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# Analysis of Location Tracker Devices (GPS Microcontroller STM 32) on The Position of Solar-powered Electric Bicycles

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**Abstract.** Solar electric bicycles aim for remote areas, where there is no electricity coverage. To find out the position of the solar electric bicycles, therefore research on solar electric bicycles was made with the addition of an STM 32 microcontroller. This research was conducted to determine the speed and holding time of data retrieval during the data delivery from location to serve. This research was carried out by analysing the variations of holding 15 minutes with a delay of 3 seconds: holding 30 minutes with a delay of 2 seconds: holding 1 hour with a delay of 30 seconds. The research results showed that the difference between GPS (Global position system) and the delay was 4%. From the result of this study, conclude that the use of GPS microcontroller STM32 was good enough.

## 1. Introduction

Energy consumption continues to increase, causing all countries to compete to create alternative energy sources. Every discovery of new things about energy should qualify that generate a large enough amount of energy but minimises the cost and no negative impact on the environment. Therefore, the search for new energy is directed to solar energy by using solar cell panels that can convert solar energy into electrical energy [1]. One form of application of the use of solar cells usually found in vehicles [2] like an electric bicycle using solar cells. Electric bicycles use solar cells to be a solution for solar energy utilisation, where this vehicle has high mobility and does not cause pollution. To make it easier for users to find out the location of an electric bicycle using solar cells, a Global Position System (GPS) is installed on the bicycle.

Position tracker system makes easy to search or find some object, especially for tracking the position of solar-powered electric bicycles that have been developed by adding an STM32 GPS microcontroller in this study. Research on tracking positions has been widely carried out, one of them is research conducted by [3]. On that research, a GPS is placed with a variety of specific locations; then the GPS data is accessed from a different location using short message system (SMS). The results of this study indicate that the GPS system has a fairly high level of accuracy with an average shift value of 16.25 m. Research on GPS on moving objects has been examined by [4] and [5], both researchers use Geographic Information System (GIS) to show geographic information on the map so that the coordinates of the position data from that location are sent to the user via SMS. The results of both studies show that the system used can work very well. In research conducted by [4], it shows that the average time to send location data through SMS requires around 17.8 seconds. The use of GPS and GSM network (by SMS data) on a moving object has been widely used and applied not only to



vehicles but also on other moving objects [6-8]. The use of GPS is also very helpful for users because it has the wide range of capacity as reported by researchers [9, 10].

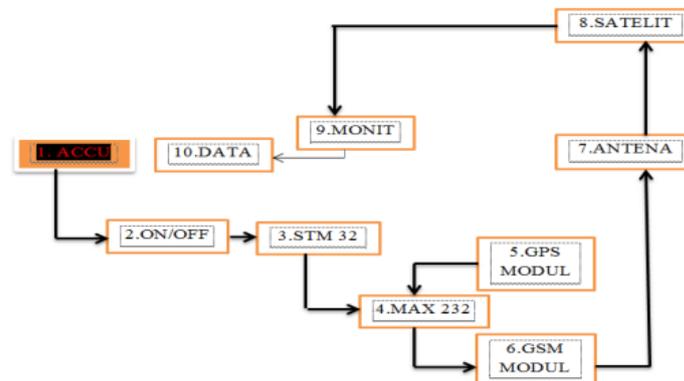
This study aims to determine the effect of the data transmission period to the delay time data received from a solar electric bicycle that uses GPS microcontroller STM32 and comparing the results of the speed on the speedometer and the speed on the GPS. In addition to the mileage on the odometer and mileage tool on GPS microcontroller STM32 also discussed.

