



EMERGENCY BEACON FOR ELDERLY

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ABSTRAK

Sistem kecemasan menjadi satu keperluan untuk keluarga dua pendapatan yang semakin meningkat hari ini. Disebabkan had realiti, kebanyakan orang tidak mampu menjaga warga tua. Pada masa yang sama, kes-kes kematian meningkat dengan mengejut di kalangan golongan tua yang tinggal bersendirian. Isu ini telah menarik perhatian kepada masyarakat untuk mencari penyelesaian. Oleh itu, melampirkan satu sistem kecemasan dapat menjamin keselamatan warga tua di mana bantuan segera akan disediakan apabila sistem diaktifkan. Kini, beberapa jenis telefon bimbit di pasaran cuba untuk menyediakan penyelesaian kepada masalah tersebut dengan menambahkan fungsi kecemasan seperti dailan cepat. Walau bagaimanapun, sistem tersebut menggunakan sistem kecemasan berasaskan suara dan tidak cekap kerana sifat manusia akan berasa panik apabila kecemasan berlaku dan mengakibatkan kesukaran dalam menbagi maklumat yang tepat. Selain itu, ia juga merupakan satu masalah untuk warga tua yang mempunyai penyakit mata. Isu-isu ini akan menanggung masa menyelamat dan menyebabkan tragedi berlaku. Batasan-batasan ini menjadi motivasi untuk membina sebuah sistem kecemasan yang mudah beroperasi, kos murah, dan meminta pertolongan berasaskan SMS. Sistem kecemasan yang berasaskan mikropengawal dapat menghantar mesej teks kepada nombor yang tertentu dengan mengaktifkan satu butang melalui rangkaian GSM. Butang yang berlainan warna memudahkan warga tua untuk menghantar mesej kecemasan. Fungsi penggera akan mengingatkan warga tua untuk mengemaskini status semasa mereka untuk keluarga atau penjaga mereka. Maklumat yang diperlukan akan disimpan dalam sistem dan dihantar secara automatik untuk menyelesaikan isu-isu yang berlaku semasa kecemasan. Untuk memajukan sistem tersebut, sistem ini boleh diintegrasikan dengan menggunakan modul GPS untuk mengesan lokasi semasa dan ia akan menjadi sistem kecemasan yang sempurna dan dapat digunakan di mana-mana tempat.

ABSTRACT

Emergency Beacon System has become a necessity as the demand for double-income families is increasing these days. Due to the limitation of reality, people nowadays are not capable of taking care of the elderly. At the same time, the tremendous increase of cases of sudden death among solitary living elderly had drawn attention to the society to solve this problem. Hence, attaching an emergency beacon system with the elderly will guarantee the safety of the elderly where immediate assistance will be provided when the system is activated. Currently, several types of cell phones in the market attempted to provide solution to this problem by including emergency beacon function such as speed dialing. However, these beacons are using voice based emergency system and is not efficient due to the nature where human will feel panic or blank out their mind when emergency occurs and resulting in difficulties in providing correct information when something emergency occurred. Besides that, it is difficult for elderly with vision problem to press the speed dial button if depending on cell phone. These issues might delay the rescue time and cause some avoidable tragedies. These limitations become a motivation to develop an easy to operate, low cost, SMS based and user friendly emergency beacon system. The purpose of this microcontroller-based emergency beacon system is to send multiple text messages to certain preset numbers by activating a push button via GSM network. Color coded dedicated push button make it easy for elderly to send emergency message. An alarm function will remind elderly to update their current status for their family or guardian. Necessary information will preset into the system and sent out automatically to resolve the issues of blank out during emergency. For further enhancement, this system can be integrated using a GPS module to detect the current location and it will become a perfect emergency beacon system which can be used in any place to trace the location of the sender to provide necessary assistance immediately.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Children nowadays are busy with their careers and spend most time at work. In order to work without any trepidation, they prefer to send their elderly parents to senior care homes during working hour. Unfortunately, most of the elderly refuses to go or feels uncomfortable going to the senior care homes. They would rather stay at home alone. So, the only option for the children is to leave their elderly parent at home for most of the time. This is causing burden or worry among children, especially if their elderly parent are ill. The elderly may face higher risk in their safety. Serious illness such as heart disease or asthma, need emergency care and can be fatal if emergency aid was not provided. It is very dangerous if the illness becomes serious suddenly and there is nobody around or it is not being noticed, it may lead to death.

