Creating Auxiliary Tool to Monitor the Condition and Position of a Person by Using GPS (Global Positioning System) Technology

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Abstract—*The human activities are very complex and some of the activities, such as travelling, hiking, and mountaineering, are not always close to a hospital or other medical facilities that can provide first aid when someone is having health problems.*
Objectives to be gained through this research are to create a auxiliary tool to monitor the condition and position of a person using GPS (Global Positioning System) technology and to find out the performance of the tool.
Research and development is comprised of several stages, in which the study measures refer to the R&D cycle borg and Gall with modification to aligned with the goals and the actual conditions of the study. The steps being taken include: 1) Pre-Development Model, 2) Design Configuration System, 3) Design Tool, and 4) Implementation Tool.
The conclusion of this study indicate that: first, the tool works in accordance as expected, which are work from remote and accurately, with the results from the implementation and testing shows irregular heart rate went up and down significantly and accurately, and the tool manage to sends sms with latitude and longitude format, from remote area..
Keywords —*GPS (Global Positioning System), Photoplethysmograph (PPG)*

I. INTRODUCTION

IV.1. Background

Health is an invaluable part of a human being's life. Without it, people can become uninspired, de-motivated, and unable to thrive for success. It is important to always pay an attention on health, especially after a person has been declared a disease that can hinder positive activities. Based on Healthy Clinic Madani's reports (2010) someone mortality due to health diagnosis is slow and poor handling by the medical team in Indonesia reach 8-11/100.000 human population lives, it is a high number in ASEAN.

With high mobility and complexity on human activities and maybe high risk on these activities, such as travelling, hiking, and mountaineering, prevent from predictability situation. If there is emergency situation, thay are not always close to a hospital or other medical facilities that can provide first aid when they are having health problems. On the other hand the progress of science and technology has encouraged people to try to overcome all the problems that arise in their community. One of them is computer technology that not only influence in one area only, but in all areas of human life. (Sumitro, 2004). The development of computer usage can be done by adding some of the hardware and creating other devices which are suitable for the desired purpose. Additional hardware is called the interface, which serves to connect a computer to additional equipment (Arianti Putranti Rudy, 2012).

Starting from these cases, the idea to create an auxiliary tool that can monitor the condition of a person by measuring body temperature, and heart rate which can be monitored at any time. Thus it takes a tool that can monitor the condition of a person's body with the general parameters of temperature loss, heart rate, and the position, so it can be quickly resolved in an integrated manner with the accurate information taken from remote area.

IV.2. Formulation of the Problems

Issues addressed in this study based on the background outlined above are:

i. How to make an auxiliary tool to monitor the condition and position of a person by using GPS (Global Positioning System) technology
ii. Whether the device can work well and produce accurate data when compared with other sensors?

II. MATERIAL

II.1 Human Heart

The human heart is an organ that provides a continuous blood circulation through the cardiac cycle and is one of the most vital organs in the human body It is responsible for supplying the body with oxygenated blood. Each time the heart beats, it exerts a pressure on the veins and arteries called blood pressure. Blood pressure is extremely important and must be controlled if it is too high or low. Blood pressure can be controlled by medication prescribed by your doctor, proper exercise and a diet filled with plants and vegetables.

