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Design and Validation of a Microcontroller Based SMS Notification System for Disease Surveillance

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Abstract: *While outbreaks of infectious diseases have long presented a public health challenge, especially in developing countries like Nigeria; within recent years, the frequency of such outbreaks has risen tremendously. Furthermore, with the recent outbreaks of emerging and re-emerging infectious diseases such as Ebola virus disease and other epidemic prone diseases in Nigeria demanding immediate public health action, there is a need to strengthen the existing notifiable disease surveillance and notification system with increased clinicians' involvement in timely reporting of notifiable diseases to designated public health authorities for prompt public health action. In this work, a microcontroller based SMS notification system for disease surveillance uses Atmega328p on Arduino microcontroller board. The GSM module (SIM900A) uses a registered SIM from any network to connect to the mobile network. It is used as a notification system to send reports to different health workers to create awareness during disease outbreak and to facilitate early detection and reporting of disease for the treatment of victims. The implementation of microcontroller-based SMS notification system for disease surveillance comprises of two push buttons, one is used to select the disease and the other is used to send an SMS for the selected disease to create awareness whenever an outbreak occurs. This is achieved with the aid of the GSM module (SIM900A) used, which is responsible for sending the SMS when connected to the mobile network, it runs base on the AT command (attention command) that works on the UART protocol to send the desired SMS text to the designated phone numbers. , The aim of this project was achieved because an SMS of the selected disease was received by the designated Mobile phone numbers.*

Keywords: *Disease; Design; Validation; Microcontroller; Notification System*

1.0 INTRODUCTION

Disease surveillance is the continuous scrutiny of occurrence of disease and health related event, to enable promote intervention of the control of diseases.it involves the ongoing systematic collection, collation and interpretation of data on disease occurrence and public health related event and dissemination of the information obtained from such data for prompt public health action (Elvis, Isere & Akinola, 2015).

However, disease notification involves the official and family reporting of the occurrence of specific diseases and conditions to designated public health authorities by clinicians and other health personnel for action using designated reporting tools (Federal ministry of health, 2009). Disease notification is an important source of data collection for an effective and efficient disease surveillance system, Disease surveillance and notification (DSN) have been recognized as an effective strategy for the prevention and control of diseases most especially epidemic prone diseases. It is crucial to note that disease outbreak do not give notice before its occurrence neither they respect the boarders of nations. When they eventually occur, they are likely to spread like wide fire an often resulting in high morbidity and case fatality rate with consequent economic impact.

An effective and efficient disease surveillance and notification system allows early detection of disease outbreaks that will prompt intervention for the reduction of morbidity and mortality that may result from the epidemics of those infectious diseases. Levels of disease surveillance and notification can be individual, local, national and international. National disease surveillance and notification system often depends on effective distract/Local Government area (LGA) disease monitoring and control mechanism with the clinicians actively involved (Jonathan et al, 2017).

2.0 REVIEW OF RELATED WORKS

The disease surveillance notification (DSN) system was designed and implemented by previous researcher using different techniques or technologies.

Albar, K. et al (2009) design and developed an RF (Radio Frequency) based disease surveillance and notification (DSN) system. The system consist of a RF transmitter and receiver module which is used to transmit the outbreak of three (3) disease such as Malaria, Cholera and measles. The design also consist of and LCD display module that displays the names of the outbreak diseases detected and sent to the RF transmitter module. The RF disease surveillance notification (DSN) system is made to operate with the short range frequency devices such as 400MHz -1250MHz and the disadvantage of this design is that it covers distance of 500feet only, but its advantage is that it works quite well at all time which means it is reliable.

George T.K., et al (2012) come up with a Wi-Fi based disease surveillance notification (DSN) system to raise awareness on the outbreak of some communicable diseases. The design uses Wi-Fi which is a technology for radio wireless local area networking of devices based on the IEEE 802.11 standard. The design consist of the Wi-Fi module i.e. the Wi-Fi module is a single module that can act a transmitter and a receiver at the same time. The Wi-Fi DSN uses a wide land area network (WLAN) to connect to the internet this means it has the advantage of covering a very long distance since the internet is a very wide range. The design also requires no LCD module because it displace the outbreak of diseases in the other Wi-Fi electronic devices with monitors or LCD screen such as PCs, laptops, palmtops etc. it also covers three disease such as Malaria, typhoid and cholera. One major disadvantages of this design is that it can be affected by computer virus or it can be vulnerable to computer attacks. Another additional to its large area coverage is that, the information spreads faster than the RF disease surveillance and notification (DSN) system.

Khaltrep J.K., *et al* (2014) designed and implemented a disease surveillance notification system using microcontroller and a GSM module. The GSM module is SIM800L that uses a registered SIM from any network to connect to the mobile network. This design also capable of sending a report on three (5) diseases outbreak only. The advantage of this design is that it also covers a wide area network, since it uses the GSM network that can reach a lot of people within an entire country and even beyond. The diseases sent or reported are displayed and viewed on the screen of the GSM mobile phones. One of the major disadvantage of this design is that it is affected by network fluctuations. However, the proposed design which is a microcontroller based SMS notification system for disease surveillance is an enhancement to the Khaltrep's design. This design also uses GSM module, but a SIM900A GSM module that tends to be much more efficient and reliable when connecting to the GSM mobile network, than a SIM800L GSM module. The project design uses an Arduino Microcontroller board like all other microcontrollers, it runs on a computer software program called "Source Code". A source code is a set of computer instructions or command that controls a hardware. This design is capable of reporting up to five (5) different outbreak diseases such as Malaria, Cholera, Yellow fever, Measles and Meningitis. It is also viewed using the screen of the GSM mobile phones in form of SMS text message, and also covers almost the entire country since it uses the GSM mobile network.