## 2. Research Method

To determine the effect of the data transmission period to the delay time data received and comparison of speed on the speedometer with the mileage on the odometer and mileage on the GPS microcontroller STM32 on electric bicycles using solar cells. Then, in this study using a folding bicycle modified by adding a solar panel to the top of the bicycle as shown in Figure 1. Three solar panels with a capacity of 50 Watt peak are assembled to produce 150 Watt peak. This power is used to fill a 48 Volt capacity battery which is used to drive an electric bicycle as well as the power supply for the GPS microcontroller STM32 circuit. The circuit scheme of the GPS system is shown in Figure 2. In this framework, the battery acts as the main power for charging the GPS device. An STM32 is used as a CPU in this circuit, max 32 as a component for input/output, and GSM MODUL is used to send data to serve. In the GPS circuit, there is one line connected to the antenna cable, the antenna on the GPS is tasked with finding signals so that GPS can continue to get signals from satellites. In this study, the retrieval data is only taken 5 data at every holding intervals to represent the accuracy of the timer is the holding time of 15 minutes, 30 minutes and 60 minutes. The three variations of holding time are chosen to determine the significant delay time that occurs between the data transmission time and the data receiving time. As was the case in previous studies, but on that study using holding time of 1 minute and 10 minutes to determine the delay time that occurred [4].



**Figure 1.** Electric bicycle with three solar panels.

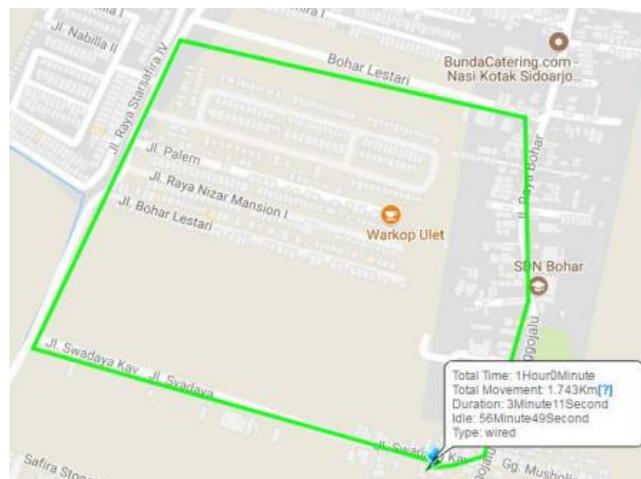


**Figure 2.** The circuit scheme of the GPS system.

### 3. Result and Discussion

#### 3.1. Delay Time Data Reception on Sending GPS Data to The Server

To determine the effect of data transmission time to the reception delay time, then the 5 data is taken at each time interval to represent the accuracy of the timer which is the holding time of 15 minutes, 30 minutes and 60 minutes. The collection of experimental data samples was carried out in Ronggojalu village, Masangan Wetan, Sukodono District, Sidoarjo. Figure 3 shows the results of tracking from a solar cell electric bicycle. It shows that the tracking results are in accordance with the path that is traversed.



**Figure 3.** The results of tracking the position of the electric bicycle with solar cell power.

In the experiment with holding time of 15-minutes, it shows that at number 1 the delay is 0 seconds, while in the number 2 between sending data and receiving data in the monitor there is a time delay of 2 seconds as shown in Table 1. In general, from this test, the average delay time between sending and receiving data is not too long, ranges from 3 seconds / 5 tests = 0.6 seconds at each holding time. Experiments with holding time of 30-minute indicate that experiments number 3 and 4 have a delay time 1-second as shown in table 2. With these conditions, generally at holding time 30 minutes has an average delay time of 2 seconds / 5 test = 0.4 sec testing at each holding time. Whereas in the experiment with holding time of 60 minutes shows the delay time is quite long in experiments number 2 and 4 which is 7 seconds and 35 seconds, as shown in table 3. This causes the average value to increase to 42 seconds slightly: 5 tests = 8.4 seconds at each holding time. All data can be seen in Tables 1, 2 and 3.