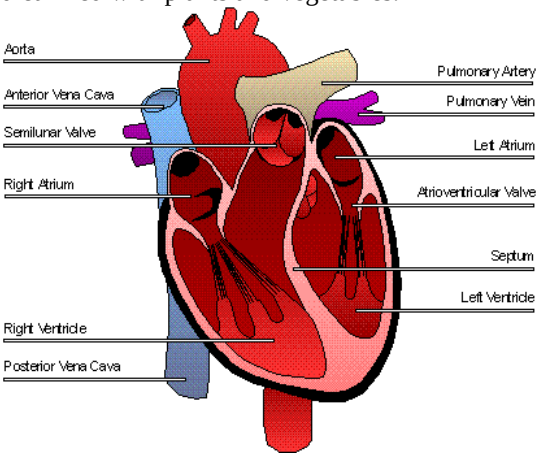

Fig. 1. The Human Heart

The heart lies in the chest cavity between the lungs. It is made of a special kind of muscle called myocardium, and is enclosed in a double-layered, membranous sac called a pericardium. The walls of the heart are made up of three layers, while the cavity is divided into four parts. There are two upper chambers, called the right and left atria, and two lower chambers, called the right and left ventricles. The Right Atrium, as it is called, receives blood from the upper and lower body through the superior vena cava and the inferior vena cava, respectively, and from the heart muscle itself through the coronary sinus. The right atrium is the larger of the two atria, having very thin walls. The right atrium opens into the right ventricle through the right atrioventicular valve(tricuspid), which only allows the blood to flow from the atria into the ventricle, but not in the reverse direction. The right ventricle pumps the blood to the lungs to be reoxygenated. The left atrium receives blood from the lungs via the four pulmonary veins. It is smaller than the right atrium, but has thicker walls. The valve between the left atrium and the left ventricle, the left atrioventicular valve(bicuspid), is smaller than the tricuspid. It opens into the left ventricle and again is a one way valve. The left ventricle pumps the blood throughout the body. It is the Aorta, the largest artery in the body, which originates from the left ventricle. The part of the human heart can be seen in Fig. 1.

The heart pumps nearly five quarts of blood through your body every 60 seconds. An adult heart beats approximately 100.000 times a day, pumping about 2.000 gallons of blood. It has been estimated that the heart will beat about 3 billion times during a 70 year lifetime.

Given the heart's arduous task of supplying the body with blood every day, it must be well taken care of. A heart that is improperly cared for may develop heart disease. Heart disease is the leading cause of death among Americans.

II.2 Photoplethysmograph

Fig. 2. The pulsatile (AC) component of the PPG signal and corresponding electrocardiogram (ECG)

A plethysmograph is an instrument for measuring changes in volume within an organ or whole body. Photoplethysmography (PPG) is a simple and low-cost optical technique that can be used to detect blood volume changes in the microvascular bed of tissue. It is often used non-invasively to make measurements at the skin surface. The PPG waveform comprises a pulsatile ('AC') physiological waveform attributed to cardiac synchronous changes in the blood volume with each heart beat, and is superimposed on a slowly varying ('DC') baseline with various lower frequency components attributed to respiration, sympathetic nervous system activity and thermoregulation as seen in Fig. 2. Although the origins of the components of the PPG signal are not fully understood, it is generally accepted that they can provide valuable information a bout the cardiovascular system.

The PPG technology has been used in a wide range of commercially available medical devices for measuring oxygen saturation, blood pressure and cardiac output, assessing autonomic function and also detecting peripheral vascular disease. The introductory sections of the topical review describe the basic principle of operation and interaction of light with tissue, early and recent history of PPG, instrumentation, measurement protocol, and pulse wave analysis.

Fig. 3. A portable oximeter with plethysmogram

PPG used pulse oxymeter. Pulse oximeter, as seen in Fig. 3, is medical device that monitor the level of oxygen in a patient's blood and alert the health-care worker if oxygen levels drop below safe levels, allowing rapid intervention. It is often attached to a medical monitor so staff can see a patient's oxygenation at all times. Most monitors also display the heart rate. These devices are essential in any setting in which a patient's blood oxygen levels requires monitoring like operations, emergency and intensive care, and treatment and recovery in hospital wards.

II.3 Temperature Sensor

Temperature is playing a vital role for consideration in taking medical treatment, and therefore an accurate measurement is a must.

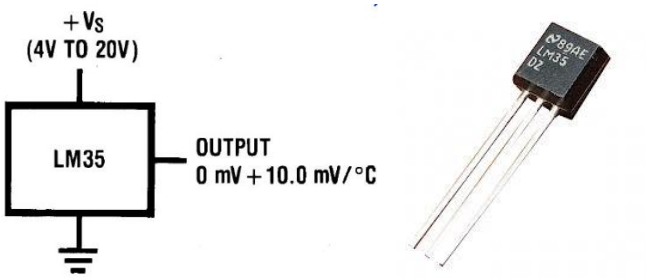

Fig. 4. LM 35

The LM35 series are precision integrated-circuit temperaturesensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a largeconstant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages.