2.1 CORE FUNCTION OF DISEASE SURVEILLANCE NOTIFICATION SYSTEM

The indicators related to the core functions measures the processes and output from the system. The core function include case detection, case registration, case confirmation, reporting, data analysis and interpretation and public health response including reports and feedback from the systems to the data providers (Department of WHO, 2002).

2.1.1 CASE DETECTION

Case detection is the process of identifying cases and outbreaks. Case detection can be through the formal health system, private health system, or community structures. Case definition and a functioning rumour verification system are vital for case and outbreak detection.

2.1. 2 CASE REGISTRATION

Case registration is the process of recording the cases identified. This requires a standardized register to record minimal data elements on targeted diseases and conditions. Monitoring should establish the proportion of health facilities having the standardized registers. Evaluation could then examine the validity and quality of information recorded as well as factors that affect the registration of cases.

2.1.3 CASE CONFIRMATION

Case/outbreak confirmation refers to the epidemiological laboratory capacity for confirmation. Capacity for case confirmation is enhanced through improved referral system, networking and partnerships. This means having the capacity for appropriate specimen collection, packing and transportation. The existence of external and internal quality control mechanisms are important element for case confirmation which help to ensure the validity and reliability of test result.

2.1.4 REPORTING

Reporting refers to the process by which surveillance data moves through the surveillance system from the point of generation. It also refers to the process of reporting suspected and confirmed outbreak. Different reporting systems may be in existence depending on the type of data and information being reported, purpose and urgency of relaying the information and where data/information is being reported. The national guidelines for the different reporting systems should be implemented.

2.1.5 DATA ANALYSIS AND INTERPRETATION

Surveillance data should be analyzed routinely and the information interpreted for use in public health actions. Appropriate "alert" and "epidemic" threshold values for diseases with epidemic tendencies should be used by the surveillance staff. Capacity for routine data analysis and interpretation should be established and maintained for epidemiological as well as laboratory data.

2.1.6 EPIDEMIC PREPAREDNESS

Epidemic preparedness refers to the existing level of preparedness for potential epidemics and includes availability of preparedness plans, stockpiling, designation of isolation facilities, setting aside of resources for outbreak response etc.

2.1.7 RESPONSE AND CONTROL

Public health surveillance system are only useful if they provide data for appropriate public health response and control. For an early warning system, the capacity to the respond to detected outbreaks and emergency public health threats needs to be assessed. This can be done following major outbreak response and containment to document the quality and impact of public health response and control surveillance system designed to monitor and evaluate Programme interventions should be evaluated to establish the extent to which the objectives of the system are being met.

2.1.8 FEEDBACK

Feedback is an important function of all surveillance systems. Appropriate feedback can be maintained through supervisory visits, newsletter and bulletins. It is possible to monitor the provision of feedback by the different levels of surveillance and to evaluate the quality of feedback provided and the implementation of follow-up actions.

3.0 METHODOLOGY

This section deals with the design specifications, methods as well as steps taken to realize the implementation of microcontroller based SMS Notification System for Disease Surveillance. The project is made up of several block units which includes the power supply unit, the key button input unit, the microcontroller unit, the GSM module unit as well as the LCD display unit

3.1 COMPONENTS LIST

The component required for the hardware design includes:

i) Atmega328P Microcontroller; ii) Arduino Uno; iii) GSM Module (SIM900A); iv) 16 X 2 LCD display unit; v) Key button input; vi) LM 7805 voltage regulator; vii) 16MHz crystal oscillator

3.1.1 DESIGN OF THE POWER SUPPLY UNIT

The power supply unit consist of the 230v/12v AC, 2000mA step down transformer, the bridge rectifier diode chip (BDR1), the filter capacitor(C1) as well as the 5v voltage regulator (LM7805) as shown in figure 3.2

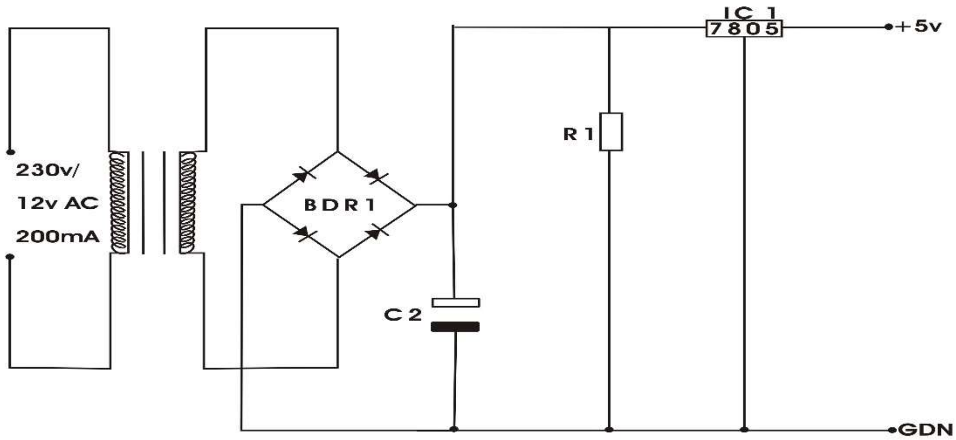

Figure 3.1: The power supply unit.

