International Journal for Scientific Research (IJSR)

المجلة الدولية للبحوث العلمية

Vol. (3), No. (7) July 2024 الإصدار (3)، العدد (7)

Multi-Paging Technology for Emergency Rooms

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Abstract

This report presents the design, implementation and testing of a multi-paging device that should be installed in ERs "Emergency Rooms" to page doctors by more than one method. The designed multi-paging device was successful in paging the specific contact as will be shown at the end of this paper.

Keywords: Multi-Paging, Transmitter Module, Receiver Module, Microcontroller, Emergency Rooms.

Introduction

Inside the Room, the people involved and the special techniques used to respond to life-or-death situations. If you yourself find the need to visit an emergency room, this Project will make it less stressful by revealing what will happen and why things happen the way they do in an emergency department.

The usage of the electronics and the telecommunication projects to develop a new idea to reduce the pressure inside the ER will help the team to communicate easily, to decide perfectly and they are virtually connected.

The usage of the wireless communication becomes a backbone in every system because of the large scale of benefits.

Problem Definition

The regular way of paging takes a lot of time. The high cost because of the non-centralization of paging.

The time needed to find someone inside or outside the hospital.

Research Objectives

- **General Objectives**

To design and implement a microcontroller based wireless doctor list board with the ability of paging the doctors inside and outside the hospital using two methods:

- Short Message Service (SMS) through Global System for Mobile Communications (GSM) network.
- Sound paging through public address (PA) system.

- **Specific Objectives**

- To design and implement a transmitter module.
- To design and implement a receiver module.
- To interface the switches to the microcontroller.
- To interface a cell phone to the system.
- To record and play back audio paging.
- To program the microcontroller.

Research Domain and Limitations

This project went through two phases:

- Phase one: studying the GSM-system to find the best way to communicate, establishing the system design and selecting suitable components.
- Phase two: buying all the needed components, drawing the overall schematics, fabricating the PCB layout, assembling the devices, performing some measurements and finally testing the Multi-paging device.

Research Methodology

If a request must be done to doctor to attend into the ER the staff hit the switch named on the board with the doctor name, the system automatically recognize the doctor contact information and the personal information and then the system prepare a code for the request to be transmitted to the server room, the server receive the request and start sound paging and start the SMS request for the doctors outside the hospital.

The project uses a microcontroller and a wireless communication technology to accomplish the task.

Background of the Study

Emergency Department

An emergency department (ED), also known as accident & emergency (A&E), emergency room (ER), emergency ward (EW), or casualty department is a medical treatment facility specializing in acute care of patients who present without prior appointment, either by their own means or by ambulance. The emergency department is usually found in a hospital or other primary care centre.

Due to the unplanned nature of patient attendance, the department must provide initial treatment for a broad spectrum of illnesses and injuries, some of which may be life threatening and require immediate attention. In some countries,

emergency departments have become important entry points for those without other means of access to medical care.

The emergency departments of most hospitals operate 24 hours a day, although staffing levels may be varied in an attempt to mirror patient volume.

History

The first specialized trauma care centre in the world was opened in 1911 in the United States at the University of Louisville Hospital in Louisville, Kentucky, and was developed by surgeon Arnold Griswold during the 1930s. Griswold also equipped police and fire vehicles with medical supplies and trained officers to give emergency care while en route to the hospital.

Proposed Approach

Microcontroller

A microcontroller (also MCU or µC) is a functional computer system-on-a-chip as shown in figure (1) below. It contains a processor core, memory and programmable input/output peripherals.

Microcontrollers include an integrated CPU, memory (a small amount of RAM, program memory or both) and peripherals capable of input and output.

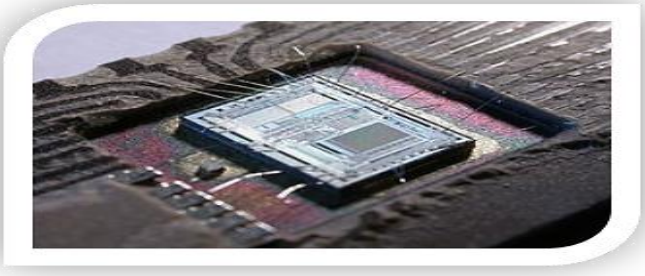

Figure (1): Microcontroller chip

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

Microcontroller Architecture

It emphasizes high integration in contrast to a microprocessor which only contains a CPU (the kind used in a PC). In addition to the usual arithmetic and logic elements of a general-purpose microprocessor, the microcontroller integrates additional elements such as read-write memory for data storage, read-only memory for program storage, Flash memory for permanent data storage, peripherals and input/output interfaces. At clock speeds of as little as 32 KHz, microcontrollers often operate at very low speed compared to microprocessors, but this is adequate for typical applications. They consume relatively little power (mill watts or even microwatts) and will generally have the ability to retain functionality while waiting for an event such as a button press or interrupt. Power consumption while sleeping (CPU clock and peripherals disabled) may be just Nano watts, making them ideal for low power and long lasting battery applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, remote controls, office machines, appliances, power tools and toys. By reducing the size, cost and power consumption compared to a design using a separate microprocessor, memory and input/output devices, microcontrollers make it economical to electronically control many more processes.

Programs

Microcontroller programs must fit in the available on-chip program memory, since it would be costly to provide a system with external, expandable and memory. Compilers and assembly language are used to turn high-level language programs into a compact machine code for storage in the microcontroller's memory. Depending on the device, the program memory may be permanent,

read-only memory that can only be programmed at the factory or program memory may be field-alterable flash or erasable read-only memory.

Programming Environments

Microcontrollers were originally programmed only in assembly language but various high-level programming languages are now also in common use to target microcontrollers. These languages are either designed especially for the purpose, or versions of general purpose languages such as the C programming language. Compilers for general purpose languages will typically have some restrictions as well as enhancements to better support the unique characteristics of microcontrollers. Some microcontrollers have environments to aid developing certain types of applications. Microcontroller vendors often make tools freely available to make it easier to adopt their hardware.

Many microcontrollers are so quirky that they effectively require their own non-standard dialects of C, such as SDCC for the 8051, which prevent using standard tools (such as code libraries or static analysis tools) even for code unrelated to hardware features. Interpreters are often used to hide such low level quirks. Interpreter firmware is also available for some microcontrollers.

Simulators are available for some microcontrollers, such as in Microchip's MPLAB environment. These allow a developer to analyze what the behavior of the microcontroller and their program should be if they were using the actual part. A simulator will show the internal processor state and also that of the outputs, as well as allowing input signals to be generated. While on the one hand most simulators will be limited from being unable to simulate much other hardware in a system, they can exercise conditions that may otherwise be hard to reproduce at will in the physical implementation, and can be the quickest way to debug and analyze problems.

Pin Descriptions

VCC: Digital supply voltage.

GND: Ground.

Port A (PA7..PA0): Port A serves as the analog inputs to the A/D Converter. Also port A serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used.

Port B (PB7..PB0): Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

Port C (PC7..PC0): Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

Port D (PD7..PD0): Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit).

RESET: Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

XTAL1: Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2: Output from the inverting Oscillator amplifier.

AVCC: AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF: AREF is the analog reference pin for the A/D Converter. As shown in figure (2) below.

