtime here is novelty research where data can be appropriately read using GPS in real-time (Aji et al., 2022). Sensor data can be recognized quickly (Hnatushenko et al., 2018), (Benitez Cortes et al., 2019), (Liani et al., 2021), (Mukti et al., 2021), (Vinnikov et al., 2021), (Xie et al., 2022), (Shi et al., 2018). This method provides quick action for health and hygiene workers to cope with leaking waterways from farm points and other polluting factors such as factory areas.

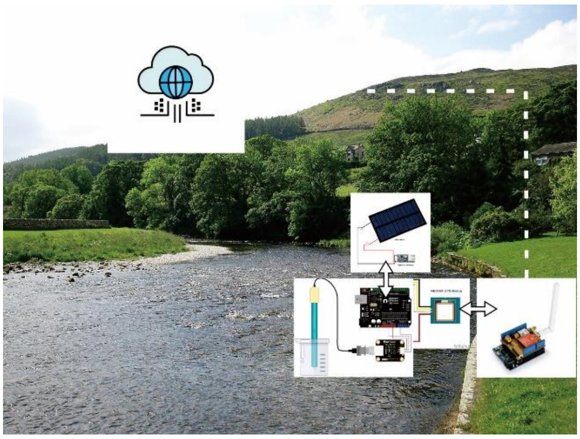

Figure 1. GPS IoT Prototype System to monitor river water pollution

From the Previous research, *Ganesh Ram, Aravind Dhandapani* (June 2022), with his research entitled, *Development of pH value detection sensor for water to detect and Automate Water Neutralization Process*, at the end of the research is the detection of quality water for people usage. It indicates the same with its auto-monitoring system.

Figure 1 obtains the descriptions of this GPS-based monitoring (Vinnikov et al., 2021), (Radhika et al., 2022), (Shi et al., 2018). The first is how the power consumption of sensor nodes, the overall prototype, the Application Server, and the internet server is obtained. The first is how to analyze river water and how much pH is produced by the river water according to the point where the GPS Module is installed (Want et al., 2018), (Sunehra et al., 2020). Then the next thing is regulating the power consumption taken from sunlight. Then how to transmit water pH sensor data to the internet server, attenuation, and Quality of Service from LoRaWAN devices (Moushi et al., 2018), (Anand et al., 2019).

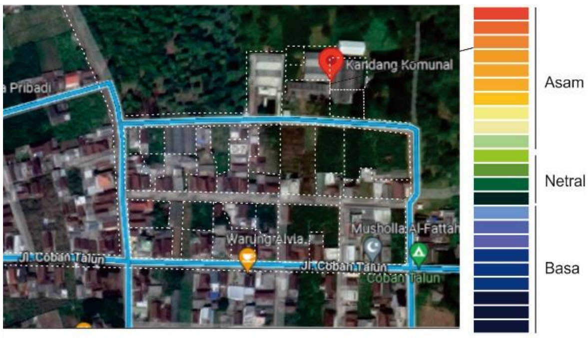

Figure 2. Water pH level in an area from GPS data

Furthermore, the prototype data analyzed the value of uplink and downlink data from the LoRaWAN server. From here, we can discover the Quality and service of the device or prototype built in the test or monitoring area. At the same time, the website is a system that will display data from MySQL or MariaDB using Python programming code. Then display the data simultaneously from the stored pH sensor to MariaDB. Moreover, MariaDB sends the data to the server in real-time. In this case, PHP and Javascript are needed to convert and call data from MariaDB or MySQL Db so that data can be displayed in real time on the website we build. An area monitoring system with water pH level data is shown in Figure 2.

Talking about the website is the same as talking about management information systems. In this case, the water pollution information system is based on the Website and the Internet of Things (IoT) (Arta et al., 2022), (Zhang et al., 2022), (Radhika et al., 2022), (Adi, Sihombing, et al., 2021),

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(Adi, Mustamu, et al., 2021). This management information system is a planning control that provides detailed, fast, and accurate information. This fast value is taken from the internet of things, a system that was built (Munsadwala et al., 2019), (Arta et al., 2022), while the accuracy comes from data sensors installed in the environment, referred to as sensor calibration, for example, water pH. Until pH water data can be obtained by all people easily using an IP Address or Homepage address of application servers such as Thingspeak, The Things Network, or domains in general.