**Table 1.** Test data with 15-minute holding time.

No	Date	Sending time	Receive time	Longitude	Latitude	Delay
1	2017-08-27	16:25:34	16:25:34	112.697774	-7.392929	0 second
2	2017-08-27	16:40:34	16:40:36	112.697774	-7.392948	2 second
3	2017-08-27	16:55:36	16:55:36	112.697794	-7.392931	0 second
4	2017-08-27	17:10:36	17:10:37	112.697794	-7.392931	1 second
5	2017-08-27	17:25:37	17:25:37	112.697825	-7.392907	0 second

**Table 2.** Test data with 30-minute holding time.

No	Date	Sending time	Receive time	longitude	latitude	Delay
1	2017-08-27	17:40:37	17:40:37	112.697805	-7.392928	0 second
2	2017-08-27	18:10:37	18:10:37	112.697805	-7.392911	0 second
3	2017-08-27	18:40:37	18:40:38	112.697805	-7.392900	1 second
4	2017-08-27	19:10:38	19:10:39	112.697805	-7.392921	1 second
5	2017-08-27	19:40:39	19:40:39	112.697835	-7.392900	0 second

**Table 3.** Test data with 60-minute holding time.

No	Date	Sending time	Receive time	longitude	latitude	Delay
1	2017-08-27	20:10:37	20:10:37	112.697856	-7.392900	0 second
2	2017-08-27	21:10:37	21:10:44	112.697805	-7.392907	7 second
3	2017-08-27	22:10:44	22:10:44	112.697805	-7.392933	0 second
4	2017-08-27	23:10:44	23:11:19	112.697866	-7.392938	35 second
5	2017-08-28	00:10:19	00:10:19	112.697815	-7.392927	0 second

In general, from Tables 1, 2 and 3, almost all the holding time taken by the data is real-time data when sending data. This means that in general the delay time is very small this is caused because the GPS signal on the STM 32 is very good. This might change because the presence of an antenna blocks the incoming signal on the GPS to send to the server. Delay time is the difference between sending GPS data with the time to receive the server data. In the three tables, it was found that there was an accumulation of high delay time with a duration of 35 seconds in table 3 of the 4th data, which in that data used holding time of 60 minutes. This is due to a barrier that interferes with the GPS signal to send data. From the third result of the holding time variation that is tested, the best delay time and feasible to use is at holding time of 30 minutes.

### 3.2. Comparison of Speed on GPS with Speed on Speedometer

The test carried out this time intended to determine the difference in speed displayed on GPS with speed displayed on the speedometer installed on a solar cell power electric bicycle. The results of these experiments show that GPS and speedometer show the speed measurements generally have the same value, as shown in Table 4.

**Table 4.** Speed testing data with GPS and Speedometer.

No	Date	Sending time	Receive time	longitude	latitude	Speed on GPS	Speed on Speedometer
1	2017-08-22	04:06:25	04:06:25	112.769382	-7.343834	9.8 km/hour	9.5 km/hour
2	2017-08-22	04:06:30	04:06:30	112.769566	-7.343875	5.0 km/hour	5.0 km/hour
3	2017-08-22	04:06:33	04:06:33	112.769669	-7.343895	8.8 km/hour	8.7 km/hour
4	2017-08-22	04:06:37	04:06:37	112.769833	-7.343942	9.0 km/hour	8.9 km/hour

From the data obtained the speed difference shown on the GPS on the monitor screen with a speedometer can be calculated as follows:

Number 1:

$$\frac{(speed\_GPS - speed\_speedometer)}{speed\_GPS} \times 100\% = \frac{9.8 - 9.5}{9.8} \times 100\% = 3\%$$

With the same formula, the difference in speed is shown in GPS and Speedometer is obtained in experiment Number 2 = 0%, Number 3 = 1%, and Number 4 = 1%. With these results, the difference in speed shown by GPS and Speedometer is around 4%, indicating that the use of GPS with STM32 microcontroller is quite accurate and good.

### 3.3. Comparison of GPS Mileage with The Odometer Mileage

The testing data below is the result of testing of a solar electric bicycle. This test aims to compare between the use of GPS and the odometer to determine the distance of each. The measurement data can be seen in Table 5 and Figure 4.