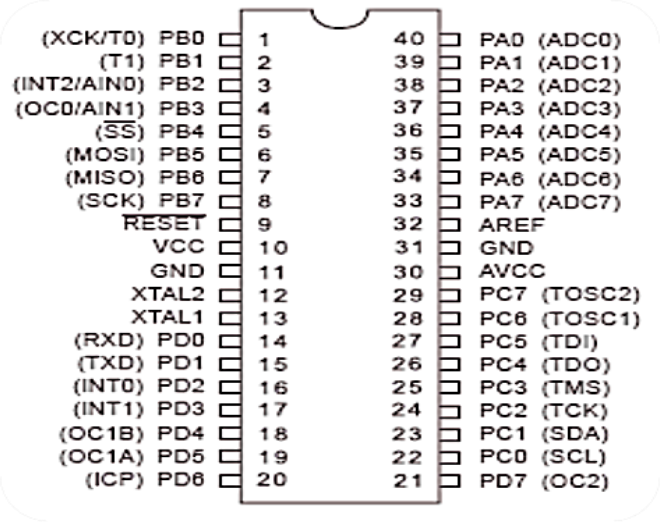

Figure (2): AVR Atmega 8535L Microcontroller Pins

Microcontroller (Atmega Series)

The AVR is a Modified Harvard architecture 8-bit RISC single chip microcontroller (µC) which was developed by Atmel in 1996. The AVR was one of the first microcontroller families to use on-chip flash memory for program storage as opposed to One-Time Programmable ROM, EPROM, or EEPROM used by other microcontrollers at the time.

Device Overview

The AVR is a Modified Harvard architecture machine with program and data stored in separate physical memory systems that appear in different address space Ts but having the ability to read data items from program memory using special instructions as shown in figure (3) below.

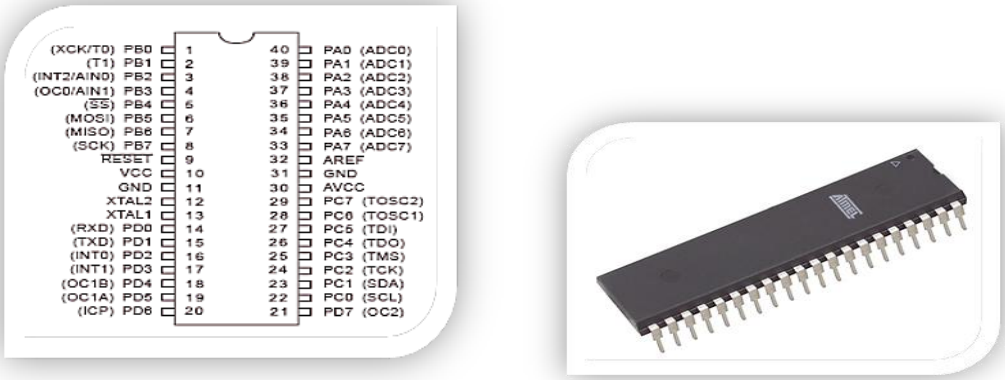

Figure (3): AVR Atmega16L Microcontroller overview

Voltage Regulator

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages as shown in figure (4) below.

Figure (4): Voltage regulator

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

Encoders and Decoders Working Mechanism

The radio frequency spectrum is filled with noise and other signals, especially those frequencies where unlicensed transmitter operation under FCC part 15 rules is allowed. When using a wireless remote control system it is desirable to have a way of filtering out or ignoring those unwanted signals to prevent false data from being received.

One way to accomplish this is to use microprocessors at the transmitter and receiver that are programmed with error detection and correction algorithms something like those used in modems. A much simpler way is to use an encoder IC at the transmitter and a decoder IC at the receiver. These ICs automatically generate and decode multiple serial codes that must match before data is accepted as valid.

In the early days of "radio control", before these coding ICs were available, radio controlled garage doors sometimes opened themselves when they received transmissions from a plane passing overhead or a two-way radio operating in the area. Encoding and decoding is now used in most wireless control systems to prevent this type of interference and to provide security.

Encoder HT12E

The 212 encoders are a series of CMOS LSIs for remote control system applications. They are capable of encoding information which consists of N address bits and 12_N data bits. Each address/ data input can be set to one of the two logic states. The programmed addresses/data are transmitted together with the header bits via an RF or an infrared transmission medium upon receipt of a trigger signal. The capability to select a TE trigger on the HT12E further enhances the application flexibility of the 212 series of encoders as shown in figure (5) below.

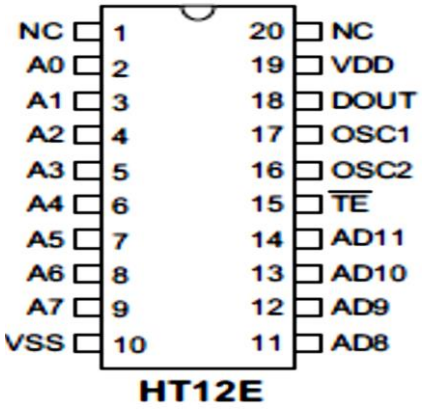

Figure (5): Encoder HT12E

Decoder HT12D

The 212 decoders are a series of CMOS LSIs for remote control system applications. They are paired with Holtek_s 212 series of encoders (refer to the encoder/decoder cross reference table). For proper operation, a pair of encoder/decoder with the same number of addresses and data format should be chosen.

The decoders receive serial addresses and data from a programmed 212 series of encoders that are transmitted by a carrier using an RF or an IR transmission

medium. They compare the serial input data three times continuously with their local addresses. If no error or unmatched codes are found, the input data codes are decoded and then transferred to the output pins. The VT pin also goes high to indicate a valid transmission.

The 212 series of decoders are capable of decoding information that consist of N bits of address and 12_Nbits of data. Of this series, the HT12D is arranged to provide 8 address bits and 4 data bits as shown in figure (6) below.

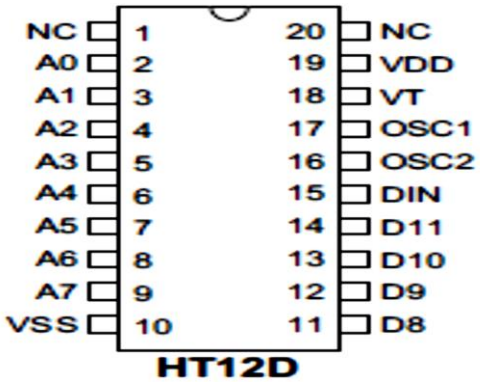

Figure (6): Decoder HT12E

Switch

Electrical switches. Top, left to right: circuit breaker, mercury switch, wafer switch, DIP switch, surface mount switch, reed switch. Bottom, left to right: wall switch (U.S. style), miniature toggle switch, in-line switch, push-button switch, rocker switch, micros witch as shown in figure (7) below.

In electronics, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another.

The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts. Each set of contacts can be in one of two

states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is nonconducting. The mechanism actuating the transition between these two states (open or closed) can be either a "toggle" (flip switch for continuous "on" or "off") or "momentary" (push-for "on" or push-for "off") type.

Figure (7): Types of switch

A switch may be directly manipulated by a human as a control signal to a system, such as a computer keyboard button, or to control power flow in a circuit, such as a Light switch. Automatically operated switches can be used to control the motions of machines, for example, to indicate that a garage door has reached its full open position or that a machine tool is in a position to accept another work piece. Switches may be operated by process variables such as pressure, temperature, flow, current, voltage, and force, acting as sensors in a process and used to automatically control a system. For example, a thermostat is a temperature-operated switch used to control a heating process. A switch that is operated by another electrical circuit is called a

relay. Large switches may be remotely operated by a motor drive mechanism. Some switches are used to isolate electric power from a system, providing a visible point of isolation that can be pad-locked if necessary to prevent accidental operation of a machine during maintenance, or to prevent electric shock.

Darlington Transistor

In electronics, the Darlington transistor is a semiconductor device which combines two bipolar transistors in tandem (often called a "Darlington pair") in a single device so that the current amplified by the first is amplified further by the second transistor. This gives it high current gain (written β or hFE), and takes up less space than using two discrete transistors in the same configuration. The use of two separate transistors in an actual circuit is still very common, even though integrated packaged devices are available.