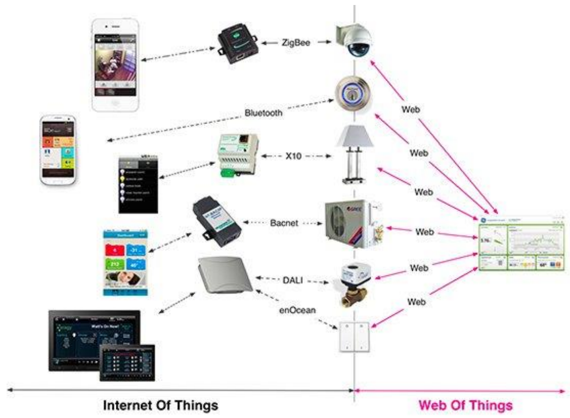

Figure 3. IoT to Web of Things

Finally, from the discussion on the Internet of Things, the water pH monitoring system combined with the website service will turn into a Web of Things, as shown in figure 3. The role of Web technology influences this, the script code used and the combination of GPS data (Adi, Sihombing, et al., 2021) and IoT sensors (Xie et al., 2022), (Want et al., 2018), (Xie et al., 2022) based on MySQL database which is changed to real-time graph and data table form. Then a new problem arises, namely how to determine the incoming data because the incoming data on this Web application is not limited in number. To overcome this, a limitation of the data sensor to the server or Website server is needed.

RESEARCH METHODS

The flowchart in figure 4 shows the method used in this research. From the method, it can be seen that the initial data is obtained from the sensors contained in the end node, and then the conversion process is carried out to get the sensor data displayed on the Web server and internet server and continued on the Website Pages. The first time is to initialize the GPS Lib library. In the LoRa module, run the GPS Module (Anand et al., 2019), and ensure that the pH water is connected correctly and calibrated, then the pH water data is sent to the internet via the application server, and sensor data can be seen in real time on the website. In figure 5, the GPS Module works with a satellite system (Sunehra et al., 2020), (Shi et al., 2018). GPS detects the Longitude and Latitude layout, uses UART connected to the microcontroller and power supply, sends data to the GUI using Python and MariaDB, then converts to PHP and javascript and displays it to the website.

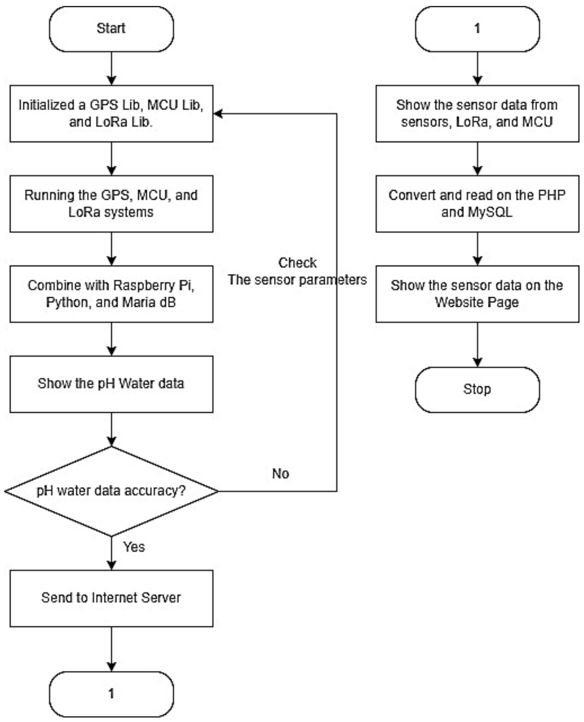

Figure 4. The System Work

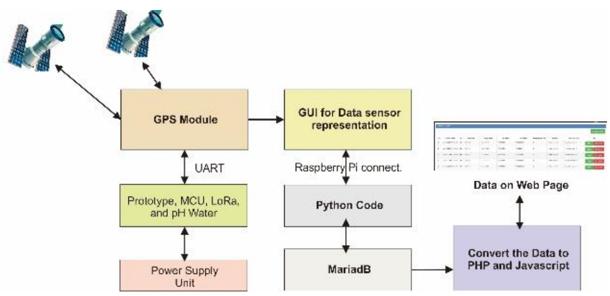

Figure 5. Communication data from a satellite to a website

The system as a whole can be seen in Figure 5 to facilitate an understanding of the system to be built. From Figure 5, it can be concluded that the GPS module contained in the prototype reads position data from the pH water sensor, and then from that data, it is processed into MySQL data form and displayed on the Website Pages. The processes

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occur the conversion process of the sensor data entered in the MySQL database belonging to the Raspberry Pi 4.0, namely MariaDB, which is then converted to PHP and Javascript.