To solve this problem, most children will buy a cell phone for their elderly parent for contact purpose. They expect their elderly parent to call them or the emergency response center when they are not feeling well. Hence, for those who have elderly staying home by themselves, the elderly will be provided with a cell phone to be used in case of emergency as a solution.

1.2 Problem statement

Nowadays, the number of cases of death among solitary living elderly is still increasing. This is because, for the elderly, cell phone usually is not a good and effective method of contact during emergency situation. The elderly may fail to recall the phone number of their family members when they are in panic or in pain. Besides that, the probability of key-in wrong number is also high enough to be considering as a factor. Another factor is the failure of the elderly to deliver emergency message or failure to provide accurate information during emergency situation. These problems may delay the time taken to deliver the first aid fast.

In order to solve the problems of cases of key in the wrong phone number, failure to recall phone number or failure to deliver emergency message, an emergency beacon was develop where emergency message can be sent via short message service (SMS) to preset numbers by just pressing a button. This provided conveniences and developed an easy way for elderly to transfer their personal information including address and brief medical record in case of emergency.

1.3 Objective

The objective of this project is to develop a microcontroller based emergency beacon for the elderly utilizing the wide coverage of GSM network. In order to meet the main objective, the following sub-objectives were pursued:

- i. To develop an algorithm that relay an emergency message using short messaging service (SMS) over a GSM network.
- ii. To develop hardware circuitry for interfacing a GSM module with a microcontroller based human- machine interface (HMI) system.

1.4 Project Scope

The work reported in this thesis is limited to the design and development of an Emergency Beacon with the following specification:

- i. Utilize GSM 900/1800 network
- ii. Three (3) user programmable emergency preset number
- iii. One (1) emergency button (Red)
- iv. One (1) reply button (Black)
- v. User programmable Emergency message template
- vi. User programmable Message template

A wire-wrapped prototype was build for design verification. Basic functional tests were conducted to ensure the design prototype meets the required operating specification.

1.5 Organization of This Thesis

This thesis is discussed about the development of microcontroller based emergency beacon system. The emergency beacon system is using GSM network to send emergency SMS to certain contact numbers. This thesis begins with some overview of GSM network and comparison between different kinds of emergency beacon system that available in current market.

Major components and system algorithm will be discuss in detail includes how the components interface among each others. Result and several testing are presented before conclude the outcome of project development, future recommendation and commercialization.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter consists of the literature review on GSM technology that should be considered on developing this project. Research and analysis that had been carried out in the development of emergency beacon system which was done by others will be discussed also. There are four types of emergency beacon system currently available in the market. Each type of emergency beacon will be described in details including the advantages, disadvantages and the differences will be compared.

2.2 GSM Technology

GSM technology includes GSM, GPRS, EDGE and UMTS/HSDPA network. It is a technology that developed by European Telecommunications Standard Institute (ETSI) to replace the first generation (1G) analog cellular network. GSM technology is invented to standardise and compatibility the communication system by using Time Division Multiple Access (TDMA) standard. Mobile phone is

developing based on this GSM technology and allows global communication through different service operators.

According to GSM world, GSM technology is now used by over 1.5 billion people all over the world. It provides different kinds of no voice business and allow user to make multiple choice in distance communication. GSM brings a lot of benefit in high speed integrated data, mail, voice data, fax and SMS service and provides a safety and secured communication networks from intruders.

GSM is an open system network and is a non propriety technology. One of the great benefits of GSM is it facilitates international roaming. As it is adopted by more than 170 countries, users have the facility of using their GSM cell phone in all these places without having to change the phone number and service operator. GSM is also a low cost communication technology system, it only charge the fee after the time division data package had been send. Besides that, GSM network is also better than wire data transmission for remote distance transmission and poor environment condition. Construction cost for the GSM network is also cheaper than wire data transmission network [1].

2.2.1 GSM Network

Global System for Mobile Communications (GSM) network is a second generation (2G) cellular phone technology. This network is the most popular and widely used digital mobile telephony system among all of the GSM network technologies. It transmits data by digital circuit switch using one slot of the time division channel. A channel will be reserve during the process of data transmission and service charge is depending on the duration for channel reservation.

GSM network provides a more secure and best platform for more features communication network. Short Message Service (SMS) or text messaging is one of

the famous features that successfully apply on this 2G cellular phone technology. The other features include users are able to download content from service provider like picture message and ringtone [2].