This configuration was invented by Bell Laboratories engineer Sidney Darlington. The idea of putting two or three transistors on a single chip was patented by him, but not the idea of putting an arbitrary number of transistors, which would have covered all modern integrated circuits.

A similar transistor configuration using two transistors of opposite type (NPN and PNP) is the Sziklai pair, sometimes called the "complementary Darlington" as shown in figure (8) below.

International Journal for Scientific Research (IJSR)
المجلة الدولية للبحوث العلمية
Vol. (3), No. (7) July 2024 الإصدار (3)، العدد (7)

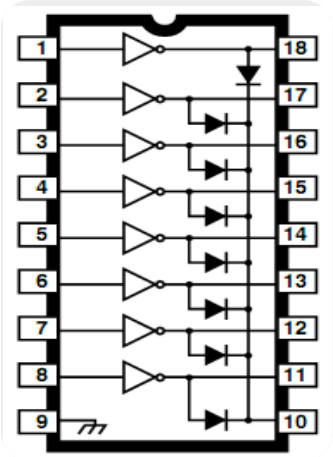

Figure (8): (Darlington transistor)

Behavior

A Darlington pair behaves like a single transistor with a very high current gain. This is beneficial as many commonly-used transistors with high gains have a low current threshold. The total gain of the Darlington is the product of the gains of the individual transistors:

$$\beta_{\text{Darlington}} = \beta_1 \times \beta_2$$

A typical modern device has a current gain of 1000 or more, so that only a tiny base current is required to make the pair switch on. Integrated devices have three leads (B, C and E) which are equivalent to the leads of a standard individual transistor.

The base-emitter voltage is also higher; it is the sum of both base-emitter voltages:

$$V_{BE} = V_{BE1} + V_{BE2}$$

To turn on there must be ~0.6 V across both base-emitter junctions which are connected in series inside the Darlington pair. It therefore requires more than 1.2 V to turn on. When a Darlington pair is fully conducting, there is a residual saturation

voltage of 0.6 V in this configuration, which can lead to substantial power dissipation. Another drawback is that the switching speed can be slow, due to the inability of the first transistor to actively inhibit the current into the base of the second device. This can make the pair slow to switch off. To alleviate this, a resistor of a few hundred ohms between the second device's base and emitter is often used. Integrated Darlington pairs often include this resistor.

It has more phase shift at high frequencies than a single transistor and hence can become unstable with negative feedback much more easily.

Ask Modulator/ Demodulator

Demodulator: The ST-RX02-ASK is an ASK Hybrid receiver module as shown in figure (9) below.

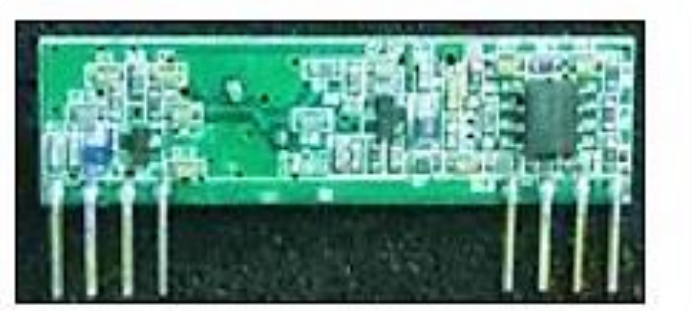

Figure (9): Ask Demodulator

- ✓ An effective low cost solution for using at 315/433.92 MHZ.
- ✓ The circuit shape of ST-RX02-ASK is L/C.
- ✓ Receiver Frequency: 315/ 433.92 MHZ
- ✓ Typical sensitivity: -105dBm
- ✓ Supply Current: 3.5mA

✓ IF Frequency:1MHz

Modulator: (The ST-TX01-ASK is an ASK Hybrid transmitter module) as shown in figure (10) below

Figure (10): ASK Modulator

ST-TX01-ASK is designed by the Saw Resonator, with an Effective low cost, small size, and simple-to-use for designing.

Frequency Range: 315 / 433.92 MHZ0

Supply Voltage: 3~12V.

Circuit Shape: Saw

Amplitude-Shift Keying

Amplitude-shift keying (ASK) is a form of modulation that represents digital data as variations in the amplitude of a carrier wave.

The amplitude of an analog carrier signal varies in accordance with the bit stream (modulating signal), keeping frequency and phase constant. The level of amplitude can be used to represent binary logic 0s and 1s. We can think of a carrier signal as an ON or OFF switch. In the modulated signal, logic 0 is

represented by the absence of a carrier, thus giving OFF/ON keying operation and hence the name given.

Like AM, ASK is also linear and sensitive to atmospheric noise, distortions, propagation conditions on different routes in PSTN, etc. Both ASK modulation and demodulation processes are relatively inexpensive. The ASK technique is also commonly used to transmit digital data over optical fiber. For LED transmitters, binary 1 is represented by a short pulse of light and binary 0 by the absence of light. Laser transmitters normally have a fixed "bias" current that causes the device to emit a low light level. This low level represents binary 0, while a higher-amplitude light wave represents binary 1.

Pager

Figure (11) A Motorola alphanumeric pager used in Brazil in the 1990s, operated by Teletrim. A pager (often called a beeper) is a simple personal telecommunications device for short messages. A one-way numeric pager can only receive a message consisting of a few digits, typically a phone number that the user is then requested to call.

Figure (11): A Motorola alphanumeric pager

Alphanumeric pagers are available, as well as two-way pagers that have the ability to send and receive email, numeric pages, and SMS messages.

The first practical pager was introduced in 1950 by physicians in the New York City area. The first pager system had a range of approximately 40 km (25 mi) and the physicians paid US$12 per month for the service. The actual pager device was developed and manufactured by Reevesound Company of New York and weighed approximately 200 grams (6 oz).

Until the popular adoption of mobile phones in the 1990s, pagers filled the role of common personal and mobile communications. Today, pagers mainly support the "critical messaging" markets.

Function and Operation

Paging is a subscription service offered in a variety of plans and options to meet the needs of a subscriber and the type of device used. In general, all pagers are given unique phone numbers while alphanumeric pagers are given an email address, usually consisting of the phone number.

When calling a phone number assigned to a pager, the calling party reaches a recorded greeting asking the caller to enter a numeric message, and sometimes giving the caller an option to leave a voice mail message. The numeric message given is usually a phone number. Generally, the paged person will receive an alert from the pager with the phone number and/or a pager code within a few minutes. In the case of email paging, the text is displayed.

Beepers were the first and are the simplest form of paging. They were named beepers because they originally made a beeping noise, but current pagers in this category use other forms of alert as well. Some use audio signals, others light up and some vibrate, often used in combination. The majority of restaurant pagers fall into this category.

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

Voice/Tone pagers provide the ability to listen to a recorded voice message when an alert is received.

Numeric pagers are the type of devices offering only a numeric display of the phone number to be called and pager codes, an informal language wherein sets of numbers symbolize preset messages.

Alphanumeric pagers are essentially modified versions of numeric pagers with sophisticated display to accommodate text. These devices are usually given an email address to receive text messages.

Two-way Alphanumeric pagers are alphanumeric pagers capable of both sending and receiving text messages and email. To do this, the units either have a small built in keypad that allows the user to input messages, or the message can be typed from a wireless keyboard and is received by the pager. Other pager models rely on existing message templates that the user can choose to send back - this has the advantage of standardising communications, increasing speed of a message reply and reducing the chance of a miss-communication. Increasingly, two-way pagers are offered with GPS. GPS allows field agents location information to be sent back to a control centre that can use the information to send only location relevant information, and, to improve response times by designating jobs or activities only to the closest field personnel.