$$(x - A_1)^2 + (y - B_1)^2 + (z - C_1)^2 - \left(c(t_1 - d)\right)^2 = 0 \quad (1)$$
$$(x - A_2)^2 + (y - B_2)^2 + (z - C_2)^2 - \left(c(t_2 - d)\right)^2 = 0 \quad (2)$$
$$(x - A_3)^2 + (y - B_3)^2 + (z - C_3)^2 - \left(c(t_3 - d)\right)^2 = 0 \quad (3)$$
$$(x - A_4)^2 + (y - B_4)^2 + (z - C_4)^2 - \left(c(t_4 - d)\right)^2 = 0 \quad (4)$$

In equations 1-4, x, y, and z are the rectangular coordinates of the GPS on the receiver, while A, B, and C are the coordinates of the GPS satellites; moreover, Satelite positions define $(A_i, B_i, C_i,)$, from spherical coordinates $(\rho_i, \varphi_i, \theta_i)$, then the relationship between the Satellite and spherical positions is as in equations 5-7.

$$A_i = \rho \cos(\varphi_i) \quad (5)$$
$$B_i = \rho \cos(\varphi_i) \sin(\theta_i) \quad (6)$$
$$C_i = \rho \sin(\varphi_i) \quad (6)$$

RESULTS AND DISCUSSION

The display on the Website page is data taken from the end-node sensor. The system other than the real-time mechanism can also be seen by adding the CRUD system (Create, Read, Update, Delete). This system needs to be made on the website based. As shown in the following figure 6.

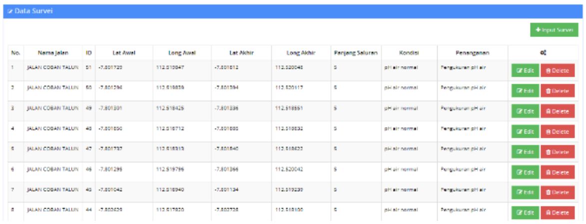

Figure 6. Data on the Web Page's example

Furthermore, figure 7 and figure 8 are examples of a WEB page for adding data, in which there is a CRUD that can change data easily.

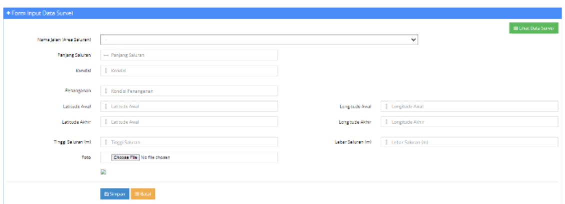
Figure 7. Additional Data Menu example

GPS performs specific location tracking at a minor area known as Ward and Street. This is where GPS performs additional important points when tracking, as shown in Figure 9 and Figure 10.

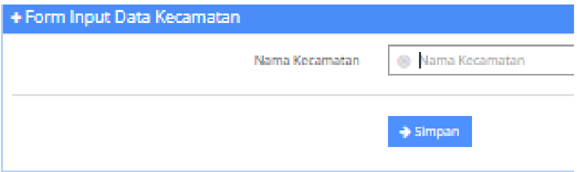

Figure 8. Add data districts example

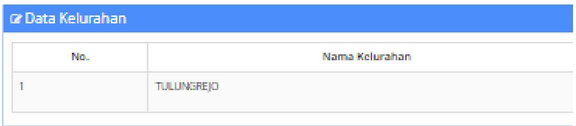

Figure 9. Add data Ward example

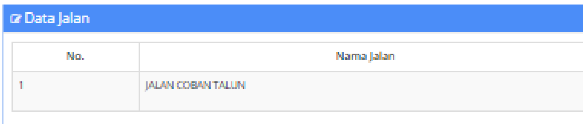

Figure 10. Add data Street example

Furthermore, this GPS-based Web feature has three view features OpenStreetMap View, Street View, and Satellite Point View. OpenStreetMap View is shown in Figure 11, and the display is just a line of street data added to the Web. While Street Point View can be seen in Figure 12, these are the points where measurements are made. To make it more transparent, change the Satellite Point View menu so that the satellite displays specific points, namely Longitude and Latitude, and the results of Capture images when we perform measurements. In detail can be seen in Figure 14.

