BEST
Journal of Applied Electrical & Science Technology – University of PGRI Adi Buana Surabaya
p-ISSN 2715-2871
e-ISSN 2714-5247

Smart Backpack Solution for Child SafetyMonitoring using GPS Tracker and Internet of Things (IoT)

Anggarjuna Puncak Pujiputra
Department of Ship Electrical Engineering
Shipbuilding Institute of Polytechnic
Surabaya, Indonesia
anggarjuna.puncak@ppns.ac.id

Thomas Brian
Department of Ship Electrical Engineering
Shipbuilding Institute of Polytechnic
Surabaya, Indonesia
thomas.brian@ppns.ac.id

Putri Nur Rahayu
Department of Ship Building Engineering
Shipbuilding Institute of Polytechnic
Surabaya, Indonesia
putri.nur@ppns.ac.id

Atmiasri
Electrical Engineering
University of PGRI Adi Buana
Surabaya, Indonesia
atmi.asri@unipasby.ac.id

***Abstract*— Supervision of children is an important thing to do for the development of behavior and child safety. The existence of cases around such as after school not going straight home, skipping school to play online games, even in the mass media there are cases of elementary school children who do not go home immediately. in the mass media there are cases of elementary school children who died from drowning while playing. This can cause parents to worry about their children. On the other hand, the space for parents to supervise children directly is limited due to their activities such as taking care of the house or working, so there is an alternative to make a tracking device or GPS Tracker with the concept of the Internet of Things (IoT) that can solve the problem. The manufacturing method includes three stages, namely the design stage, the testing stage, and data analysis stage in order to produce the expected tool. The results of this research are first, GPS Tracker is built by three main components (Ardunino Nano, Ublox NEO-6M, and SIM800L). Second, the tool functions optimally when outside the room with percentage of error 0% and less than maximum when indoors with an error of 40%. room with 40% error. Third, the device is able to track position at various distances. Fourth, the tool has an average working endurance of 4 hours 26 minutes with a power source of 3.7 VDC 3500mAH battery.**

Keywords—Detector, Face, Check-in, Airport, Artificial intelligence

I. INTRODUCTION

Parental supervision plays a crucial role in children's behavioral development and safety, particularly during late childhood (ages 6–12), when children are highly active in group play and interaction with new environments [1]. However, incidents such as children not returning home directly after school, skipping school to play online games, or tragic cases reported in mass media—such as elementary school children drowning while swimming in excavation sites—have raised serious concerns among parents [2].

These problems cause anxiety for parents regarding the whereabouts and safety of their children when outside the home. On the other hand, parents often have limited ability to supervise their children directly due to responsibilities such as household chores, work, or business travel. To address this issue, one effective solution is the use of Global Positioning System (GPS) technology, often referred to as a GPS tracker, which can be installed in a child's backpack. This allows parents to monitor the child's location in real-time and take prompt action if any irregularities are detected.

Previous research has explored the implementation of GPS trackers for child monitoring. For instance, Baihaqi et al. [3] and Dariyono [4] utilized the Arduino Mega microcontroller with the Ublox NEO-6M GPS module and the SIM800L GSM module to transmit location data via SMS, accessible through Google Maps. Setiawan [5] developed a system based on the AT-09 Bluetooth Low Energy (BLE) module, where the tracker maintains Bluetooth connectivity with a parent's smartphone, and sends location information via SMS if the connection is lost.

Considering the current trend where many people rely on internet-based services, this study advances previous designs by incorporating the Internet of Things (IoT) concept. It utilizes the SIM800L module not only for SMS, but also as an internet gateway, enabling continuous and automated GPS data transmission via web-based monitoring platforms [6][7][8][9][10]. This system employs the Ublox NEO-6M GPS module as the signal receiver and the Arduino Nano as the microcontroller, with the goal of providing a real-time, accessible, and efficient monitoring solution for parents.

II. RESEARCH METHODS

This research was carried out through three stages, design stage, testing stage, and data analysis stage.