II.4 Microcontroller

A microcontroller is a small and low-cost computer built for the purpose of dealing with specific tasks, such as displaying information in a microwave LED or receiving information from a television's remote control. Microcontrollers are mainly used in products that require a degree of control to be exerted by the user.

Microcontrollers are generally built using a technology known as Complementary Metal Oxide Semiconductor (CMOS). This technology is a competent fabrication system that uses less power and is more immune to power spikes than other techniques. A microcontroller usually comprises of a CPU, ROM, RAM and I/O ports, built within it to execute a single and dedicated task.

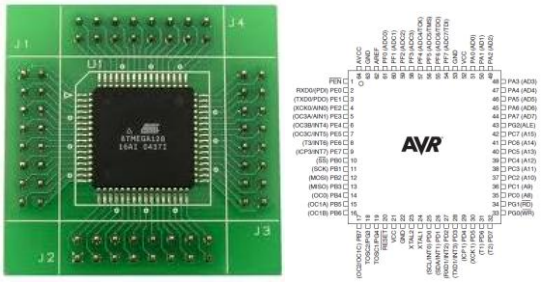

Fig. 5. ATmega128

ATmega128, as seen in Fig. 5, is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega128 achieves throughputs approaching 1MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

II.5 Serial Communication

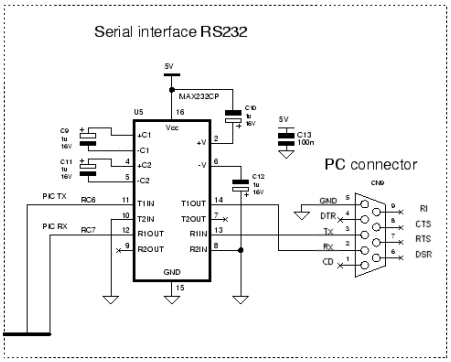

Fig. 6. Development board with a serial connection to/from the PC that lets RS232 work between a microcontroller and the PC

In telecommunications, RS-232 is the traditional name for a series of standards for serial binary single-ended data and control signals connecting between a DTE (Data Terminal Equipment) and a DCE (Data Circuit-terminating Equipment). It is commonly used in computer serial ports. The standard defines the electrical characteristics and timing of signals, the meaning of signals, and the physical size and pinout of connectors. The current version of the standard is TIA-232-F Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange, issued in 1997.

An RS-232 serial port was once a standard feature of a personal computer, used for connections to modems, printers, mice, data storage, uninterruptible power supplies, and other peripheral devices. However, the low transmission speed, large voltage swing, and large standard connectors motivated development of the universal serial bus, which has displaced RS-232 from most of its peripheral interface roles. Many modern personal computers have no RS-232 ports and must use an external converter to connect to older peripherals. RS-232 devices are still found, especially in industrial machines or scientific instruments. The schematic in Fig. 6 shows a development board with a serial connection to/from the PC that lets RS232 work between a microcontroller and the PC.

II.6 Global Positioning System (GPS)

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map.

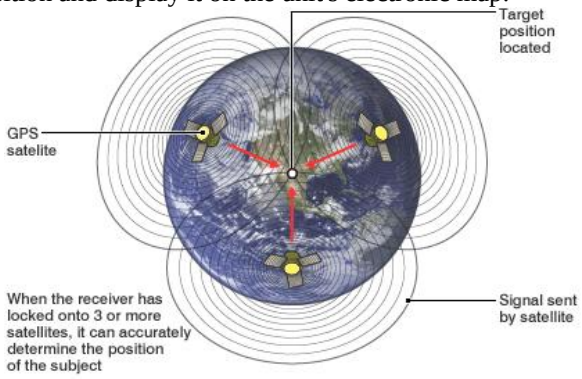

Fig. 7. How GPS with three satellites works

A GPS receiver must be locked on to the signal of at least three satellites, as seen in Fig. 7, to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

Today's GPS receivers are extremely accurate, thanks to their parallel multi-channel design. GPS with 12 parallel channel receivers are quick to lock onto satellites when first turned on and they maintain strong locks, even in dense foliage or urban settings with tall buildings. Certain atmospheric factors and other sources of error can affect the accuracy of GPS receivers.

