A Short Message Service Reporting System for Intelligent Street Lighting

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Abstract—This paper proposes on develops an Intelligent Street Light Monitoring System via a GSM mobile station using short message service (SMS) messaging to increase the efficiency of a street light that offer us the reliable and rapid report system. The structure of this system is divided in four parts. The system use SMS for reporting, therefore one GSM modem installed on the server that acts as a transceiver to communicate between a wireless sensor network and a GSM modem. To control the GSM modem, SMS gateways are used. SMS gateway is a telecommunication network facilities for receiving and sending SMS transmission to or from telecommunications network that support SMS. Database will stores reporting SMS and can be access through web page. For database part, MySQL program was used while for web development, PhP was used for scripting language. This web page allows Intelligent Street Lighting officer to monitor the incoming message for documentation such as a health status of light, operation time, how many nodes will trigger in one day and check the power consumption used in the street light.

I. INTRODUCTION

This paper describes a system that enables a short message service reporting system for Intelligent Street Lighting (ISL). SMS are choosing as a communication medium because SMS is cheaper when compared with voice messaging or web access[1]. Besides, text messaging can be done at any place and at any time so it very suitable medium for the system. Intelligent Street Lighting is a new technology developed to replace the traditional street lighting system. The objectives are to help reduce the energy consumption utilize by the street light and to develop real-time monitoring system for ease of maintenance that can be monitor through a web-based data repository system [2]. Besides that this project is also to build reporting system with the objective that action will be taken precipitate and straightway whenever message is receive. The report send from wireless sensor network through SMS to the GSM modem and then SMS gateway program will act to control the GSM modem to connect to database before the message appear in the server site[3]. This system helps committee of Intelligent Street Lighting System to monitor incoming message report by the system in online on the web page. If the street light facing a problem such as the LED burns, the system will automatically send the message though to GSM modem. After GSM modem received the message the system will automatically replay the message to the technician for informs that the light have a problem and need to be repair. Technician will go to the site and repair the lamp. After the lamp repaired, technician will send back the message to the system and the system will record it. This system increases the performance to manage, monitor and control the street light. This system also implemented to store all the report and required information, i.e. health status of light and nodes trigger [4]. All the information can be accessed on-line by committee and thus the information will able to updated, edited, added or removed.

II. METHODOLOGY

This project consists of two major parts which are the development of hardware and software.

A. Hardware development

The system flowchart in Figure 1 and Figure 2 shows the relationship between hardware and software development and how the systems from WSN trigger with the GSM modem [5].
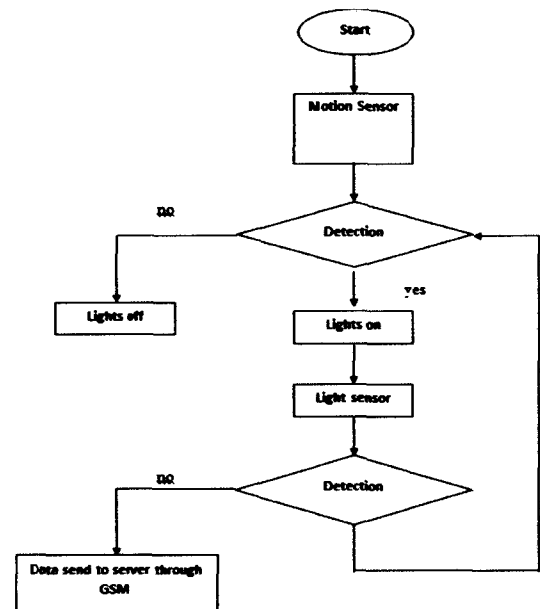