2.2.2 GPRS Network

General Packet Radio Services (GPRS) network is a kind of technology that applies on GSM network and it is also call as 2.5 generation (2.5G) cellular phone technology. It transmits data by using packet switch through four slots of time division channel. Transmission data will be slide into packet form before transmit through the GSM network. This data transmission method allows data communication in higher speed and cheaper.

Multimedia Messaging System (MMS) is a feature that develops successfully with the technology of GPRS network. This allows users to send pictures, videos or sound clips to each others like SMS since GPRS can handle more data traffic [3,4].

2.2.3 EDGE Network

Enhanced Data rates for GSM Evolution (EDGE) network is also calling as enhanced GPRS (EGPRS) network. EDGE is using 8-PSK modulation during the data transmission process. Three bits of data is process simultaneously by using 8-PSK modulation, which mean triple the data rate per subscriber compare to GPRS network. EDGE enables the delivery of more demanding mobile services, such as the downloading of music clips, video, multimedia messaging, full web browsing and e-mail [4].

2.2.4 UMTS/HSDPA Network

Universal Mobile Telecommunications System (UMTS) is also call as third generation (3G) cellular communication network. It transmits data by using Code Division Multiple Access (CDMA) and make it has faster data transfer rate than EDGE since it can be transmitting in different frequency level.

However, only few areas and networks support UMTS since it is still an infancy technology. This technology might unable to use also when moving from one nation to another nation even with countries that support the technology. It is because the UMTS may have set in different spectrum [5].

2.3 Frequency Band of GSM Network

GSM supports multiple frequency levels like 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. Different phone operators will use different frequency bands and allows distance communication as long as the frequency band is supported by the GSM phone. In Malaysia, 900 MHz and 1800 MHz frequency levels are provides by few service operators [6]. Mobile phone that supports multiple frequency levels is needed in order to use the service from different company operators.

The frequency bands that usually operate in mobile phone are Dual Band, Tri-Band and Quad Band. Dual band frequency is operates at 900 MHz and 1800 MHz and Tri-Band supports three frequency levels which are 900 MHz, 1800 MHz and 1900 MHz. Then for Quad-Band, it is supports four frequency levels which are 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. This kind of mobile phone can be use in anywhere as long as the distance communication is following the GSM standard [7,8].

2.4 Protocol Architecture of GSM

GSM network is work based on three major systems. First of the system is SS (Switching System) and it consists of five databases. These databases are HLR, MSC, VLR, AUC and EIR. HLR (Home Location Register) is a database that use for storing and managing subscriber's information. Subscribers are needed to register in mobile phone company HLR before a new connection is purchase. MSC (Mobile Service Switching Centre) is use to perform switching functionality of the entire network. VLR (Visitor Location Register) is a database that uses to store temporary data regarding subscriber which is needed by MSC. AUC (Authentication Centre) is a filter that uses to secure the network system. Its major task is to authenticate and encrypt those parameters which verify user's identification and hence enables the confidentiality of each call made by subscriber. EIR (Equipment Identity Register) perform a task similar with AUC by restricting for calls been stolen.

The second GSM network system is BSS (Base Station). It includes BSC and BTS which use to connect subscriber to network by using radio transmission. BSC (Base Station Controller) responsible to connect a physical link from subscriber (MS) to BTS, configuration cell data and control radio frequency in BTS. The processed data from BSC will be sending to MSC (Mobile Switching Centre) and transmit to different mobile network. BTS (Base Transceiver Station) is radio equipment that uses to receive and transmit data that control by BSC.

Then, the last system is OSS (Operation of Support System). It is a system that uses to operate and maintain the connection between MSC and BSC. For sending a SMS, the text message from sender's phone will be stored in a central short message centre (SMSC) which then forwards it to the destination mobile through MSC [9,10].