III. METHODS

III.1 Tools

a. Modul GPS Receiver, using Garmin GPS 10 with specification receiver: WAAS enabled, 12 parallel channel GPS receiver continuously tracks and uses up to 12 satellites to compute and update your position
b. Handphone, to take data from GPS and displaying the information
c. Arduino Nano
d. Temperature Sensor
e. Heart Sensor
f. Power Supply
g. Battery
h. laptop Lenovo Ideapad Y450 with hardware: Processor Intel Core2Duo P7450 2.13GHz; RAM memory 4GB; VGA Card nVidia GeForce G210M 512MB; Hard Disk 500GB; Storage Internal 3GB; Memory card SD card up to 32GB.

III.2 Research and Development Stages

Research and development is comprised of several stages, in which the study measures refer to the R&D cycle borg and Gall with modification to aligned with the goals and the actual conditions of the study. The steps being taken include:

a. Pre-Development Model,
   Including initial data collection, requirement analysis, planning model
b. Design Configuration System,

In monitoring the body condition and the position of a person with a web interface in this study are generally divided into two parts, first is designing and creating the hardware, and second is designing and creating communication systems, data base, and sms.

Fig. 8. Diagram Block System

c. Design Tool,

1. Planning the System

For hardware monitoring the body condition, consisting of a few things, such as the Minimum System microcontroller ATmega128. In order to connected and stored data via web server, the tool used serial communication to send data packets, Usart0 configuration on ATmega128, and the GPS devices used serial communication on Usart1, and IC MAX 232 used to converted TTL voltage levels to RS-232 voltage.

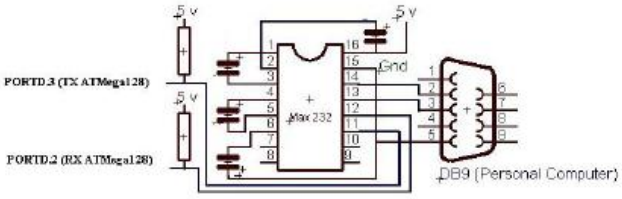

Fig. 9. Circuit Converter TTl to RS-232.

2. Planning the Amplifiers for temperature and heart sensors

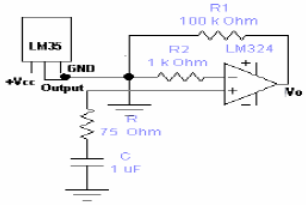

Fig. 10. Temperature Sensor Circuit

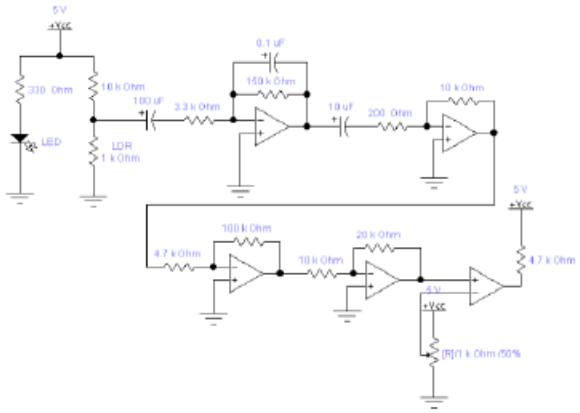

Fig. 11. PPG Circuit

3. Planning the GPS
   GPS module that will be used is a tool that is already integrated GPS modem.

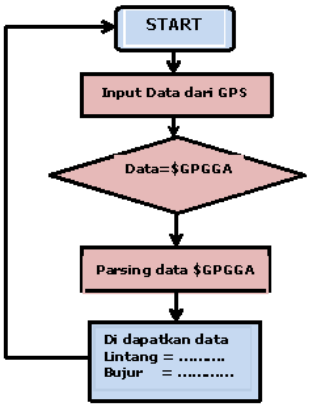

Fig. 12. Flowchart for GPS System

4. Planning PHP for sending data via serial communication
5. Planning SMS in Handphone
   Communication media used herein are SMS. There are two formats SMS, periodically sent with information about data position of the sender and single delivery format. Single delivery is possible when a computer like to request a one-time position.