A. Diagram Block

The diagram block is made to provide an overview briefly how the tool can be formed and run according to the objectives set, can be seen in the picture as follows:

p-ISSN 2715-2871
e-ISSN 2714-5247

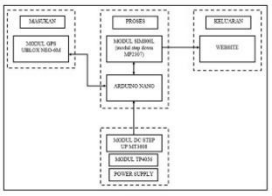


Fig. 1. Diagram Block

From the picture above, it can be explained that there are three building blocks, as follows :

1. Input

Ublox NEO-6M which functions to receive GPS signals signal from the satellite which is then sent to the microcontroller for processing.

2. Process

Arduino Nano as a microcontroller that functions to instruct, integrate and process latitude and longitude data, so that it can be sent to the website database via the internet using SIM800L [5].

*B. **Product Design***

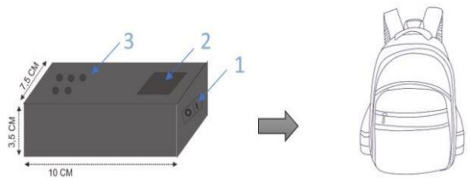


Fig. 2. GPS Tracker Product Design

The tool design is made to be inserted into a children's school backpack with a box size of 10 cm x 7.5 cm x 3.5 cm. On the box cover there are :

1. On/off switch
2. Hole for GSM/Internet signal
3. GPS antenna

C. ***Wiring Diagram***

Wiring diagrams are made as a reference in assembling tool with the aim to facilitate the implementation of assembly of the components, as follows:

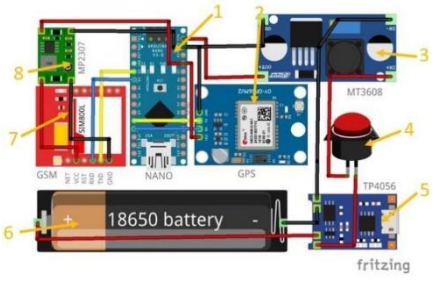


Fig. 3. GPS Tracker Wiring Diagram

The following is a list of components from the wiring diagram of the GPS Tracker:

1. Arduino Nano
2. Ublox NEO-6M GPS module
3. MT3608 Step Up Module
4. Switch
5. TP4056 Charger Module
6. 18650 3.7 VDC/3500mAh Battery
7. SIM800L Module
8. MP2307 Step Down Module

Fig. 4. GPS Tracker Flowchart

From the flowchart above, it can be explained after declaration and initialization of variables on the Arduino Nano then the GPS module (Ublox Neo 6M) and GSM (SIM800L) will try to get a GPS signal and an internet. After the GPS module gets a signal from satellites, it will then be processed into latitude and longitude data on the Arduino Nano. Furthermore, the data will be sent through the internet network by the GSM module to the database website that has been integrated with the Google Maps API. Then the website database will automatically update the data and google maps API will show the tracked location point. The process will continue to repeat automatically every one minute.

III. RESEARCH & DISCUSSION

A. Product Presentation

GPS Tracker products that will be installed in the child's school bag. The scheme of this GPS Trcaker is that the GPS module (Ublox Neo 6M) can receive GPS signals from satellites, then sent and processed into latitude and longitude data by arduino nano, then sent and processed into latitude and longitude data by ardino nano, then sent to the longitude data by ardino nano, then sent to the database via the internet by the GSM module (SIM800L), and the

p-ISSN 2715-2871
e-ISSN 2714-5247

data that enters the database will be visualized on the Google Maps API on the website.

Fig .5 GPS Tracker

B. ELECTRICAL POWER SOURCE TESTING

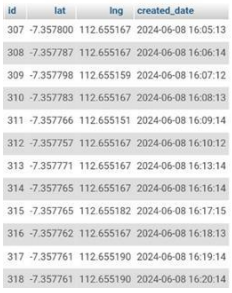
The first test was carried out to test the electrical power source that will enter each module according to specifications so that the module can work properly and no damage occurs. The following is the test data that has been done.