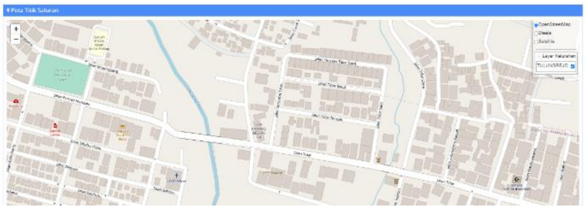
Figure 11. OpenStreetMap View

Figure 12. Street Point View

The point in Figure 12 can be more specific and detailed if the user adds data. For example, the data is water pH and Water Temperature. The data taken is the measurement of the pH sensor located on the sensor and attached to the GPS Module as a single unit. The pH sensor, GPS, and LoRa Module are installed as a single unit, and we can take this pH water and GPS data as primary data. Moreover, Satellite Point View and Details data View is shown in Figure 13 and Figure 14, and this is GPS data that has been combined or synchronized with Longitude and Latitude data on Google Maps.

Figure 13. Satellite Point View

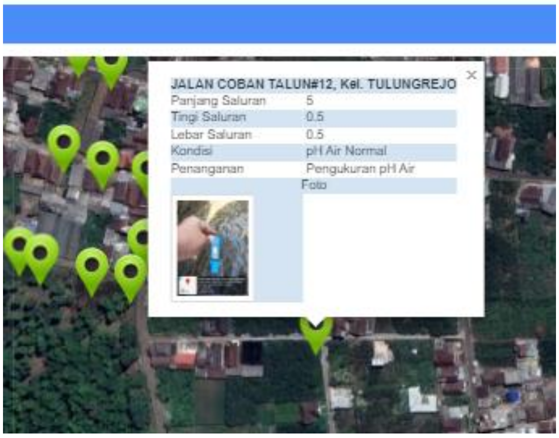

Figure 14. Details data View

CONCLUSIONS AND SUGGESTIONS

Conclusion

The overall system of this environmental monitoring website can work well and provide specific information for users. This GPS-based detection system has been tested and shows high accuracy, but for IoT devices, it must continue to be updated and maintained at any time, for example, once a week. From testing GPS data not to perfect, all data can be sent but can reach 96% accuracy of GPS data. This is because there is a data error during the uplink and downlink process data. The data obtained is data on the position of pH water with the points that have been fixed so that we can automatically get real-time data on pH water with the GPS module's value.

Suggestion

There must be data settings; therefore, GPS data with pH water data is not sent continuously. Data can be sent weekly, then delay or automatic sleep every 5 hours. This is done to reduce packet loss or packet data error (bit) and data effectiveness and MySQL data capability in storing data in the database, so it is also necessary to increase the database capacity to be more significant. Finally, an increase in programming ability towards a more specific mobile is needed for accessibility, flexibility, and user convenience.

REFERENCES

Adi, P. D. P., Indarti, N., Wahyu, Y., Sudarmanto, B. A., Mukti, F. S., & Parenreng, J. M. (2022). ECG-LPWAN based for Real-time monitoring Patient's Heart Beat Status. *In 2022 International Seminar on Application for Technology of Information and Communication (ISemantic)*, 7–14.

Adi, P. D. P., Mustamu, N. E., Siregar, V. M. M., & Sihombing, V. (2021). Drone simulation for agriculture and LoRa based approach. *Internet of Things and Artificial Intelligence Journal*, *1*(4), 221–235. https://doi.org/10.31763/iota.v1i4.501

Adi, P. D. P., Sihombing, V., Siregar, V. M. M., Yanris, G. J., Sianturi, F. A., Purba, W., Tamba, S. P., Simatupang, J., Arifuddin, R., & Prasetya, D. A. (2021). A Performance Evaluation of ZigBee Mesh Communication on the Internet of Things (IoT). *In 2021 3rd East Indonesia Conference on Computer and Information Technology (EIConCIT)*, 7–13. https://doi.org/10.1109/EIConCIT50028.2021.9431875

Aji, A. F., Lathief, M. F., Munawwaroh, D. A., & Gumilar, L. (2022). Sistem Keamanan Biometrik Sidik Jari dan GPS Tracking Pada Sepeda Motor Berbasis Teknologi IoT. *Jurnal Teknik Informatika Dan Elektro*, *4*(2), 73–81. https://doi.org/10.55542/jurtie.v4i2.256

Anand, S., Johnson, A., Mathikshara, P., & Karthik, R. (2019). Real-time GPS tracking using serverless architecture and ARM processor. *2019 11th International Conference on*

Communication Systems & Networks (COMSNETS), 541–543. https://doi.org/10.1109/COMSNETS.2019.8711273

Arta, I. K. C., Febriyanto, A., Nugraha, I. B. M. H. A., Widharma, I. G. S., & Purnama, I. B. I. (2022). Animal Tracking Berbasis Internet of Things. *Majalah Ilmiah Teknologi Elektro*, *21*(1), 7. https://doi.org/10.24843/MITE.2022.v21i01.P02