Most modern paging systems use simulcast delivery by satellite-controlled networks. This type of distributed system makes them inherently more reliable than terrestrial based cellular networks for message delivery. Many paging transmitters may overlap a coverage area, while cellular systems are built to fill holes in existing networks. When terrestrial networks go down in an emergency, satellite systems continue to perform. Because of superior building penetration

and availability of service in disaster situations, pagers are often used by first responders in emergencies.

Liquid Crystal Display

Figure (12) Reflective twisted nematic liquid crystal display:

1. Polarizing filter film with a vertical axis to polarize light as it enters.
2. Glass substrate with ITO electrodes. The shapes of these electrodes will determine the shapes that will appear when the LCD is turned ON. Vertical ridges etched on the surface are smooth.
3. Twisted nematic liquid crystal.
4. Glass substrate with common electrode film (ITO) with horizontal ridges to line up with the horizontal filter.
5. Polarizing filter film with a horizontal axis to block/pass light.
6. Reflective surface to send light back to viewer. (In a backlit LCD, this layer is replaced with a light source.)

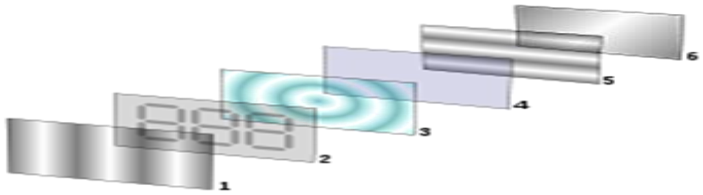

Figure (12): Reflective twisted nematic liquid crystal display.

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals (LCs). LCs do not emit light directly.

They are used in a wide range of applications, including computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones. LCDs have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they cannot suffer image burn-in.

LCDs are more energy efficient and offer safer disposal than CRTs. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. The most flexible ones use an array of small pixels. The earliest discovery leading to the development of LCD technology, the discovery of liquid crystals, dates from 1888. By 2008, worldwide sales of televisions with LCD screens had surpassed the passive-matrix and active-matrix addressed LCDs Figure (13) A general purpose alphanumeric LCD, with two lines of 16 characters.

Monochrome passive-matrix LCDs were standard in most early laptops (although a few used plasma displays) and the original Nintendo Game Boy until the mid-1990s, when color active-matrix became standard on all laptops. The commercially unsuccessful Macintosh Portable (released in 1989) was one of the first to use an active-matrix display (though still monochrome).

Passive-matrix LCDs are still used today for applications less demanding than laptops and TVs. In particular, portable devices with less information content to be displayed, where lowest power consumption (no backlight), low cost and/or readability in direct sunlight are needed, use this type of display.

Figure (13): A general-purpose alphanumeric LCD, with two lines of 16 characters

Displays having a passive-matrix structure are employing super-twisted nematic STN or double-layer STN (DSTN) technology (the latter of which addresses a color-shifting problem with the former), and color-STN (CSTN) in which color is added by using an internal filter.

STN LCDs have been optimized for passive-matrix addressing. They exhibit a sharper threshold of the contrast-vs-voltage characteristic than the original TN LCDs. This is important, because pixels are subjected to partial voltages even while not selected. Crosstalk between activated and non-activated pixels has to be handled properly by keeping the RMS voltage of non-activated pixels below the threshold voltage, while activated pixels are subjected to voltages above threshold. STN LCDs have to be continuously refreshed by alternating pulsed voltages of one polarity during one frame and pulses of opposite polarity during the next frame. Individual pixels are addressed by the corresponding row and column circuits. This type of display is called passive-matrix addressed, because the pixel must retain its state between refreshes without the benefit of a steady electrical charge. As the number of pixels (and, correspondingly, columns and rows) increases, this type of display becomes less feasible. Slow response times and poor contrast are typical of passive-matrix addressed LCDs with too many pixels.

New zero-power (bistable) LCDs do not require continuous refreshing. Rewriting is only required for picture information changes. Potentially, passive-matrix addressing can be used with these new devices, if their write/erase characteristics are suitable.

High-resolution color displays, such as modern LCD computer monitors and televisions, use an active matrix structure. A matrix of thin-film transistors (TFTs) is added to the electrodes in contact with the LC layer. Each pixel has its own dedicated transistor, allowing each column line to access one pixel. When a row line is selected, all of the column lines are connected to a row of pixels and voltages corresponding to the picture information are driven onto all of the column lines. The row line is then deactivated and the next row line is selected. All of the row lines are selected in sequence during a refresh operation. Active-matrix addressed displays look "brighter" and "sharper" than passive-matrix addressed displays of the same size, and generally have quicker response times, producing much better images.

Global System for Mobile Communications

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile), is a standard set developed by the European Telecommunications Standards Institute (ETSI) to describe technologies for second generation (or "2G") digital cellular networks. Developed as a replacement for first generation analog cellular networks, the GSM standard originally described a digital, circuit switched network optimized for full duplex voice telephony. The standard was expanded over time to include first circuit switched data transport, then packet data transport via GPRS. Packet data transmission speeds were later increased via EDGE. The GSM standard is succeeded by the third generation (or "3G") UMTS standard developed by the 3GPP. GSM networks will evolve further as they begin to incorporate fourth generation (or "4G") LTE Advanced standards. "GSM" is a trademark owned by the GSM Association.

The GSM Association estimates that technologies defined in the GSM standard serve 80% of the world's population, encompassing more than 5 billion people across more than 212 countries and territories, making GSM the most ubiquitous of the many standards for cellular networks.

SMS

Short Message Service (SMS) is a text messaging service component of phone, web, or mobile communication systems, using standardized communications protocols that allow the exchange of short text messages between fixed line or mobile phone devices. SMS text messaging is the most widely used data application in the world, with 2.4 billion active users, or 74% of all mobile phone subscribers. The term SMS is used as a synonym for all types of short text messaging as well as the user activity itself in many parts of the world.

SMS is also being used as a form of direct marketing known as SMS marketing. SMS as used on modern handsets was originated from radio telegraphy in radio memo pagers using standardized phone protocols and later defined as part of the Global System for Mobile Communications (GSM) series of standards in 1985 as a means of sending messages of up to 160 characters, to and from GSM mobile handsets. Since then, support for the service has expanded to include other mobile technologies such as ANSI CDMA networks and Digital AMPS, as well as satellite and landline networks. Most SMS messages are mobile-to-mobile text messages though the standard supports other types of broadcast messaging as well.

Technical Details (GSM)

The Short Message Service – Point to Point (SMS-PP) was originally defined in GSM recommendation 03.40, which is now maintained in 3GPP as TS 23.040. GSM 03.41 (now 3GPP TS 23.041) defines the Short Message Service – Cell Broadcast

(SMS-CB), which allows messages (advertising, public information, etc.) to be broadcast to all mobile users in a specified geographical area.

Messages are sent to a Short message service center (SMSC) which provides a "store and forward" mechanism. It attempts to send messages to the SMSC's recipients. If a recipient is not reachable, the SMSC queues the message for later retry. Some SMSCs also provide a "forward and forget" option where transmission is tried only once. Both mobile terminated (MT, for messages sent to a mobile handset) and mobile originating (MO, for those sent from the mobile handset) operations are supported. Message delivery is "best effort", so there are no guarantees that a message will actually be delivered to its recipient, but delay or complete loss of a message is uncommon, typically affecting less than 5% of messages. Some providers allow users to request delivery reports, either via the SMS settings of most modern phones, or by prefixing each message with *0# or *N#. However, the exact meaning of confirmations varies from reaching the network, to being queued for sending, to being sent, to receiving a confirmation of receipt from the target device, and users are often not informed of the specific type of success being reported.