Figure 1: Flowchart of WSN Street Light System

Based on the flowchart in Figure 1, the operation of the street light started when the sensors detect the moving vehicle or pedestrian. While the sensors detect the movement, the light will turn on from dimmed mode. After the vehicle or pedestrian passed the light, the light will dim back. The process continuous if there have a vehicle passes the sensor nodes until tomorrow morning. After the operation of the system finish tomorrow morning, the Zigbee wireless sensor network will send the data to GSM modem including the number of the nodes trigger. Besides that if the nodes facing a problem such as the lamps or LED burns, the Zigbee wireless sensor network will automatically send a report to GSM modem [6].
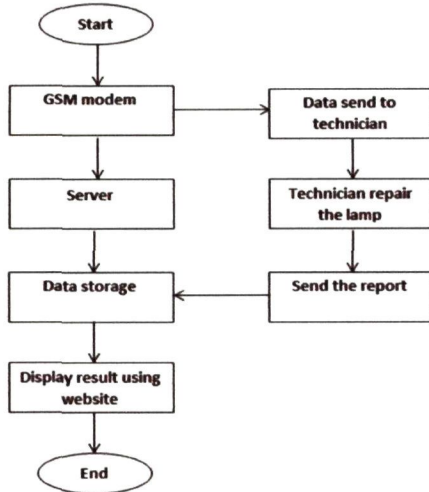
B. Software development

Figure 2: Flowchart of GSM System Network

Based on the Figure above, the GSM system network will receive two types of report. The first report is based on the nodes problem and the second report is for the nodes trigger. Nodes trigger means that on how many vehicle or pedestrian will pass the nodes in one night. If the GSM receive the report for nodes trigger, the message will go to the server and the database will storage the report and display in web page. If the nodes burn or not function as well, the report that GSM receive from WSN will automatically forward to the technician and technician go to the site and repair it. After settle repaired, the technician send message to the database for informs that the lamp has been repaired. All the information then will display at the web page.

C. Main architecture of short message service reporting system for intelligent street lighting

Nowadays, web services moving towards mobile world as a new emerging technology for application communication. Mobile device technology is able to operate as a service consumer or service provider. This paper introduces architecture for providing SMS services for web applications. Figure 3 show the structure of the short message service reporting system for Intelligent Street Lighting which is composing of wireless sensor network, data source server and the gateway.
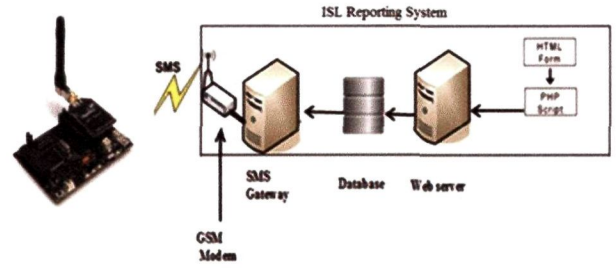

Figure 3: SMS reporting system

The whole structure of SMS reporting system as shown in Figure 3 is divided into four(4) parts. The GSM modem acts as a receiver and sender to communication between Zigbee wireless sensor network and GSM network and SMS protocol [6]. The GSM modem is controlled by a SMS gateway program that sends a set of AT commands to a USB port that is connected to GSM modem. In this system, Wavecom GSM modem selected to use which is supports Text and Protocol Description Unit (PDU) modes [7]. Gammu program installed on the desktop is use as SMS gateway to control the ISL reporting system between GSM modem and ISL database system[8]. The ISL database is used to keep reporting information and also user information running the open source MySQL software. Web server is used to web-based SMS management to monitor the reporting system. The web server was developed with two (2) options. The first option is main option and the other one (1) is optional for add more function[9]. The main option consist the main operation for this system as stated below:

i.   Information of the system
ii.   Received and send message
iii. The benefits and contacts information

The operation that is available for the additional options for this system is:

i.   Autoreply the message, every problems node will automatically be reply
ii.   Calculation system for the power consumption
iii. Graph of power and energy usage

A. AT Command

AT command are instructions that use to control the GSM modem. AT is the abbreviation of Attention which every command line start with "AT". There are lot of the commands that are used to control wired dial-up modem, such as ATD (Dial), ATA (Answer), ATH (Hook control), and ATO (Return to online data state), are also supported by GSM modems and mobile phone. Besides this common AT command set, GSM modem support an AT command set that is specific to the GSM technology, which include SMS-related commands like AT+CMGS (Send SMS message), AT+CMSS (Send SMS message from storage), AT+CMGL (List SMS message) and AT+CMGR (Read SMS message).