Tabel 1 Electrical Power Source Testing

No.	Modul	Spesifikasi	V in	Keterangan
1	Arduino Nano	7 - 12 VDC / 5 VDC (USB)	7.25 VDC	Sesuai
2	MT3608	3 - 32 VDC	3.76 VDC	Sesuai
3	MP 2307	4.5 VDC - 23 VDC	5 VDC	Sesuai
4	Modul GSM	3.7 - 4.2 VDC	3.65 VDC	Sesuai
5	Modul GPS	2.7 - 5 VDC	5 VDC	Sesuai

C. Testing GPS Tracker in Environmental Conditions

The second test is performance testing sending latitude and longitude data to the database in two specific environmental conditions, namely when outdoors room and indoors. The following is the data testing that has been done.



id	lat	lng	created_date
307	-7.357800	112.655167	2024-06-08 16:05:13
308	-7.357787	112.655167	2024-06-08 16:06:14
309	-7.357798	112.655159	2024-06-08 16:07:12
310	-7.357783	112.655167	2024-06-08 16:08:13
311	-7.357766	112.655151	2024-06-08 16:09:14
312	-7.357757	112.655167	2024-06-08 16:10:12
313	-7.357771	112.655167	2024-06-08 16:13:14
314	-7.357765	112.655167	2024-06-08 16:16:14
315	-7.357765	112.655182	2024-06-08 16:17:15
316	-7.357762	112.655167	2024-06-08 16:18:13
317	-7.357761	112.655190	2024-06-08 16:19:14
318	-7.357761	112.655190	2024-06-08 16:20:14

Fig 6. Database on Environmental Conditions

Table 2. Testing GPS Tracker in Environmental Conditions

No.	Kondisi		Latitude & Longitude	Terbaca		Delay
	Diluar	Didalam		Ya	Tidak	
1	✓		-7.357800, 112.655167	✓		16:05:13
2	✓		-7.357787, 112.655167	✓		16:06:14
3	✓		-7357798, 112.655159	✓		16:07:12
4	✓		-7.357783, 112.655167	✓		16:08:13
5	✓		-7.357766, 112.655151	✓		16:09:12
6	✓		-7.357757, 112.655167	✓		16:10:12
7		✓	-		✓	16:11:00
8		✓	-		✓	16:12:00
9		✓	-7.357771, 112.655167	✓		16:13:14
10		✓	-		✓	16:14:00
11		✓	-		✓	16:15:00
12		✓	-7.357765, 112.655167	✓		16:16:14
13		✓	-7.357765, 112.655182	✓		16:17:15
14		✓	-7.357762, 112.655167	✓		16:18:13
15		✓	-7.357761, 112.655190	✓		16:19:14
16		✓	-7.357761, 112.655190	✓		16:20:12
			Galat kondisi diluar ruangan			0%
			Galat Kondisi didalam ruangan			40%

D. Testing the GPS Tracker at a Specific Distance

The third test is testing the performance of the GPS Tracker performance regarding data that can be sent via the internet to the website database with a distance of more than 10 km. The following is the test data that has been done.

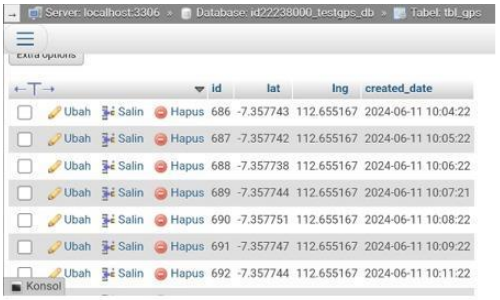
Fig .7 Google Maps API View

Table 3. Testing the GPS Tracker at a Specific Distance

No.	Jarak	Latitude & Longitude	Terbaca		Delay
			Ya	Tidak	
1	<10 m	-7.360394 112.642380	✓		1 menit
2	>10 m	-7.360421 112.643143	✓		1 menit
3	>100 m	-7.360011 112.646400	✓		1 menit
4	> 1 km	-7.359591 112.651604	✓		1 menit
5	> 5 km	-7.346827 112.684052	✓		1 menit
6	> 10 km	-7,344502 112.722343	✓		1 menit

E. Battery Life Testing

The fourth test is a battery life test which is used for the GPS Tracker power source, using one lithium-ion battery (Li-Ion) 18650 with output voltage of 3.7 VDC - 4.2 VDC been done



	id	lat	lng	created_date
Ubah Salin Hapus	686	-7.357743	112.655167	2024-06-11 10:04:22
Ubah Salin Hapus	687	-7.357742	112.655167	2024-06-11 10:05:22
Ubah Salin Hapus	688	-7.357738	112.655167	2024-06-11 10:06:22
Ubah Salin Hapus	689	-7.357744	112.655167	2024-06-11 10:07:21
Ubah Salin Hapus	690	-7.357751	112.655167	2024-06-11 10:08:22
Ubah Salin Hapus	691	-7.357747	112.655167	2024-06-11 10:09:22
Ubah Salin Hapus	692	-7.357744	112.655167	2024-06-11 10:11:22