Benitez Cortes, R. P., Lopez Espinoza, R., Aguilar Navarrete, P., Camacho Gonzalez, Y., & Torres Covarrubias, V. J. (2019). Meyotl: A Web-App Prototype for the Geolocation of People with Cognitive Impairment. *2019 International Conference on Inclusive Technologies and Education (CONTIE)*, 85–855. https://doi.org/10.1109/CONTIE49246.2019.00025

Hnatushenko, V. V., Sierikova, K. Y., & Sierikov, I. Y. (2018). Development of a Cloud-Based Web Geospatial Information System for Agricultural Monitoring Using Sentinel-2 Data. *2018 IEEE 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT)*, 270–273. https://doi.org/10.1109/STC-CSIT.2018.8526717

Liani, Y. A., Munthe, I. R., Irmayani, D., Broto, B. E., Yanris, G. J., Prasetya, D. A., Haryanto, R., Adi, P. D. P., Muslikh, A. R., & Arifuddin, R. (2021). The Broiler Chicken Coop Temperature Monitoring Use Fuzzy Logic and LoRAWAN. *Proceeding - ICERA 2021: 2021 3rd International Conference on Electronics Representation and Algorithm*, 161–166. https://doi.org/10.1109/ICERA53111.2021.9538771

Moushi, O. M., Kamal, M., Haque, M., & Ahsan, M. S. (2018). Design and Development of an Online Bus Monitoring System. *2018 10th International Conference on Electrical and Computer Engineering (ICECE)*, 69–72. https://doi.org/10.1109/ICECE.2018.8636790

Mukti, F. S., Adi, P. D. P., Prasetya, D. A., Sihombing, V., Rahanra, N., Yuliawan, K., & Simatupang, J. (2021). Integrating Cost-231 Multiwall Propagation and Adaptive Data Rate Method for Access Point Placement Recommendation. *International Journal of Advanced Computer Science and Applications*, *12*(4), 772–777. https://doi.org/10.14569/IJACSA.2021.0120494

Munsadwala, Y., Joshi, P., Patel, P., & Rana, K. (2019). Identification and Visualization of Hazardous Gases Using IoT. *2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU)*, 1–6. https://doi.org/10.1109/IoT-SIU.2019.8777481

Radhika, A., Manochitra, G., Keerthanen, K., Mahendran, K., Kumar, R. M., & Sarath, N. M. (2022). Low-cost IoT-based early detection of flood monitoring and alert system using GPS and GSM. *Proceeding of 2nd International Colloquium on Computational & Experimental Mechanics (ICCEM 2021)*, *2545*, 040007. https://doi.org/10.1063/5.0108131

Shi, J., Zhang, L., & Ge, D. (2018). Remote Intelligent Position-Tracking and Control System with MCU/GSM/GPS/IoT. *Proceedings of the 2018 International Conference on Computing and Artificial Intelligence*, 66–70. https://doi.org/10.1145/3194452.3194464

Sunehra, D., Sreshta, V. S., Shashank, V., & Kumar Goud, B. U. (2020). Raspberry Pi Based Smart Wearable Device for Women Safety using GPS and GSM Technology. *2020 IEEE International Conference for Innovation in Technology (INOCON)*, 1–5. https://doi.org/10.1109/INOCON50539.2020.9298449

Vinnikov, V., Pshehotskaya, E., & Gritsevich, M. (2021). Partial Decoding of the GPS Extended Prediction Orbit File. *2021 29th Conference of Open Innovations Association (FRUCT)*, 375–384. https://doi.org/10.23919/FRUCT52173.2021.9435474

Want, R., Wang, W., & Chesnutt, S. (2018). Accurate Indoor Location for the IoT. *Computer*, *51*(8), 66–70. https://doi.org/10.1109/MC.2018.3191259

Xie, Z., Zhang, R., Fang, J., & Zheng, L. (2022). A Monitoring System Based on NB-IoT and BDS/GPS Dual-Mode Positioning. *Electronics*, *11*(16), 2493. https://doi.org/10.3390/electronics11162493

Zhang, X., Chen, P., Tang, L., Xia, Y., Li, J., Jiang, N., Xie, H., Xia, Q., & Wu, L. (2022). Planning bus networks by exploiting GPS trajectories collected by IoT-enabled vehicles. *International Journal of Communication Systems*. https://doi.org/10.1002/dac.5229