From the transformer ratings,

From the transformer ratings,

V*rms = 12v*

I*rms = 2000mA*

$V_{peak} = V_{rms} \times \sqrt{2}$ - 3.1

$= 12 \times \sqrt{2}$

$V_{peak} = 16.97v$

$I_{peak} = I_{rms} \times \sqrt{2}$ - 3.2

$= 2000mA \times \sqrt{2}$

$I_{peak} = 2828.42mA$

Voltage after rectification (Vdc) is given by,

$Vdc = 2\left(\frac{Vpeak}{\pi} - VD\right)$ - 3.3

Where VD is voltage drop across the bridge rectifier circuit (VD = 0.7v)

$$\therefore\ Vdc = 2\left(\frac{16.97}{\pi} - 0.7\right)$$

= 2(5.4017 – 0.7)

= 2(4.7017)

∴ Vdc = 9.403v

The value of the current after rectification is given by;

$$Idc = \frac{Vdc}{RL} \text{ - 3.4}$$

$\therefore\ Idc = \frac{9.403v}{RL}$

But $RL = \frac{Vpeak}{Ipeak}$ - 3.5

RL= $\frac{16.97v}{2828.42mA}$

∴ RL = 5.9998kΩ

$$\therefore\ Idc = \frac{9.403v}{5.9998k\Omega}$$

Idc = 1567.22mA

The filter capacitor (C1) is designed to hold the peak to ripple voltage at approximately 10% of the peak voltage.

∴ Vripple (Vr) = 0.1Vpeak - 3.6

Vripple (Vr) = 0.1 x 16.97 = 1.697v

The value of capacitor C1 is given by;

Vripple (Vr) $= \frac{2.4Idc}{C1}$ ………….. 3.7 Where 2.4 is a constant value

$$\therefore\ C1 = \frac{2.4Idc}{Vr} = \frac{2.4 \times 1567.22mA}{1.697v} \quad \therefore C1 = 2216.46uf$$

But a standard available close value of 2200uf was used for the construction.

3.1.2 DESIGN OF THE KEYBOARD INPUT UNIT

The keyboard input unit is made up of transistors Q1 and Q2, Resistor R1, R2, R3 and R4, capacitors C2 and C3 as well as key buttons PB1 and PB2 as shown in figure 3.3

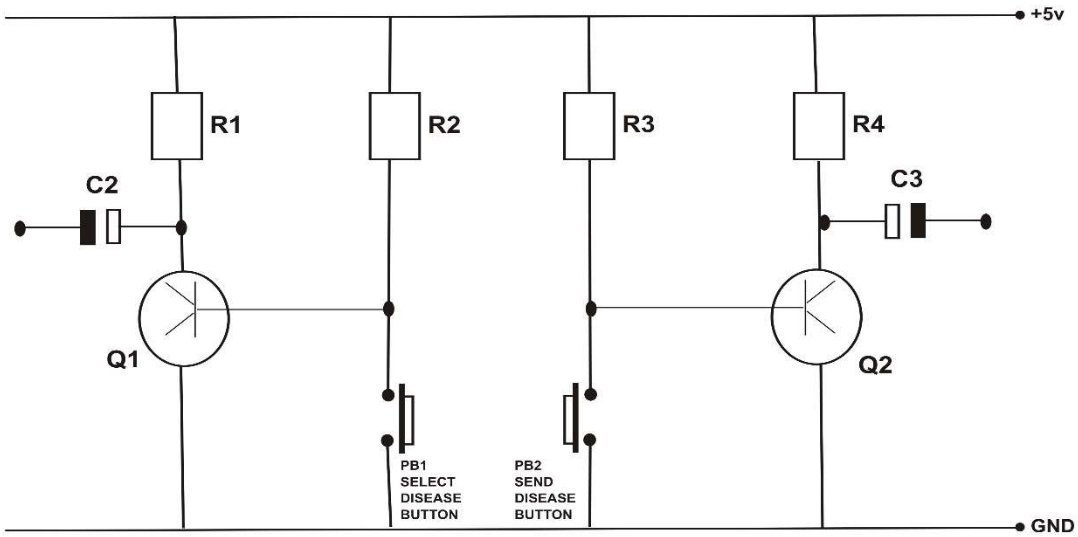

Figure 3.2: The key button input unit.

The value of resistor R1 (RC) which is a collector resistor for transistor Q1 is given by;

$$R1(RC) = \frac{Vcc - Vce}{Ic} \quad \text{-----------------------------} \; 3.8$$

Where V_{CE} is collector-emitter voltage of the transistor = 0.2v (from transistor data sheet) and

IC = collector current which means Ic = Idc = 1567.22mA.

$$\therefore \; R1(RC) = \frac{5 - 0.2}{1567.22mA}$$

$$= \frac{4.8}{1567.22mA}$$

$$R1(RC) = 3.062k\Omega$$

But a standard available close value of 3.3kΩ was used for the construction.

The value of resistor R2 (RB) which is also a base resistor of Q1 is given by;

$R2(RB) = \frac{V_{cc} - V_{BE}}{IB}$ -3.9

Where V_{BE} is base – emitter voltage of transistor Q1 = 0.6v (from data sheet of transistor (9014).

And IB is base current which is unknown but could be found using the equation;

$IB = \frac{IC}{\beta}$ - 3.91

Where $\beta = 200$ (transistor C9014 gain from datasheet).

$IB = \frac{1567.22mA}{200}$ = 783.6μA

$\therefore\ IB = 783.6\mu A$

$\therefore\ R2(RB) = \frac{5-0.6}{783.6\mu A}$

$= \frac{4.4}{783.6\mu A}$

R2 (RB) = 5.62kΩ

But a standard available close value of 5.6kΩ was used for the construction.