**Table 5.** Mileage data using GPS.

No	Speed (km/hour)	Distance (km)
1	9.3	10.310
2	9.5	10.588
3	10.2	10.883
4	6.7	11.204
5	9.2	11.327
6	13.6	11.675
7	8.5	12.141
8	8.1	12.428
9	12.5	12.756
10	12	12.868



**Figure 4.** The odometer distance is at the start and end conditions.

Speed data retrieval on GPS cannot be stable due to the influence on the signal so that it affects the transmission of speed data that appears on the monitor screen. So what is done is to calculate the mileage from a bicycle, for example, the data above using GPS in table 5 shows the initial distance is 10,310 km, and the final distance is 12,868 km. Thus the distance is 2,558 km. While on the odometer shows the number of starting bicycle runs is 48324.8 km and ends at a distance of 48327.3 km. It is seen that the odometer shows the bike mileage of 2.5 km. Then the percentage of error reading between GPS and odometer can be calculated by using the equation below,

$$\frac{(\text{distance } GPS - \text{distance } odometer)}{\text{distance } GPS} \times 100\% = \frac{2.558 - 2.500}{2.558} \times 100\% = 2.2\%$$

then the difference in reading error between GPS and odometer is 2.2%. It can be ascertained that this GPS device is quite accurate and good.

#### 4. Conclusions

From data retrieval and data analysis from location tracker devices with GPS microcontroller STM32 to the position of solar electric bikes can be concluded that the test results show that the average delay in receiving data in holding time of 15 minutes is about 0.6 seconds, holding time of 30 minutes is about 0,4 second and holding time of 1 hour is about 8.4 seconds. This because there is an accumulation of delays, from the results of the holding time that gets the best delay time and is worthy of use is holding time of 30 minutes. The results also showed that the GPS ratio with a speedometer was around 4% and the GPS ratio with an odometer was around 2.2%. This shows that the use of GPS microcontroller STM 32 is quite good. This result is expected to be used as a reference for the development of location tracker devices, especially for other transportation devices.

#### 5. References

- [1] Devabhaktuni V, Alam M, Shekara Sreenadh Reddy Depuru S, Green RC, Nims D, Near C. Solar energy: Trends and enabling technologies. *Renewable and Sustainable Energy Reviews*. 2013;**19**:555-64.
- [2] Rizzo G. Automotive Applications of Solar Energy. *IFAC Proceedings Volumes*. 2010;**43**(7):174-85.
- [3] Budiawan T. *MOBILE TRACKING GPS (GLOBAL POSITIONING SYSTEM) MELALUI MEDIA SMS (SHORT MESSAGE SERVICE)*. Semarang: University Diponegoro; 2011.
- [4] Hanifah R, Isnanto RR, Christyono Y. Simulasi Sistem Informasi Geografis (SIG) Pemantauan Posisi Kendaraan Via SMS Gateway. *Transmisi*. 2012:5.
- [5] Abidin DZ. SISTEM ONLINE UNTUK PELACAKAN PAKET MENGGUNAKAN GPS *Jurnal Processor*. 2011;**6**(2):13-24.
- [6] Deblauwe N, Ruppel P, editors. *Combining GPS and GSM Cell-ID positioning for Proactive Location-based Services*. 2007 Fourth Annual International Conference on Mobile and Ubiquitous Systems: Networking & Services (MobiQuitous); 2007 6-10 Aug. 2007.
- [7] Meneses F, Moreira A, editors. *Using GSM CellID Positioning for Place Discovering*. 2006 Pervasive Health Conference and Workshops; 2006 29 Nov.-1 Dec. 2006.
- [8] Tian Z, Yang J, Zhang J, editors. *Location-based Services Applied to an Electric Wheelchair Based on the GPS and GSM Networks*. 2009 International Workshop on Intelligent Systems and Applications; 2009 23-24 May 2009.
- [9] Lai Y, Lin J, Yeh Y, Lai C, Weng H. A tracking system using location prediction and dynamic threshold for minimizing SMS delivery. *Journal of Communications and Networks*. 2013;**15**(1):54-60.
- [10] Le-Tien T, Phung-The V, editors. *Routing and Tracking System for Mobile Vehicles in Large Area*. 2010 Fifth IEEE International Symposium on Electronic Design, Test & Applications; 2010 13-15 Jan. 2010.

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