   1) Periodically

#	No id	#	derajat lintang	#	menit lintang	#	S/ N	#	derajat bujur	#	menit bujur	#	E/ W	#

   2) Single Delivery

req	#	No id	#	derajat lintang	#	menit lintang	#	S/ N	#	derajat bujur	#	menit bujur	#	E/ W	#

d. Implementation and Testing Methods

To see the validity of the value system that has been built, we could tested the validity of the sampled data systems that already exist. The test system consists of several tests for the hardware and software that have been created. Temperature Sensor and Sensor Data tested using PPG Heart (Photoplethysmograph)

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Fig. 13. Testing GPS with PC

For GPS, it can tested by the data transmitted by the GPS which is differ according to the GPS NMEA format. These data are $ GPGGA, $ GPGSA, $ GPRMC, $ GPGSV, from the data, we only take latitude and longitude position. Data parshing is needed for accesing only Latitude and longitude position data contained in the $ GPGGA.

IV. RESULT AND ANALYSIS

V.1. Result

1.1.1. Implementation

The test is only carried out using the program because it is not possible directly to the patient but is implemented in a state of normal activity, sending sms will show GPS data in the form of longitude and latitude.

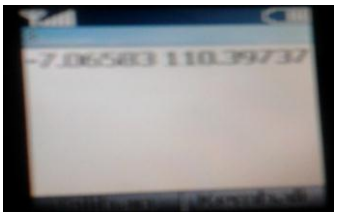

Fig. 14. Result of the system

The Fig. 14, above demonstrated that the device works according to what was expected, a tool to send sms with latitude and longitude format.

1.1.2. Accuration

With the results from the implementation and testing shows irregular heart rate went up and down significantly and accurately,

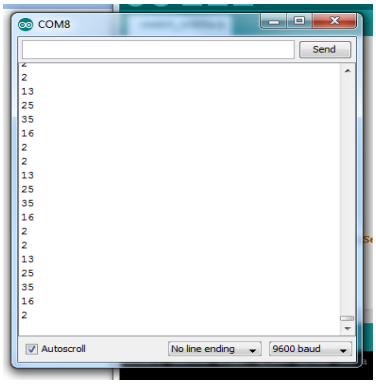

Fig. 15. Result of the data accuration

And when it is inserted into the graph the results:

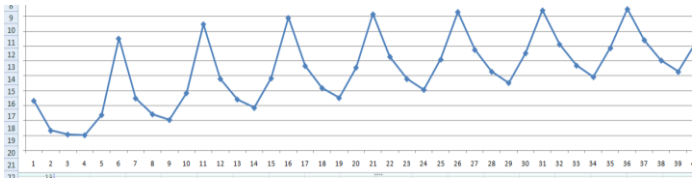

Fig. 16. Graph Plotting

Changes from start ticking until the end not significantly, with the gradually sensor readings proved that the accuracy of the sensor.

Fig. 17. Auxiliary Tool

V.2. Simulation and Analysis

The test system consists testing the hardware and software that have been created. Temperature Sensor and Sensor Data using PPG Heart (Photoplethysmograph).

The temperature sensor used is LM 35 with non-invert amplifier as a voltage amplifier output of LM 35 and then inserted into the internal ADC 8-bit microcontroller so that the data obtained as table 1.

Table 1: Measuring with Temperature Sensor dan Termometer

No	Suhu Termometer (°C)	Suhu LM35(°C)	Error (%)
1	31	31.3	0,009
2	32.5	32.6	0,003
3	34	34	0
4	34.5	34.5	0
5	35	35.2	0,005
6	35.5	35.6	0,002
7	36	36	0
8	36.5	36.7	0,005
9	37.5	37.5	0
10	38	38.2	0,005

Table 2 is the result of the measurement of the PPG sensor (Photoplethysmograph). PPG sensor is used to detect a person's heart rate so that we know the BPM of the human heart. This sensor uses 4 x the reinforcement and strengthening the output of the comparator so that the voltage level at 0-5 volts compared to the input voltage of the amplifier so it can be processed by a microcontroller through the facilities of the timer / counter.