Message Size

Transmission of short messages between the SMSC and the handset is done whenever using the Mobile Application Part (MAP) of the SS7 protocol. Messages are sent with the MAP MO- and MT-Forward SM operations, whose payload length is limited by the constraints of the signaling protocol to precisely 140 octets (140 octets = 140 * 8 bits = 1120 bits). Short messages can be encoded using a variety of alphabets: the default GSM 7-bit alphabet, the 8-bit data alphabet, and the 16-bit UTF-16 alphabet. Depending on which alphabet the subscriber has configured in the handset, this leads to the maximum individual short message sizes of 160 7-bit characters, 140 8-bit characters, or 70 16-bit characters (including spaces). GSM 7-bit alphabet support is mandatory for GSM handsets and network elements, but

characters in languages such as Arabic, Chinese, Korean, Japanese or Cyrillic alphabet languages (e.g. Russian, Serbian, Bulgarian, etc.) must be encoded using the 16-bit UTF-16 character encoding (see Unicode). Routing data and other metadata is additional to the payload size.

Larger content (concatenated SMS, multipart or segmented SMS, or "long SMS") can be sent using multiple messages, in which case each message will start with a user data header (UDH) containing segmentation information. Since UDH is part of the payload, the number of available characters per segment is lower: 153 for 7-bit encoding, 134 for 8-bit encoding and 67 for 16-bit encoding. The receiving handset is then responsible for reassembling the message and presenting it to the user as one long message. While the standard theoretically permits up to 255 segments, 6 to 8 segment messages are the practical maximum, and long messages are often billed as equivalent to multiple SMS messages. See concatenated SMS for more information. Some providers have offered length-oriented pricing schemes for messages; however, the phenomenon is disappearing.

SMS Gateway Providers

SMS gateway providers facilitate SMS traffic between businesses and mobile subscribers, including mission-critical messages, SMS for enterprises, content delivery, and entertainment services involving SMS, e.g. TV voting. Considering SMS messaging performance and cost, as well as the level of messaging services, SMS gateway providers can be classified as aggregators or SS7 providers.

The aggregator model is based on multiple agreements with mobile carriers to exchange two-way SMS traffic into and out of the operator's SMSC, also known as local termination model. Aggregators lack direct access into the SS7 protocol, which is the protocol where the SMS messages are exchanged. SMS messages are delivered

to the operator's SMSC, but not the subscriber's handset; the SMSC takes care of further handling of the message through the SS7 network.

Another type of SMS gateway provider is based on SS7 connectivity to route SMS messages, also known as international termination model. The advantage of this model is the ability to route data directly through SS7, which gives the provider total control and visibility of the complete path during SMS routing. This means SMS messages can be sent directly to and from recipients without having to go through the SMSCs of other mobile operators. Therefore, it is possible to avoid delays and message losses, offering full delivery guarantees of messages and optimized routing. This model is particularly efficient when used in mission-critical messaging and SMS used in corporate communications.

Interconnectivity with Other Networks

Message Service Centers communicate with the Public Land Mobile Network (PLMN) or PSTN via Interworking and Gateway MSCs.

Subscriber-originated messages are transported from a handset to a Service Center, and may be destined for mobile users, subscribers on a fixed network, or Value-Added Service Providers (VASPs), also known as application-terminated. Subscriber-terminated messages are transported from the Service Center to the destination handset, and may originate from mobile users, from fixed network subscribers, or from other sources such as VASPs.

On some carriers non-subscribers can send messages to a subscriber's phone using an Email-to-SMS gateway. Additionally, many carriers, including AT&T, T-Mobile USA, Sprint, and Verizon Wireless, offer the ability to do this through their respective websites.

For example, an AT&T subscriber whose phone number was 555-555-5555 would receive e-mails addressed to 5555555555@txt.att.net as text messages. AT&T

subscribers can easily reply to these SMS messages, and the SMS reply is sent back to the original email address. Sending email to SMS is free for the sender, but the recipient is subject to the standard delivery charges. Only the first 160 characters of an email message can be delivered to a phone, and only 160 characters can be sent from a phone.

Text-enabled fixed-line handsets are required to receive messages in text format. However, messages can be delivered to non-enabled phones using text-to-speech conversion.

Short messages can send binary content such as ringtones or logos, as well as Over-the-air programming (OTA) or configuration data. Such uses are a vendor-specific extension of the GSM specification and there are multiple competing standards, although Nokia's Smart Messaging is common. An alternative way for sending such binary content is EMS messaging, which is standardized and not dependent on vendors.

SMS is used for M2M (Machine to Machine) communication. For instance, there is an LED display machine controlled by SMS, and some vehicle tracking companies use SMS for their data transport or telemetry needs. SMS usage for these purposes is slowly being superseded by GPRS services due to their lower overall cost. GPRS is offered by smaller telco players as a route of sending SMS text to reduce the cost of SMS texting internationally.

AT Commands

Many mobile and satellite transceiver units support the sending and receiving of SMS using an extended version of the Hayes command set, a specific command language originally developed for the Hayes Smart modem 300-baud modem in 1977.

The connection between the terminal equipment and the transceiver can be realized with a serial cable (e.g. USB), a Bluetooth link, an infrared link, etc. Common AT

commands include AT+CMGS (send message), AT+CMSS (send message from storage), AT+CMGL (list messages) and AT+CMGR (read message).

However, not all modern devices support receiving of messages if the message storage (for instance the device's internal memory) is not accessible using AT commands.

Premium-Rated Short Messages

Short messages may be used to provide premium rate services to subscribers of a telephone network.

Mobile-terminated short messages can be used to deliver digital content such as news alerts, financial information, logos and ring tones. The first premium-rate media content delivered via the SMS system was the world's first paid downloadable ringing tones, as commercially launched by Saunalahti (later Jippii Group, now part of Elisa Group) in 1998. Initially only Nokia branded phones could handle them. By 2002 the ringtone business globally had exceeded one billion US dollars of service revenues, and nearly 5 billion dollars by 2008. Today, they are also used to pay smaller payments online, for example for file sharing services, in mobile application stores or VIP section entrance. Outside the online world, one can buy a bus ticket, beverages from an ATM, pay for a parking ticket, order a store catalog or some goods (e.g. discount movie DVDs) and many more.

Premium-rated messages are also used in Donors Message Service to collect money for charities and foundations. DMS was first launched at April 1, 2004 and is very popular in the Czech Republic, e.g. the Czech people sent over 1.5 million messages to help South Asia recover from 2004 Indian Ocean Earthquake.

The Value-added service provider (VASP) providing the content submits the message to the mobile operator's SMSC(s) using a TCP/IP protocol such as the short message peer-to-peer protocol (SMPP) or the External Machine Interface (EMI). The

SMSC delivers the text using the normal Mobile Terminated delivery procedure. The subscribers are charged extra for receiving this premium content; the revenue is typically divided between the mobile network operator and the VASP either through revenue share or a fixed transport fee. Submission to the SMSC is usually handled by a third party.

Mobile-originated short messages may also be used in a premium-rated manner for services such as televoting. In this case, the VASP providing the service obtains a short code from the telephone network operator, and subscribers send texts to that number. The payouts to the carriers vary by carrier; percentages paid are greatest on the lowest-priced premium SMS services. Most information providers should expect to pay about 45% of the cost of the premium SMS up front to the carrier. The submission of the text to the SMSC is identical to a standard MO Short Message submission, but once the text is at the SMSC, the Service Center (SC) identifies the Short Code as a premium service. The SC will then direct the content of the text message to the VASP, typically using an IP protocol such as SMPP or EMI. Subscribers are charged a premium for the sending of such messages, with the revenue typically shared between the network operator and the VASP. Short codes only work within one country, they are not international.