The value of capacitor C2 is given by;

$C = \frac{Q}{V}$ -3.92

Where Q = I x t (current per second)

$C2 = \frac{I \times t}{V} = \frac{1567.22mA \times 1}{5}$

C2 = 0.3134μf

The value of resistor R3 which is also base resistor RB for transistor Q2 is given by;

R3 (RB) $= \frac{V_{CC} - V_{bE}}{Ib}$

Where, $IB = \frac{IC}{\beta} = \frac{1567.22mA}{200}$

$IB = 783.6\mu A$

$\therefore\ R3(RB) = \frac{5-0.6}{783.6\mu A}$

$= \frac{4.4}{783.6 \text{ x } 10^{-6}}$

$$= 5.62k\Omega$$

$$\therefore\ R3(RB) =\ 5.62k\Omega \text{ (Same value as R2)}$$

The value of R4 (RC) is also given by,

R4 (RC) $= \frac{V_{CC} - V_{cE}}{Ic}$

$$R4(Rc) = \frac{5 - 0.2}{1567.22mA}$$

$$= \frac{4.8}{1567.22mA}$$

$$= 3.062k\Omega$$

$$\therefore\ R4(RC) =\ 3.062k\Omega$$

R4 (RC) = 3.062KΩ (same value as R2.)

Capacitor C3 is also given by;

$$C3\ \frac{Q}{V}\ where, Q = I \text{ x } t$$

$$\therefore\ C3\ = \frac{I \text{ x } t}{V} = \frac{1567.22mA \times 1}{5}$$

∴ C3 = 0.3134µ*f* (same value as C2).

3.1.3 DESIGN OF THE MICROCONTROLLER UNIT

The Microcontroller unit consist of the Atmege328p microcontroller, 16MHZ crystal oscillator and frequency stabilizing capacitors C4 and C5 as shown in Figure 3.4

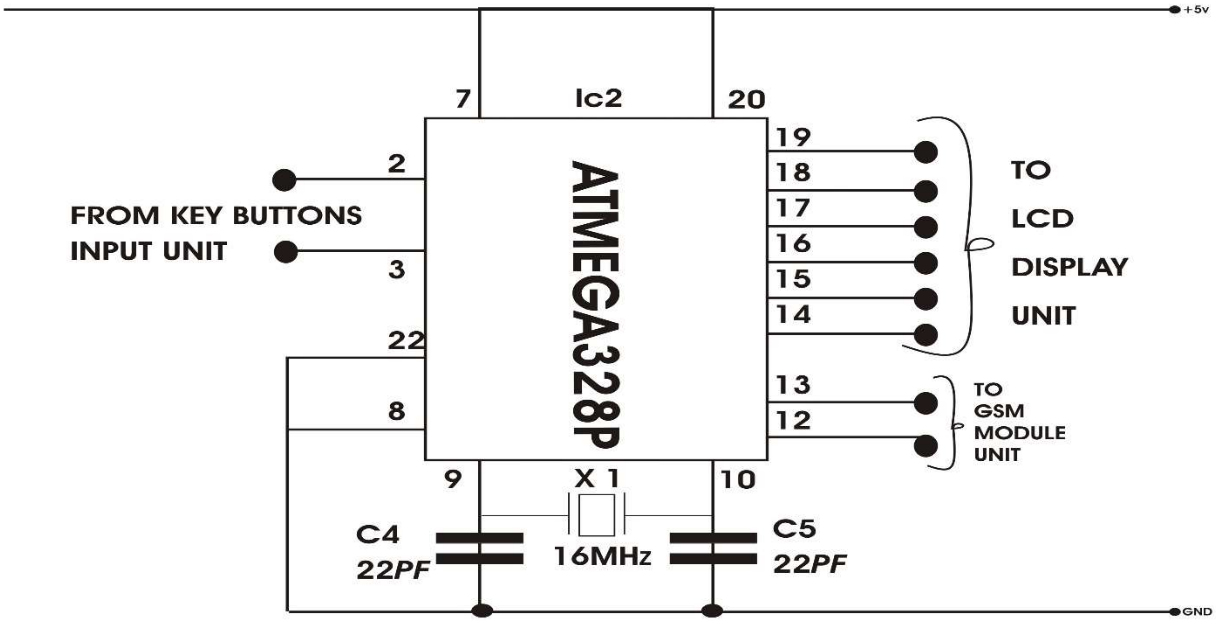

Figure 3.3: The microcontroller unit

The time of program execution by the Atmega328P microcontroller is given by,

Clock cycle, $T = \frac{1}{F}$ - 3.93

Where F = 16*MHZ*

$$\therefore\ T = \frac{1}{16MHZ} = \frac{1}{16 \text{ x } 10^6}$$

= 6.25 x 10^{-8}

$$\therefore\ T = 0.0625\mu s$$

The values of capacitors C4 and C5 were chosen to suite the time of program execution by the programmer using the Atmega328P microcontroller which are 22*pf* capacitors.