Fig. 8. The Last Database

Table 4. Battery Life Testing

Pengujian	T1	T2	Daya Tahan
1	04:56	10:11	5 jam 15 menit
2	21:46	02:37	4 jam 51 menit
3	12:07	16:27	4 jam 20 menit
4	20:01	00:21	4 jam 20 menit
5	07:26	10:54	3 jam 28 menit
Rata-rata			4 jam 26 menit

p-ISSN 2715-2871
e-ISSN 2714-5247

CONCLUSION AND SUGGESTION

Based on the results of design and data testing, the GPS tracking tool effectively functions as a monitoring device integrated with a website, utilizing three main components: Arduino Nano, a GSM module (SIM800L), and a GPS module (Ublox Neo 6M). The GPS module captures signals, which are processed into latitude and longitude data by the Arduino Nano before being transmitted to the website database via the internet using the GSM module. These data points are then visualized on Google Maps API as position markers. Environmental conditions significantly impact the tool's performance—outdoor use allows optimal functionality, whereas indoor use results in signal interference, leading to a 40% error rate with missing data in the database. Additionally, testing indicates that distance exceeding 10 km does not affect data transmission delays, though internet signal strength plays a crucial role in determining transmission speed. Regarding power efficiency, the GPS Tracker operates for an average of 4 hours and 26 minutes per charge, utilizing a 3.7 VDC battery with a capacity of 3,500 mAh.

REFERENCES

[1] Anshory AM, I., & dkk. (2016). Tahapan dan Karakteristik Perkembangan Belajar Siswa Sekolah Dasar (Upaya Pemaknaan Development Task). Seminar Nasional Pendidikan Berkemajuan dan Menggembirakan ke-1 (hal. 383–389). Pers Universitas Muhammadiyah.

[2] Yulianto, A. (2023, November 15). Bocah SD di Bogor Meninggal Tenggelam Saat Berenang dalam Kubangan. Retrieved Desember 23, 2023, from Republika Online: http://rejabar.republika.co.id/berita/bocah-sd-di bogor-meninggal-tenggelam-saat-berenang-dalam kubangan

[3] Baihaqi, A., Djatmiko, W., & Yusro, M. (2019). Rancang Bangun Tas Punggung Pintar untuk Anak Dengan Load Cell 5 Kg, GPS dan SMS Berbasis Arduino Mega 2560. JVoTE (Jurnal Pendidikan Vokasional Elektronika), 2(2), 68–76.

[4] Dariyono, M. (2018). Pemanfaatan Tas Sekolah Untuk Mendeteksi Posisi Anak Menggunakan GPS dan SMS Gateway Berbasis Arduino. Jambi: Universitas Dinamika Bangsa.

[5] Setiawan, M. H. (2022). Rancang Bangun Alat Pengawas dan Pelacak Keberadaan Anak Oleh Orang Tua Berbasis Bluetooth dan Global Positioning System (GPS). Surabaya: Universitas PGRI Adi Buana Surabaya.

[6] Atmiasri, & Wiyono, A. T. (2021). Design of Smart Garden Based on The Internet of Things (IoT). BEST Journal Applied Electrical & Science Technology, 3(2), 36–40.

[7] Misra, S., Maheswaran, M., & Hashmi, S. (2017). Security Challenges and Approaches in Internet of Things. Cham: Springer.

[8] Weyrich, M., & Ebert, C. (2016). "Reference Architectures for the Internet of Things," IEEE Software, 33(1), 112–116.

[9] Gubbi, R., Buyya, R., Marusic, S., & Palaniswami, M. (2013). "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions," Future Generation Computer Systems, 29(7), 1645 1660.

[10] Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). "Internet of Things for Smart Cities," IEEE Internet of Things Journal, 1(1), 22–32.
1626–1630.
https://doi.org/10.1109/ICACCI.2015.7275846