An alternative to inbound SMS is based on long numbers (international number format, e.g. +249911540***), which can be used in place of short codes for SMS reception in several applications, such as TV voting, product promotions and campaigns. Long numbers work internationally; allow businesses to use their own numbers, rather than short codes which are usually shared across a lot of brands. Additionally, long numbers are non-premium inbound numbers.

Applying the Proposed Approach

Block Diagram

The system consist of two blocks the 1st block is the list of doctors with RF transmitter and the 2nd is the receiver block which exists on the server room and the system is integrated with a GSM phone to send SMS to the doctors outside the hospital.

Block Diagram I Description

List switching board: the board consists of switches for requests and also includes the doctors' names beside every switch.

Microcontroller: detect the pressed switch and prepare a code to be transmitted and also control the LEDs.

Encoder: to encode the data from the microcontroller.

TX: RF transmitter module.

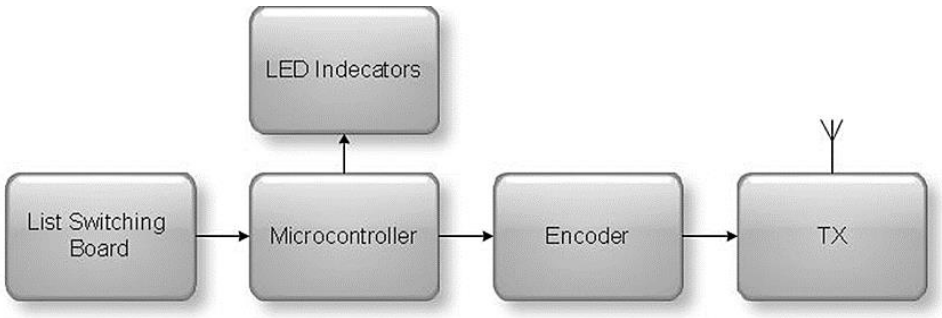

Figure (14): Block diagram

Block diagram II Description:

RX: receiver RF module.

Decoder: decode the received data.

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

Workstation: used to display the requests and send SMS through the mobile.

Speaker: for audio announcement.

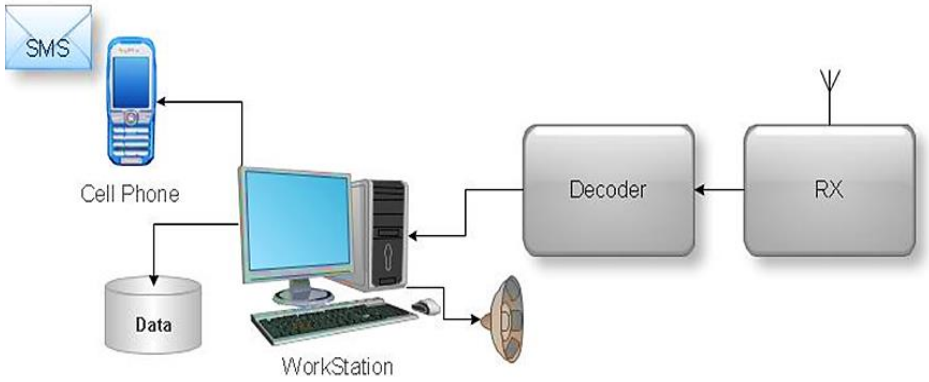

Figure (15): Block Diagram II

Board Flowchart

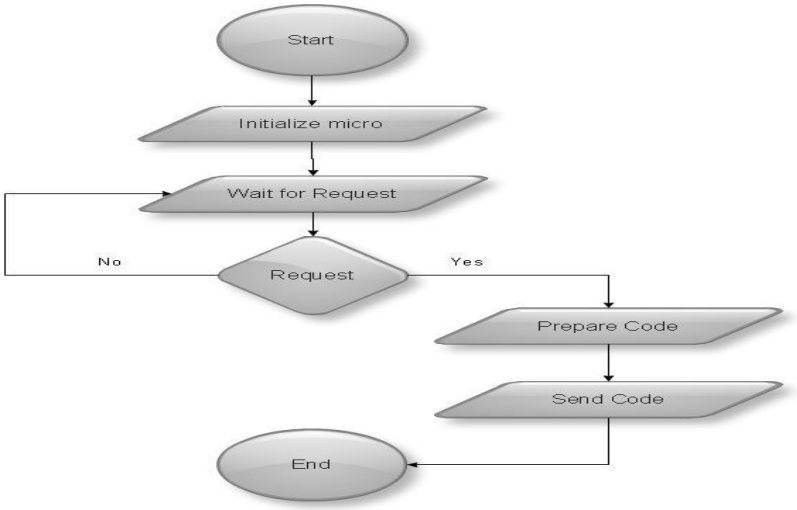

Figure (16): Board Flowchart

Workstation Flowchart

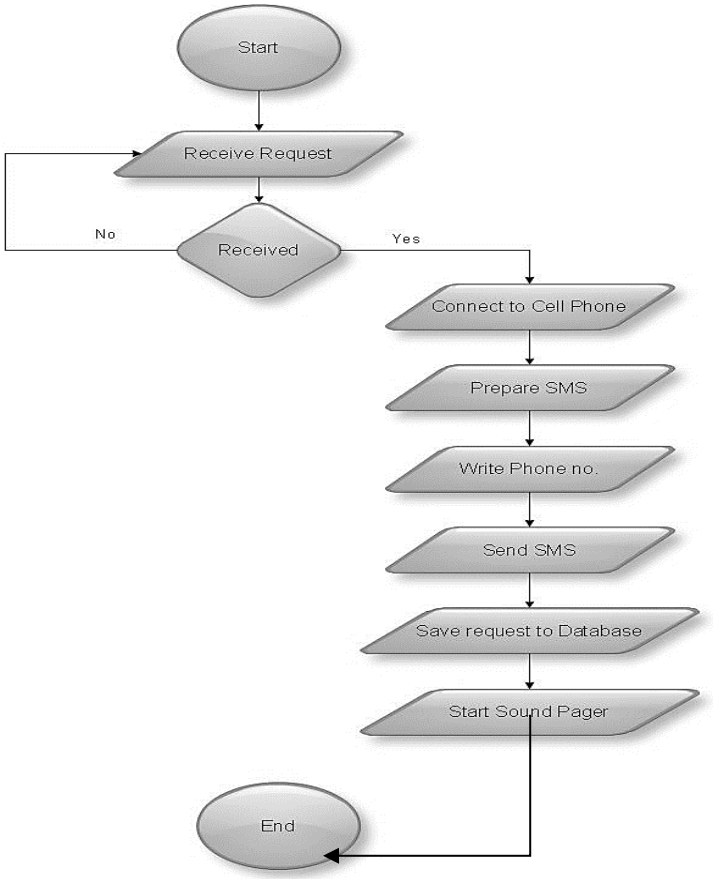

Figure (17): Workstation Flowchart

Connector

To attach the sensor and the LPT to the circuit a male connector and female connector was used.

DIP Switch

The DIP switch is on/off switch used to enable / disable on of the inputs of the sensors.

International Journal for Scientific Research (IJSR)
المجلة الدولية للبحوث العلمية
IJSR
Vol. (3), No. (7) July 2024 الإصدار (3)، العدد (7)

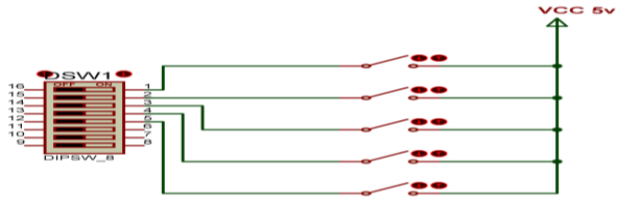

Figure (18): DIP Switch

ULN2804 (Sensor Input)

The ULN in this area connected to the sensor output to amplify the signal to 500mA in order to give the microcontroller the ability to detect the signal.