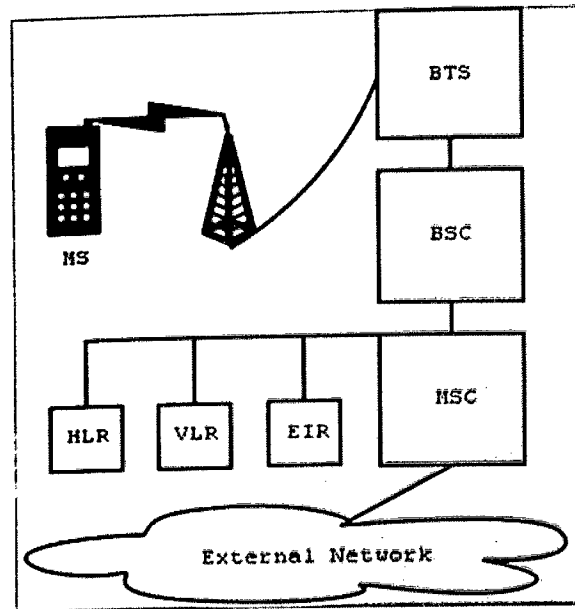


Figure 2.1: GSM architecture network

2.5 Interface Signal of GSM

All SMS will be sending in serial form. There are two ways to sending and receiving SMS message which are 'Text mode' and 'PDU mode'. Data receive might differ from data send if using text mode due to the encoder for transmitter and receiver might different. So, a preset encoder is always use when using text mode to send a SMS [1].

Message will be converted into hexa-decimal form by using PDU mode. Besides of SMS content, information of sender like service centre, stamp, message length and each others will be send along to receiver and provides a more secure and accurately method for sending a SMS. PDU mode is usually used in sending the SMS by mobile phone and GSM/GPRS modem. 'AT+CMGF=0' is the AT command to set up the PDU mode. Table 2.1 show the data send from sender and data receive by receiver [11].

Table 2.1: Data send by PDU mode

Data send	Data receive
AT+CMGF=0 AT+CMGS= "+60167623544" >Hello	0011000B910661673245F40000AA0AE8329BFD06

Table 2.2: Description of PDU string

Octet	Description
00	SMSC information
11	Define SMS send
00	TP-Message Reference
0B	Address length
91	Type of address
0661673245F4	Receiver's phone number
00	TP-PID
00	TP-DCS
AA	TP validity period
0A	Length of message
E8329BFD06	Data of message

In order to communicate between GSM/GPRS modem with microcontroller, command algorithm from microcontroller is encode into RS232 protocol and transmit through the serial port to GSM modem.

2.6 GSM Language

GSM modem is communicates by using AT command or Hayes modem command. AT command is a language that invented by a modem based manufacturer

which call Hayes Microcomputer Product. AT is the abbreviation of 'attention' and every command line of modem will start with 'AT'. 'AT' is a prefix that uses for inform the modem about the start of command line. Basically, almost all of the dial up modem, GSM modem and GPRS modem are using AT command to communicate.

There are two types of AT command, which are basic command and extended command. Basic command is AT command that do not start with symbol '+' while extended command is AT command that start with symbol '+'. All GSM/GPRS modem is using extended command. AT command with a GSM/GPRS modem can be use to access Fax service, MMS service, SMS service, configuration modem or SIM card and data link over a mobile network [12].

2.7 Comparison of GSM/GPRS Modem and Mobile Phone

GSM/GPRS modem is performing a same task with mobile phone. Both of it are uses for wireless communication and require a SIM card from a wireless carrier in order to operate. Generally, GSM/GPRS modem performs better task compare to mobile phone.

Concatenated SMS message is a text message that over the length limit. A division and combination process is needed to conduct in order to smaller the message size during transmission of message. Unfortunately, some mobile phone is failed to recombine the split message after the transmission process. Besides that, GSM/GPRS modem is also support more complete set of AT commands than mobile phone. This making the system becomes more flexible and reliable by using GSM/GPRS modem [13].