B. Protocol Description Unit (PDU)

SMS is a specification developed by ETSI(GSM 3.4.0) to send and receive message. The GSM modem able to do this task and the SMS message model has two kinds: Text Mode and PDU (Protocol Description Unit) mode. For Text Mode the structural mode based on the characters of ASCII code form and easy to read. The PDU Mode based on character in hexadecimal, encoded the data and code, so it cannot directly to read. Generally PDU mode is wide use in GSM mobile devices to transmit the message. Since the method for sending the reported use SMS service is in PDU mode, then the message must be decode to text mode to read this message [7]. The PDU structure as shown in Table 1.

Octet (s)	Description
00	Length of SMSC information (0 Using SMSC that stored in phone)
11	First octet of SMS-Submit message
00	TP-Message-Reference
0B	Address-Length of receiver number
91	Type of address of receiver number
66 98 76 46 78 F0	Receiver number (decimal semi-octets)
00	TP-PID (Protocol identifier)
08	TP-DCS (Data coding scheme)
AA	TP-Validity-Period.
0C	TP-UDL (TP-DCS:08 Length of byte)
0E2A0E270E310E2A0E140E35	TP-UD (User Data)

Table 1: The PDU format in sending and receive message

The sending and receive text message is PDU mode that include three(3) kinds of encoding which is 7 bit, 8-bit and UCS2 encoding. The 7 bit encoding use to send normal ASCII character, the 8 bit encoding used to send data and UCS2 encoding use to send Unicode character[9]. For the PDU mode, when using 7 bit encoding 160 characters can be supported; the 8 bit encoding 140 characters can be supported; the 16 bit encoding 70 characters can be supported. For sending the message, the data need to be 8 bit (HEX) bytes and encoded into the 8 bit (octet) bytes. Then to receipt the 8 bit (OCT) bytes decode into a 7 bit (ASCII) bytes.

C. Gammu, an open-source-baseed SMS Gateway

Gammu using command line utility provides access to wide range of phone and GSM modem features. This program focusing on AT command compatible phone. Gammu will act as SMS gateway by using one of its features[11]. Figure 4 shown the instruction of SMS Daemon and related components.
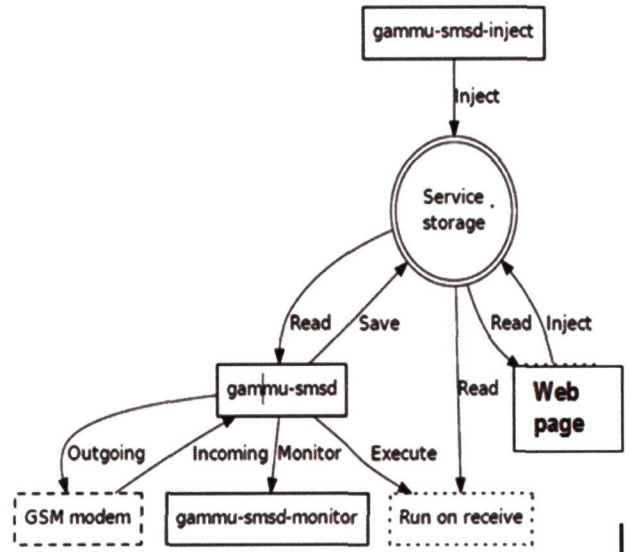

Figure 4: The Gammu Daemon Process

Gammu-smsd command is a program that periodically scans GSM modem for received message, stores the message in defined storage and also can sends message in this storage. The following is an example of gammu-smsd command;

```
>gammu-smsd -c smsdrc -i
```

The command form is <gammu-smsd> <option>
- Gammu-smsd; is command for scan GSM modem for received, send and storage the message.
- -c; is to configure file.
- smsdrc -i; to install smsdrc as windows service.

Gammu-smsd-inject command is a program that enqueues message in gammu sms daemon, which will be later sent by the deamon using connected GSM modem. The following is an example of gammu-smsd-inject command;

```
>gammu-smsd-inject TEXT +60123456789 -text "hallo world"
```

The command form is <gammu-smsd-inject> <option> <message type recipient> <message parameter>
- Gammu-smsd-inject; is command for send message purpose.
- TEXT; is mode use .
- +60123456789; received number.
- –text "hallo world" message to send.

Gammu-smsd-monitor command is a program that monitors state of Gammu SMS Daemon. It periodically display information about phone and number of processed message. The following is an example of gammu-smsd-monitor command.