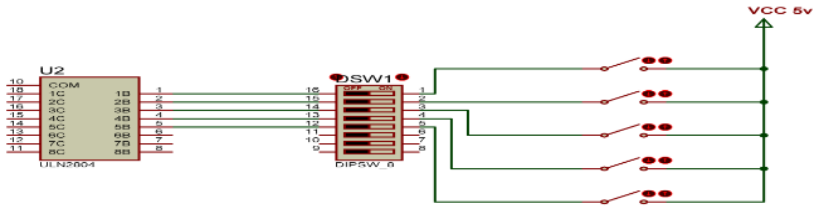

Figure (19): ULN2804 (Sensor input)

Microcontroller

Used here in order to detect the sensor inputs and through software it can send a 4 bit code to the encoder though ULN.

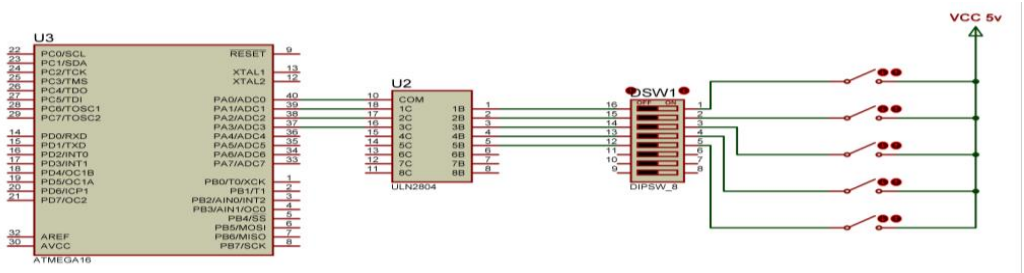

Figure (20): Microcontroller

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

ULN2804 (Encoder)

The uln2804 is used to drive the Encoder which is pull-up resistor and need 100 mA to send data so the microcontroller give a 5 volt the ULN convert it to logic 0 to be send through the encoder.

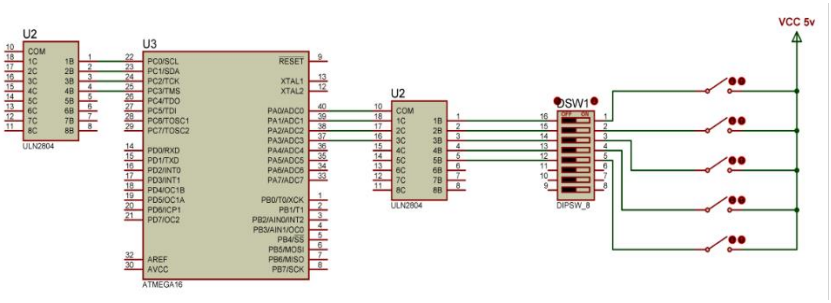

Figure (21): ULN2804 (Encoder)

Encoder

Convert the parallel 4 bit to serial and adding the address to the signal to prevent the interference and the output is serial to the transmitter module the encoder working frequency is 433MHz and with a power of 5 volts.

A saw resistor with a value of 1M ohm used to set the frequency to 433MHZ.

Transmitter Module

used to modulate the signal using ASK (0amplitude shift keying), and send data with a frequency of 433MHz through open space the module use 5 volt power and can send to maximum of 150 meter distance.

International Journal for Scientific Research (IJSR)
المجلة الدولية للبحوث العلمية
Vol. (3), No. (7) July 2024 الإصدار (3)، العدد (7)

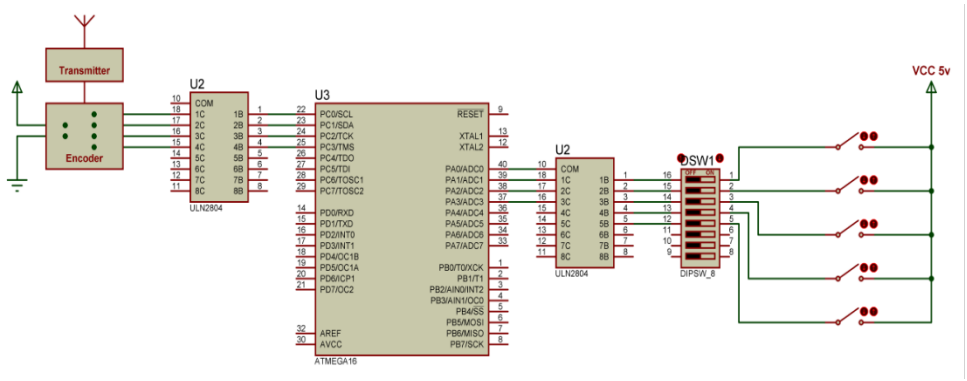

Figure (22): Transmitter module

Receiver Module

The receiver module is a demodulator to the ASK modulation and the output is digital serial connected to the decoder and it is also working at 433MHz frequency.

Decoder

Decode serial data received and convert it from serial to parallel and compare the address of the received signal with the physical decoder address and it works as 433MHz and the output is attached directly to the LPT status pins.

A saw resistor with a value of 51K ohm used to set the frequency to 433MHZ.

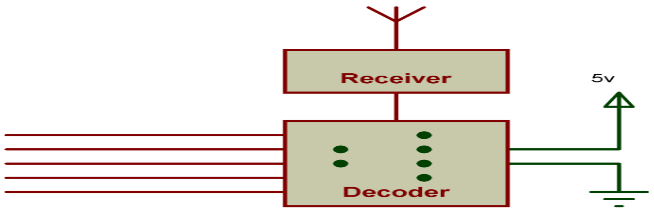

Figure (23): Decoder

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

International Journal for Scientific Research (IJSR)
المجلة الدولية للبحوث العلمية
Vol. (3), No. (7) July 2024 الإصدار (3)، العدد (7)

LPT

Local Printer Port, used here as a communication channel between the circuit and the PC and status pins was used to detect the 4 bit code.

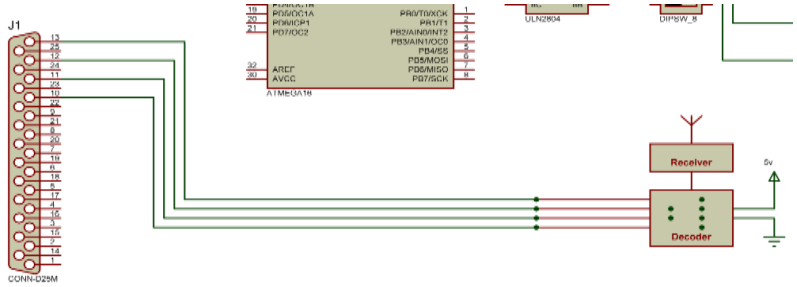

Figure (24): LPT

Power of the Receiver Circuit

The power is directly connected to the power supply of the computer 5v and GND

LED of Receiver Circuit

Used to indicate the power of the circuit if it is on or off

Resistor of LED in Receiver Circuit

Used to drop the voltage before the LED because the LED is 3.5V and it is 150 ohm.