3.1.4 DESIGN OF THE GSM MODULE UNIT

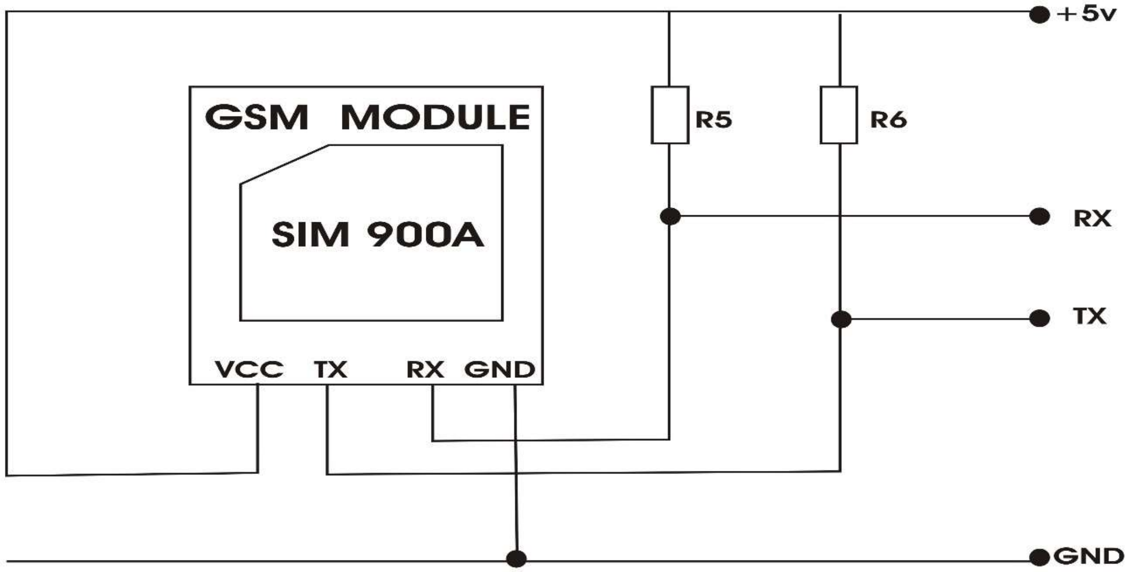

Figure 3.4**:** The GSM module unit

The value of resistor R5 is obtained using simple ohms law which is given by;

R5 = $\frac{V}{I}$ ---------------------------------- 3.94

R5 = $\frac{5}{1567.22mA}$

= 3.19kΩ

R5 = 3.19$k\Omega$

But a standard available close value of 3.2kΩ was used in the construction of the project.

The value of resistor R6 is also obtained using the same process,

R6 = $\frac{V}{I}$ ------------------------------------- 3.95

R6 = $\frac{5}{1567.22mA}$

R6 = 3.19$k\Omega$

This value is same as resistor R5 due to same configuration.

3.1.5 DESIGN OF LCD DISPLAY UNIT

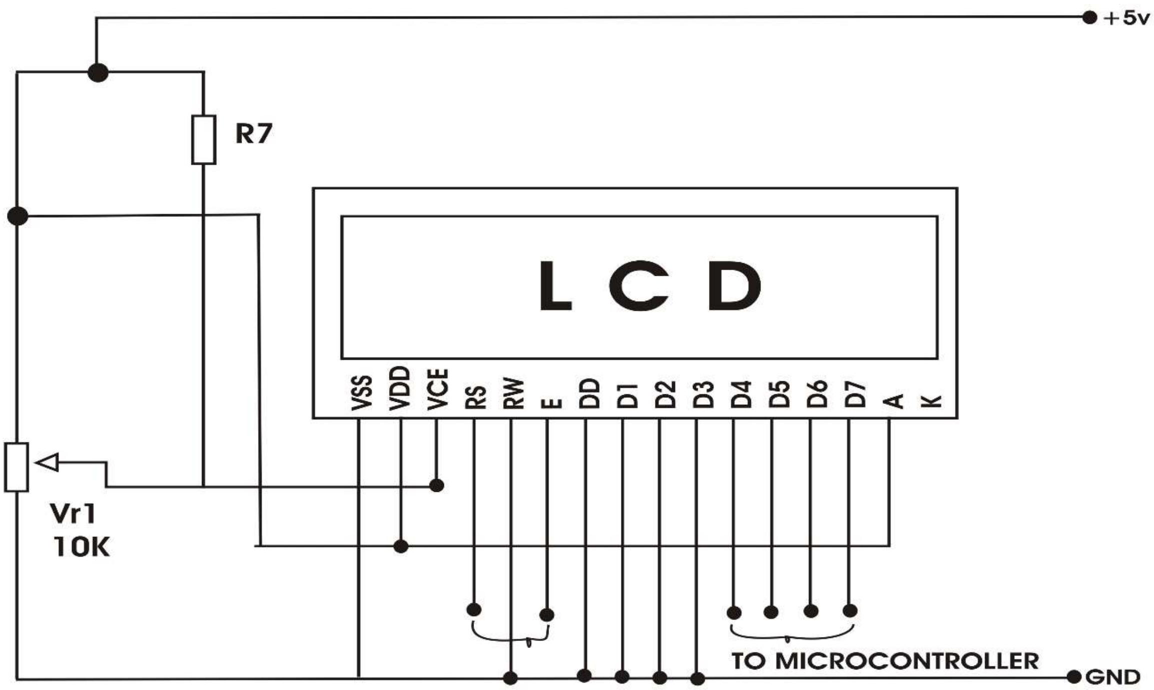

Figure 3.5: The LCD display unit

The value of resistor R7 is given by,

$$R7 = \frac{V}{I} \text{ - } 3.96$$

$$R7 = \frac{5}{1567.22mA}$$

$$= 3.19\text{k}\Omega$$

$$R7 = 3.1904k\Omega$$

3.1.6 THE COMPLETE CIRCUIT DESIGN

The complete circuit design for this project is compiled and designed from the interconnection of each section of the project which comprises of the power supply design unit, the GSM module design unit, the push button design unit, the microcontroller design unit and the LCD display design unit. The final circuit for the project construction is shown in figure 3.6