Table 2 : PPG Sensor

Nama	Umur (Th)	Jenis Kelamin (L/P)	BPM	Jenis Kegiatan	Keterangan
Habibi	24	Laki-laki	100	Lari-lari	Terdeteksi
Reza	27	Laki-laki	82	Bangun Tidur	Terdeteksi
Yus Rizal	21	Laki-laki	84	Santai	Terdeteksi
Ario	21	Laki-laki	83	Santai	Terdeteksi
Galih	22	Laki-laki	84	Santai	Terdeteksi
Faiz	25	Laki-laki	95	Memikir	Terdeteksi
Joko	22	Laki-laki	95	Memikir	Terdeteksi
Ariayani	21	Perempuan	85	Santai	Terdeteksi
Hendra	21	Laki-laki	110	Lari-lari	Terdeteksi
Wilis	22	Laki-laki	108	Lari-lari	Terdeteksi

Fig. 18. GPS Display

For GPS, it can tested by the data transmitted by the GPS which is differ according to the GPS NMEA format. These data are $ GPGGA, $ GPGSA, $ GPRMC, $ GPGSV, from the data, we only take latitude and longitude position. Data parshing is needed for accesing only Latitude and longitude position data contained in the $ GPGGA.

Table 3 : Overall Measurement

No.	Lokasi	Waktu (WIB)	Lintang (derajat)	Bujur (derajat)
1	Depan Gedungn E6	21 : 30	7.013.245	110.445.072
2	Halaman Parkir E6	21:30:15	7.013.253	110.445.097
3	Pos Satpam E1 FT	21:32:00	7.014.240	110.447.072
4	Bunderan FIK	21:45:00	7.015.301	110.449.101
5	Lapangan FIK	11:12:00	7.015.312	110.446.072
6	Lapangan depan mushola	11:17:00	7.012.224	110.446.074
7	Depan Lab	11:20:00	7.013.240	110.446.085
8	Depan Poliklinik	11:30:00	7.015.312	110.445.102

Accurately can be proven with comparison between the data taken with temperature sensor mercury thermometers and temperature sensors LM35. Table 1 shows that the temperature sensor circuit by using a non-inverting average gain very small percentage of error and almost close to zero (0.009).

For PPG Sensor (Photoplethysmograph) according to the table 2, data obtained in accordance with expectations.

The first experiment of GPS data based on research that has been done, to a connection with the GPS, the baud rate is 4800, if it exceeds the data obtained are not perfect. The appearance of the GPS data on a PC the data is not yet complete because the GPS antenna is in the room and it can not locking the global coordinates, because for locking it needs least 3 satelite, so that the GPS data can be obtained in full. Testing the second access for GPS data using a microcontroller. Before the microcontroller is connected to the GPS USART1, microcontroller must be connected to the RS232 circuit as a voltage level difference between the microcontroller and GPS. GPS data sent by the microcontroller received then parsed and retrieved the data latitude and longitude only. The data have been accessed then displayed to the LCD.

On the website indicator of a person's condition and the position are fulfilled. Since the website has a weakness in the delivery of the data received and the data do not show the same in this case due to the web-based system is always followed by a continuous refresh mode, refresh yourself in the program depends on the desire programmer itself.

V. CONCLUSION AND SUGGESTION

V.1. Conclusion

After several stages in this research, it can be concluded that:

1) The auxiliary tool works in accordance as expected, a tool to send sms with latitude and longitude format.
2) The data results of heartbeat is not straight up and down significantly so the the tool works accurately.
3) Overall results obtained from the ECG signal as expected. From testing the ECG signal data obtained average heart rate per minute is within the normal human range 60-100 BPM with average percent error of 0.139%.
4) The data received and processed with GPS is in the same place where the data sent, but in different testing showed deviation of 100. GPS data retrieval is less accurate due to the GPS signal is reflected by the obstacle such as buildings and trees.

V.2. Suggestion

This research have limitation that need to be improved in these next research in purpose applications can be more precise, there are some suggestions that can be used include:

1) Further research needs to utilize MySQL and PHP in purpose to maintain the serialized data so that applications can be developed for monitoring the condition and position of a person online.
2) For further research, it should be added MapObject which applied with cell phones that are working offline and not online for saving mobile pulse.
3) Need a smaller hardware so it can easily carried by the user.

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