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III. RESULTS AND DISCUSSION

In this part, the complete system was tested and it is divided to two(2) parts. First are hardware testing (on the GSM modem) and the others one is software or application part (on the Gammu program, database scheme and web page interface).

A. Hardware testing (GSM modem)

To test the GSM modem, HyperTerminal program and a set of AT command are used. Below is the procedure for sending AT command to a GSM modem using MS HyperTerminal.

i.   Place a valid SIM card into a GSM modem.
ii.   Connect GSM modem to a computer and set up the corresponding modem driver or if no driver use Windows standard modem driver.
iii.   Run MS HyperTerminal by selecting Start -> Program -> Accessories -> communications -> HyperTerminal.
iv.   In the Connection Description dialog box, enter a name and choose an icon for the connection. Then click OK button. Figure 5 shown the MS HyperTerminal Connection Description box.
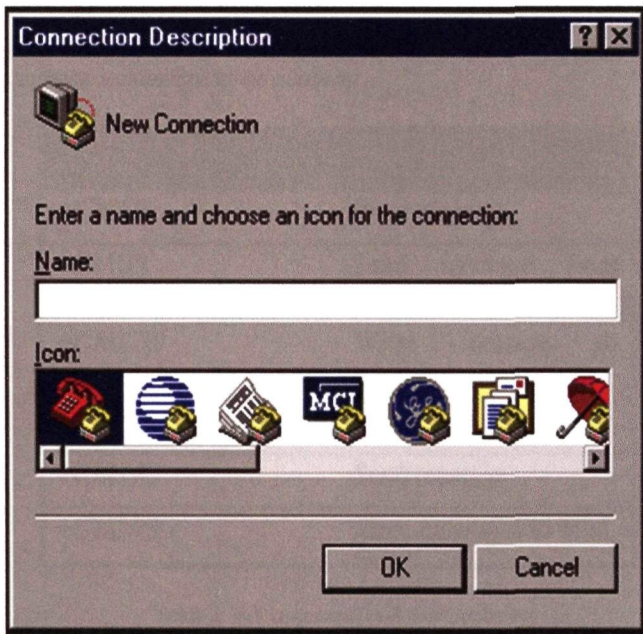

Figure 5: MS HyperTerminal Connection Description box

v.   In the Connect To dialog box, choose the COM port that the GSM modem is connecting. Figure 6 shown the MS HyperTerminal Connect to dialog box.

Figure 6: MS HyperTerminal Connect to box

Then Properties dialog box comes out and enter the correct port setting for the GSM modem. Then click Ok button. . Figure 7 shown the MS HyperTerminal Properties dialog box.

Figure 7: MS HyperTerminal Properties box

vi.   Type "AT" in the main window and a response "OK" should be return from the GSM modem. Figure 8 shown the MS HyperTerminal main windows dialog box.

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```
File   Edit   View   Call   Transfer   Help

AT
OK
AT+CGMM
   MULTIBAND   900E   1800

OK
AT+CGMI
   WAVECOM MODEM

OK
```
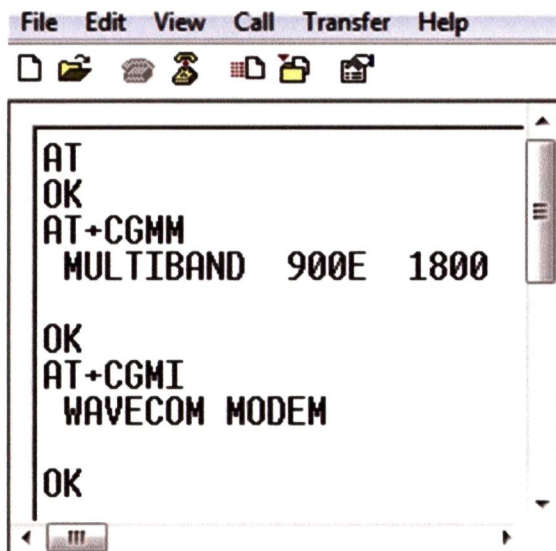
Figure 8: MS HyperTerminal main window box

AT commands are instructions used to control the modem. In the table 2 display a list of AT command used to control the hardware of the modem connected to the computer.

AT Command	Meaning
+CMGS	Send message
+CMSS	Send message from storage
+CMGW	Write message to memory
+CMGD	Delete message
+CMGC	Send message
+CMMS	More messages to send

Table 2: AT command and their meaning

Initial setup AT commands: in the table 3 describe different AT command used to setup a modem with the computer. It also describes the corresponding result if the command is executed.

AT Commands	Operation
AT	Returns a "OK" to confirm that modem is working
AT+CPIN="xxxx"	To enter the PIN for your SIM (if enabled)
AT+CREG?	A "0,1" reply confirms your modem is connected to GSM network
AT+CSQ	Indicates the signal strength, 31.99 is maximum.

Table 3: AT command and operations.

Setting SMS format by using AT commands; in the table 4 describes the different AT commands used to set format of the message (PDU or TEXT).

AT Commands	Operation
AT+CMGF=1	To format SMS as a TEXT message
AT+CSCA="+xxxxx"	Set your SMS center's number. Check with your provider.

Table 4: AT commands for setting SMS format.

Sending SMS by using AT commands. To send a SMS, the command is as below.