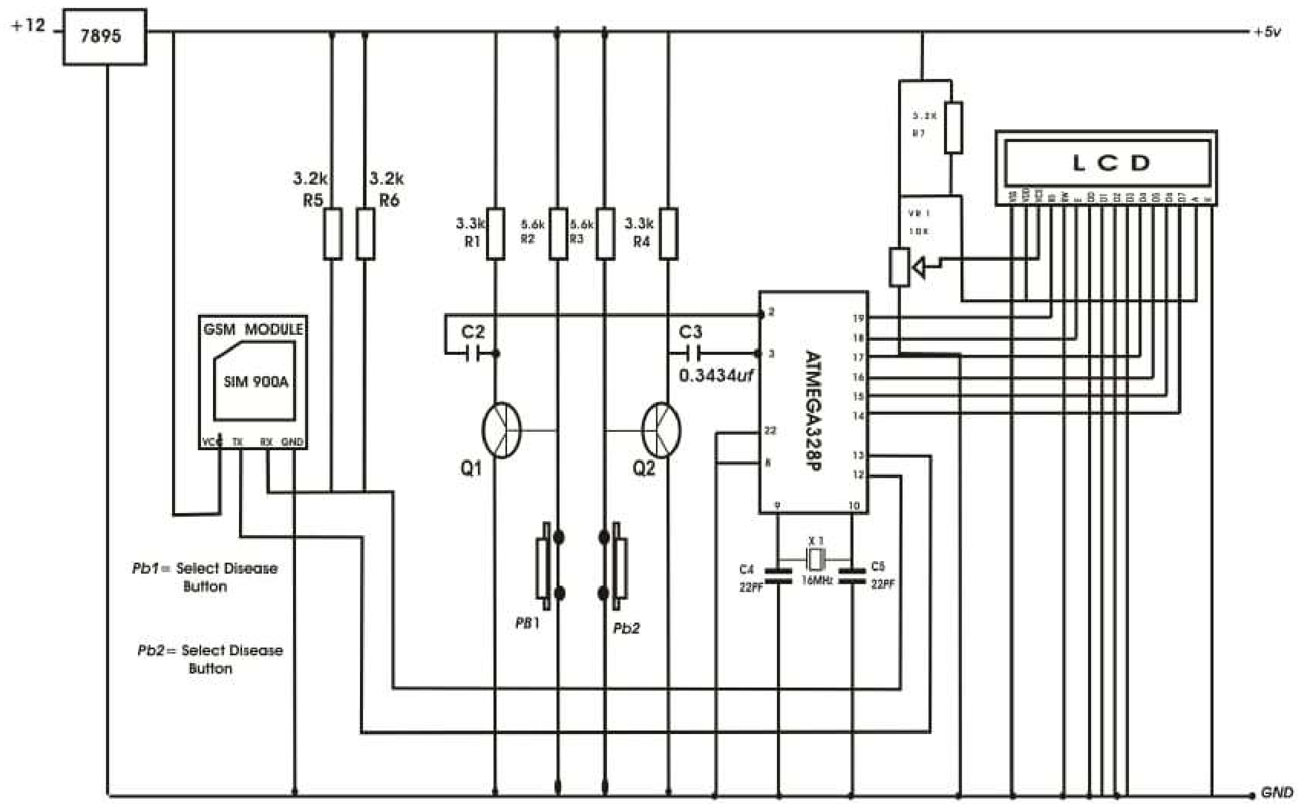

Figure 3.6: Sketched Design circuit.