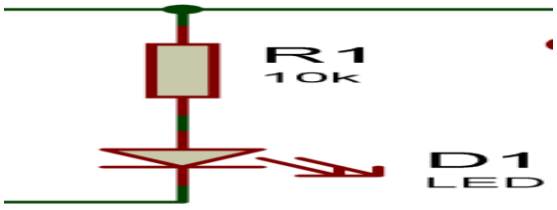

Figure (25): Resistor of LED in Receiver Circuit

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

International Journal for Scientific Research (IJSR)
المجلة الدولية للبحوث العلمية
Vol. (3), No. (7) July 2024 الإصدار (3)، العدد (7)

Overall Design

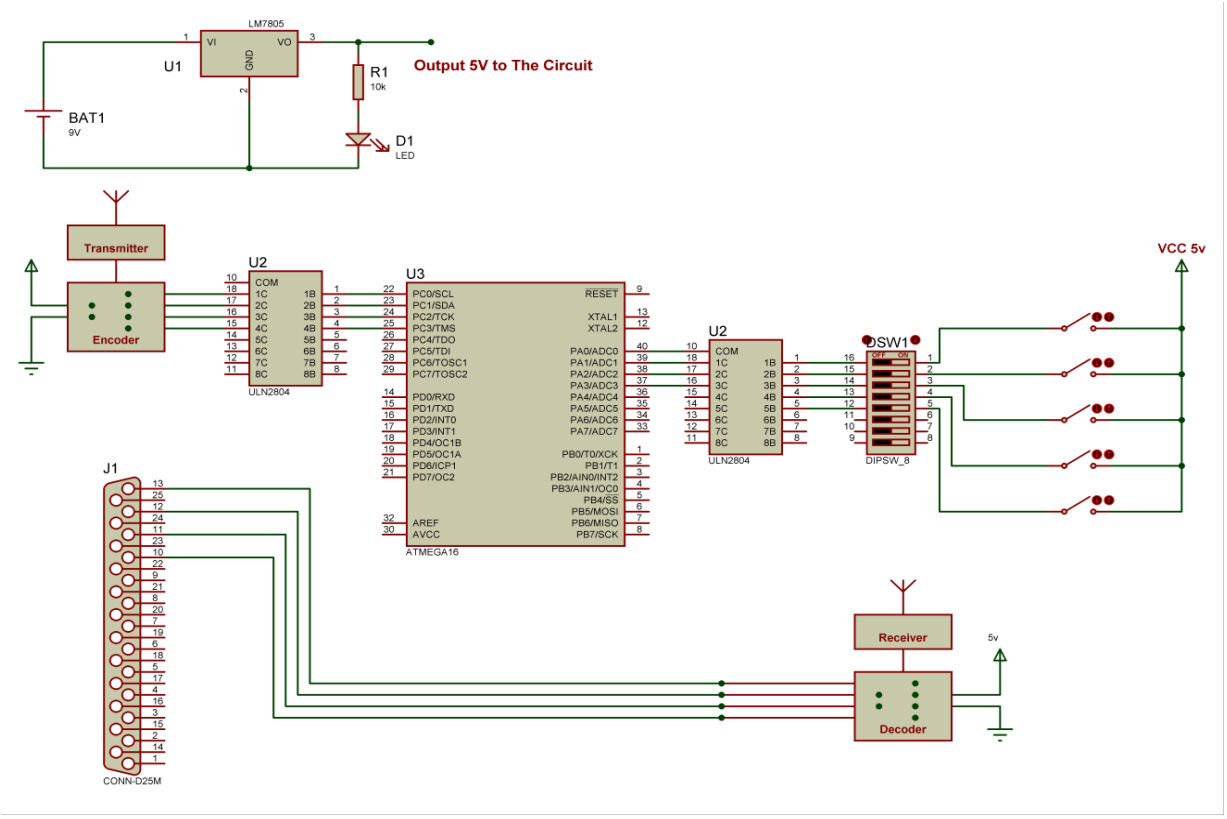

Figure (26): Overall Design

Results and Discussion

The usage of electronic wireless pager system for medical uses is one of the great inventions because of a lower price and a limited way to communicate with the groups.

The usage of the wireless technology and the readymade modules has its own classifications such as the regulations and the distance and the power of

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

transmission which all goes round 150 meter and with a transmission power of -10 dB the rules are international and it's specified by the FCC.

Size of soldering board: Many types of boards can be used to design the projects such as:

1- PCB boards.

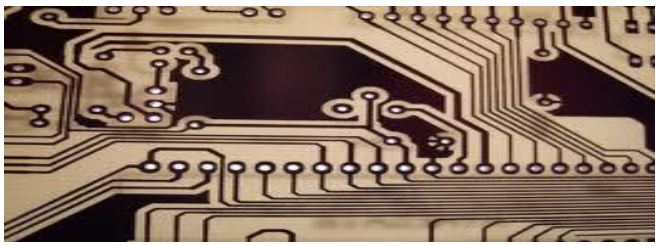

Figure (27): PCB Boards

2- Breadboards.

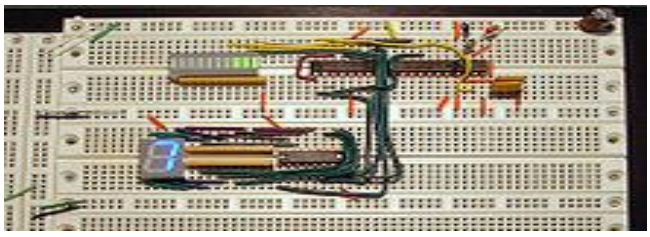

Figure (28): Bread boards

3- Prototyping Soldering Boards.

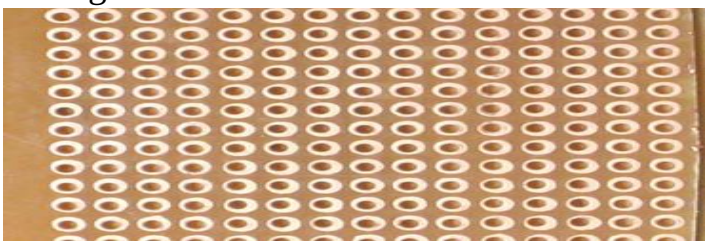

Figure (29): Prototyping Soldering Boards

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

International Journal for Scientific Research (IJSR)
المجلة الدولية للبحوث العلمية
IJSR
Vol. (3), No. (7) July 2024 الإصدار (3)، العدد (7)

Each type of board has its usage and advantages / disadvantages, for example the Bread Board can be used for testing the circuit and not for a circuit solution, and the prototyping soldering board used for the mini projects and mostly for graduation projects and finally the professional PCB board used to make a product or solution after the circuit tested and with the ability to customize the PCB board the size of the circuit can be smaller according the design.

Components Size

The components worldwide classified into two categorize

1- Surface mount technology (SMT) which allow Surface Mount Devices (SMD) “Small size and micro size” to be used.

Figure (30): Components size

2- Dual in-line package (DIP).

Figure (31): Dual in-line package (DIP)

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

Economical View

The usage of the SMD components is very expensive compared with the DIP components and the PCB fabrication and design is expensive if the circuit designed is not classified as a production due to the high cost of the first design.

Conclusion

In this paper, which turned out to be a full success, we designed a device that page doctors cell phones and call their names through a PA system. This device should be used in every ER "Emergency Room" as it helps to notice the specified doctor to attend to the ER as soon as he can to help the patient.

The project was implemented according to the following plan:

We started by studying the GSM system to find the best method to page the contacts.

We searched for components that are needed for building this device.

Finally, we assembled and tested the device. Fortunately, we got positive results.

The usage of computerized systems increase the number of benefits from the project it decease the time passing calling or requesting the doctors to the ER room and also reduce the number of nurses and staff inside the ER room.

Also, the use of RF technology gives the facility of mobility to the project.

We hope that this project will be useful for the community where such devices are needed.

Future Work

1. Secure communication channel system can be added.
2. Using a long distance coverage wireless module.

International Journal for Scientific Research, London Vol (3), No (7), 2024
https://doi.org/10.59992/IJSR.2024.v3n7p14 E-ISSN 2755-3418

3. Design a feedback to portable device.
4. Using Active RFID to identify the doctor position inside the hospital.

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