```
AT+CMGS= "+60123456789"   <Enter>
>type SMS text message here   <Ctrl-Z>
```

Receiving SMS by using AT commands. When a SMS is received, the SMS immediately sent to the computer. Below is command used to read the message.

```
AT+CMGF=1        <Enter>
AT+CMGL="ALL"  <Enter>
```

B. Application testing

In application layer or software program there are three(3) levels to achieve. The first part is SMS gateway level, second is database program and the last one is the web page interface. For the SMS gateway, Gammu program will be used to control the GSM modem. Before the SMS gateway can communicate to the database, the gammu program must be configure and installed. Then run WAMP server to retrieve information from GSM modem to database and also

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to connect the web page with the database. In Figure 9 show web page interface to monitoring SMS reporting system and be the first option as a main option of web page.
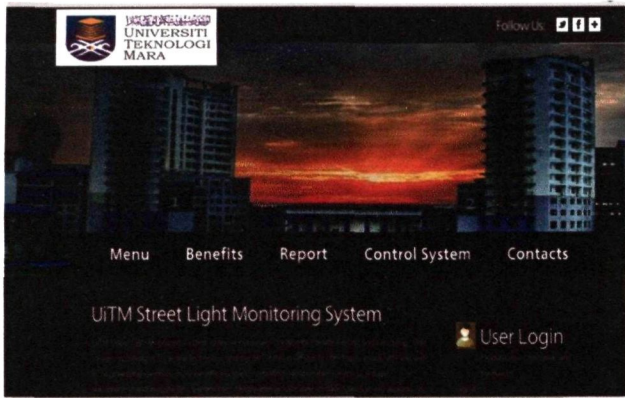

Figure 9: The main page of the web page

In Figure 10 show web page interface to monitoring SMS reporting system and it is a the second option as an optional for add more function for the reporting system.

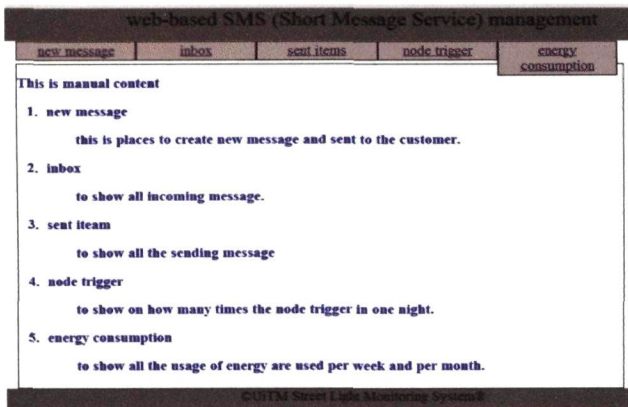Figure 10: The optional page of the web page

IV. CONCLUSION

A Intelligent Street Lighting system via a GSM mobile station using short message service (SMS) messaging has been successfully constructed and tested in this project. Based on the outcome of the result, the objectives to develop a street light with can reduce energy consumption and reduce the maintenance costs and ease the management has been achieved. From this system, the reports of any nodes problem and energy usage are become more efficient. All the problem can be monitor from the web page. The designed of this system is reliable and practical. Furthermore, to develop a Short Message Service Reporting System is cost less and do not have any add cost to maintain the system.

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