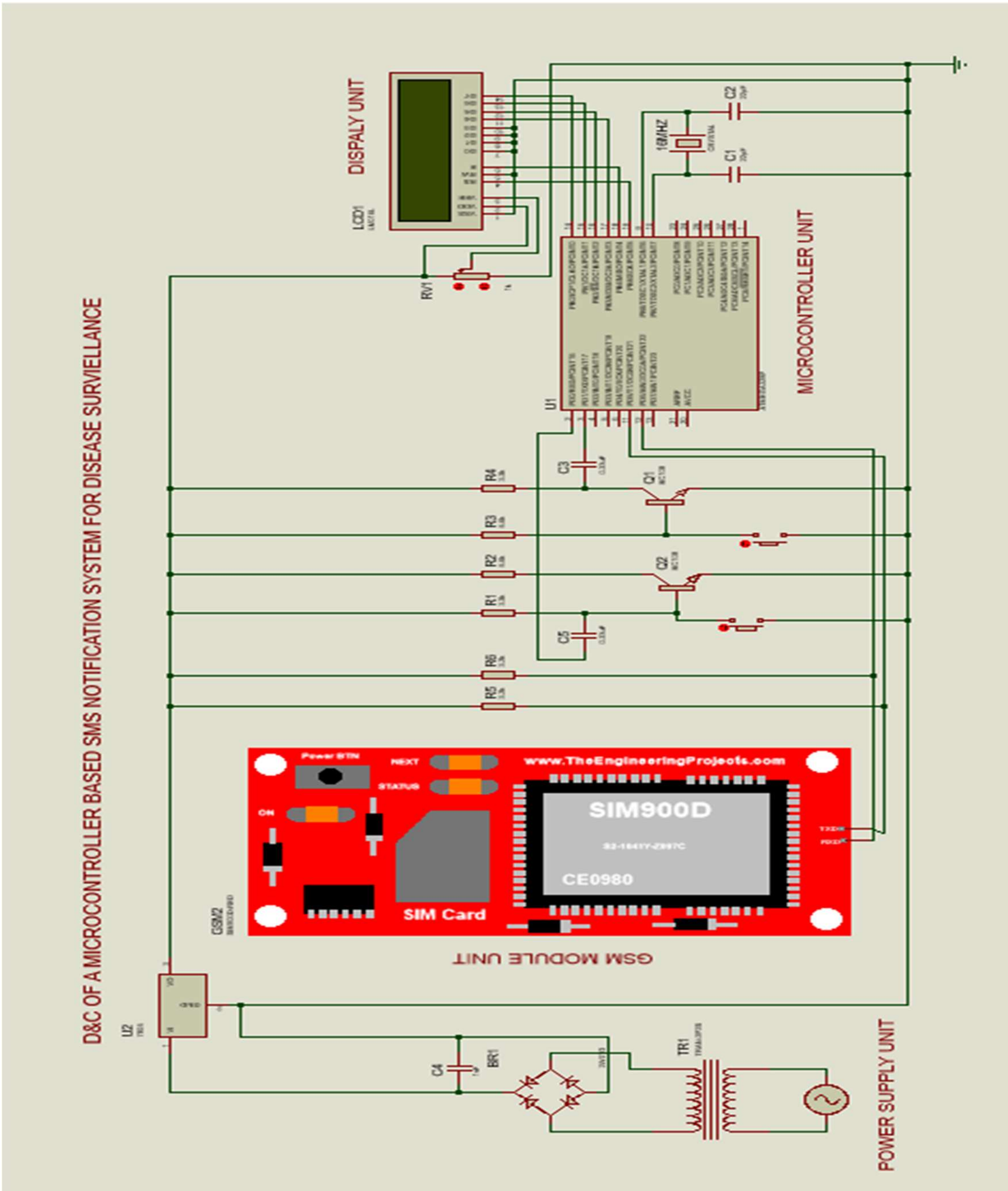
D&C OF A MICROCONTROLLER BASED SMS NOTIFICATION SYSTEM FOR DISEASE SURVIELLANCE
DISPALY UNIT
LCD1
RV1
U1
MICROCONTROLLER UNIT
16MHZ
C1
C2
C3
C5
Q1
Q2
R1
R2
R3
R4
R5
R6
www.TheEngineeringProjects.com
SIM900D
CE0980
SIM Card
GSM2
GSM MODULE UNIT
U2
C4
BR1
TR1
POWER SUPPLY UNIT

Figure 3.7: Proteus Simulation Design circuit.

3.1.7 THE ATMEGA328P MICROCONTROLLER

The Atmega328P microcontroller is a 28 pin, 8bits microcontroller with 32kb flash memory with read - while-write capabilities. The Atmega328P microcontroller used is shown in Figure 3.8

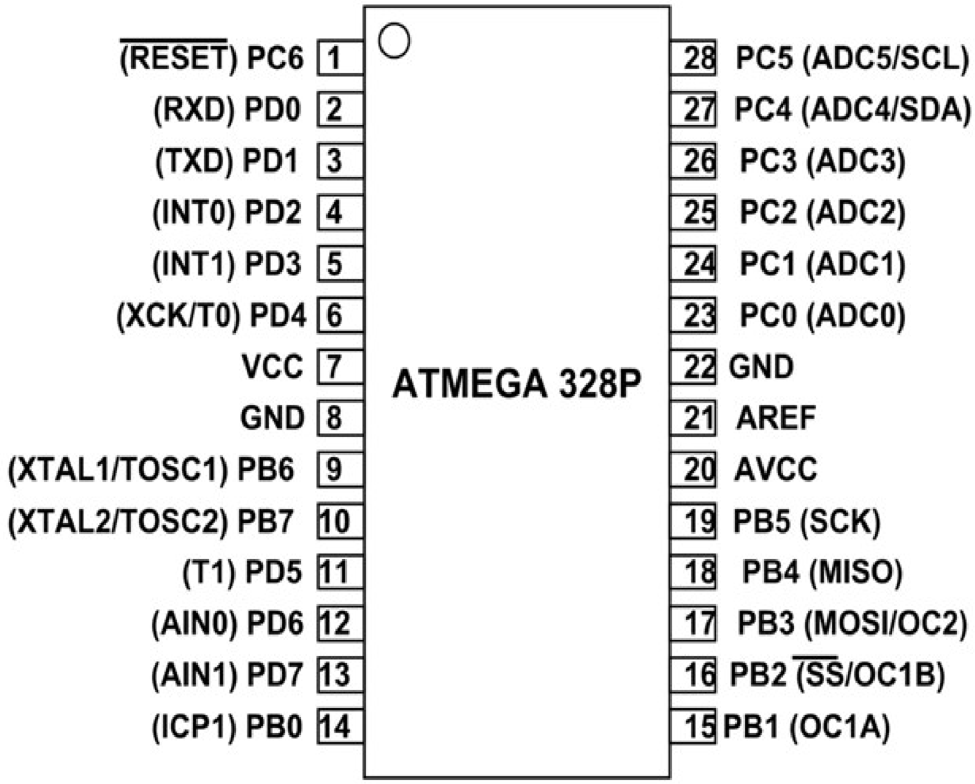

Figure 3.8: The Atmega328P microcontroller

The Atmega328P is also designed to have an endurance of 1000 write/erase cycles which means that it can be erased and programmed to a maximum of 2000 times without being damage or destroyed.