2.8 Application of GSM Network with Microcontroller

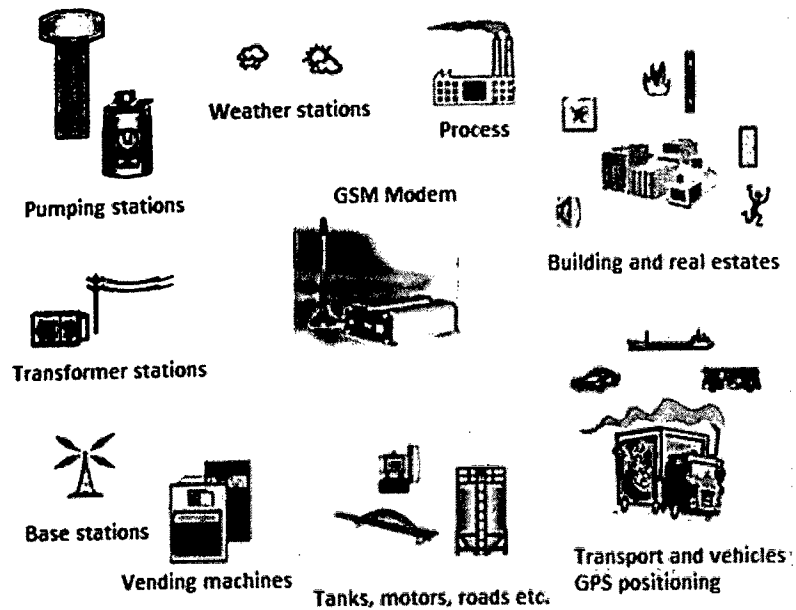


Figure 2.2: Application of GSM with microcontroller

There are many application of GSM network with microcontroller. GSM is mostly applying on access control device, transaction terminal and supply chain management. SMS service is always use in the access control device for long distance control task like home automation system. It achieves high security and reliability.

The second most famous application of GSM technology is on transaction terminal. Vending machine, ATM machine and others are using the technology to confirm the transaction and status of machine. Huge infrastructure costs due to it bring a lot of benefit in long distance communication and save a lot of unnecessary job.

The third application is supply chain management which is more focusing on leased line networking communication. GSM network is reducing huge cost on wireless networking and allow high speed global communication. This system is usually applied on communication system between head quarter with the branch office [14].

2.9 Comparison of Emergency Beacon

Emergency beacon is a useful and reliable electronic device that can provide safety and peace of mind for elderly people or patients. It is an ideal device during emergency to get medical help in shortest time [15]. Generally, emergency beacon system is divided into 2 types, the half duplex or full duplex communication system. Usually, emergency call numbers and messages was preset into the half duplex system and the machine will send the message to the preset contact number automatically once the emergency button was activated. While for the full duplex system, alert service centre will be in-charge of consulting the status of user [16].

Four different types of emergency beacon system available in the market are PRLOG, First Response Medical Alert, Spark Nano, and Emergency Panic Button SOS app + Android system. In this part, the differences as well as the pro and cons of the four different systems will be discussed and compared. Table 2.3 shows the main features of the emergency beacon systems.

There are two types of network technology used in the emergency beacon system which are Public Switching Telephone Network (PSTN) and Global System for Mobile Communication (GSM). Both of PRLOG and First Response Medical Alert are using PSTN technology. PSTN allows full duplex communication by using fixed line analogue communication system. The main disadvantage for both kinds emergency system is that the system can only be use at the places consisting of PSTN port or LAN port as home telecommunication system [17].

In term of message delivery, PRLOG uses SMS to deliver emergency message when activated. Short Message Service (SMS) provides low cost text message transfer among mobile phones [18]. It allows communication during high traffic of network and even simultaneous with telephone conversation. Messages can also be deliver to large quantity of peoples in short period and it is proven to be high reliability [19,20]. With a preset function, information like address, contact numbers and other SMS content can be store into the system before used. Correct information

can be delivered to certain people without any communication barrier during panic situation and time wasting issue can be avoiding [21].

Table 2.3: Comparison of different kinds emergency beacon system

Features	Brand			
	PRLOG	First Response Medical Alert	Spark Nano	Emergency Panic Button (SOS) App + Android System
Network	PSTN	PSTN	GSM	GSM
Message delivery type	SMS	Voice based call	SMS	SMS/Email
Location detection	Preset home address	Preset home address	GPS	GPS/Wi-Fi
Preset contact number	4 contact numbers	Contact with centre station	1 contact number	Unlimited
Preset message	Yes	No	Yes	Yes
Portability	No	No	Yes	Yes
Centre station	No	Yes	Yes	No
Report monitoring	No	Yes	No	No
Monthly charge	No	Yes (RM 64)	Yes (RM 64)	Internet fee (RM 64)

Different from PRLOG emergency system, First Response Medical Alert is using voice based call message delivery system. This emergency system is linked to a centre station service where constantly there is someone in-charge of monitoring the condition of user. User can deliver rescue message to centre station service in duplex communication when something occurred. With the monitoring service, unexpected situations such as comatose that happening on user can be discover and chances for survive will be higher due to immediate first aid provided from the centre station [22,23].