3.1.8 THE LM7805 VOLTAGE REGULATOR

The LM7805 voltage regulator is a fixed linear voltage regulator integrated circuit (IC). It belongs to the family of 78XX. The XX is replaced by two digits that indicate the output voltage. The 7805 has an output voltage of 5v, others like 7809 and 7812 have an output of 9V and 12V respectively. The LM7805 is shown in Figure 3.9

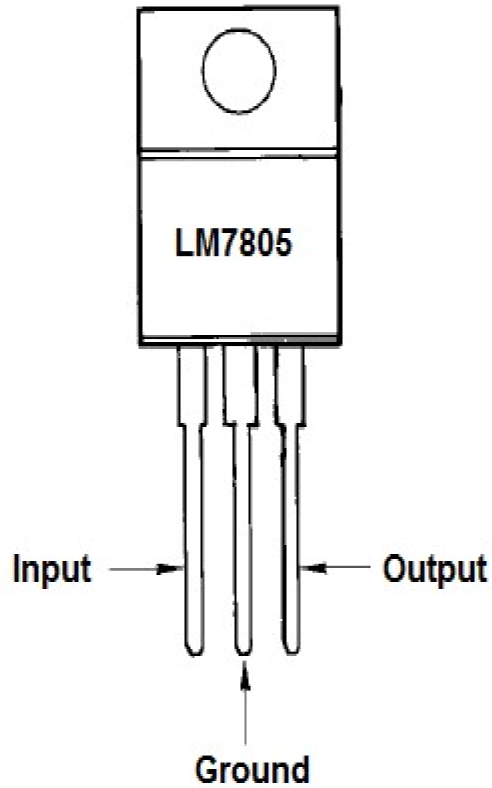

Figure 3.9: The LM7805 voltage regulator

The LM7805 voltage regulator supplies 5V to the Atmega328P microcontroller, the GSM module and other section of the project.

3.1.9 THE SIM900A GSM MODULE

A global system for mobile communication (GSM) module is an electronic device that allows a microcontroller or Arduino board to connect to a mobile network, the GSM module used for this project is a SIM900A GSM module which is shown in Figure 3.91

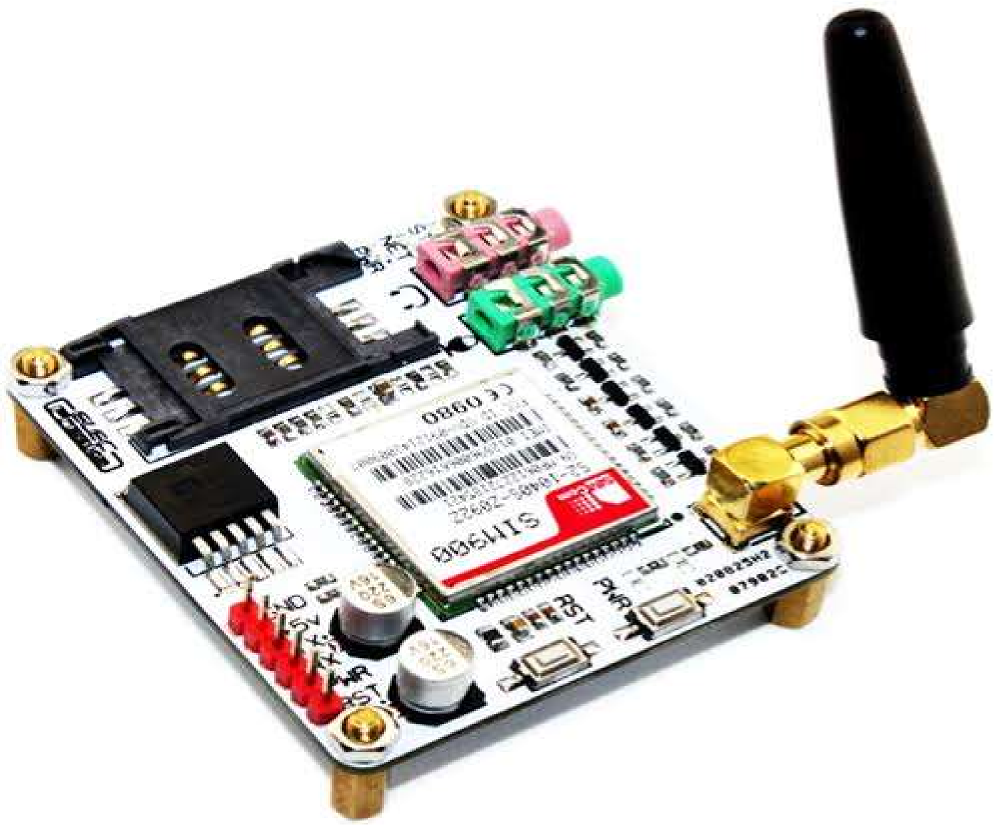

Figure 3.10: The SIM900A GSM Module.

The SIM900A GSM module was chosen for this project due to its low power consumption and its simplicity in connecting to the GSM mobile phone network. Other GSM module such as SIM800L and SIM300 are also available.

3.1.10 LIQUID CRYSTAL DISPLAY (LCD)

LCD-Liquid Crystal Display is an electronic device for displaying text or characters. We are using 16 pin LCD. 16 by 2 represents 16 characters and 2 line display. LCD's are economical and easily programmable and can easily display special and custom characters Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. The liquid crystal display is shown in figure.3.11

Figure 3.11: The Liquid Crystal Display

3.1.11 THE CRYSTAL OSCILLATOR

The crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is often used to keep track of time, as in quartz wristwatches to provide a stable clock signal for digital integrated circuits and to stabilize frequencies for radio transmitter and receivers. In this project, a 16MHz crystal oscillator is used to drive the microcontroller. The crystal oscillator is shown in figure.3.93

Figure 3.12 The Crystal Oscillator.

3.1.12 THE PUSH-BUTTON

A push button is a simple switch mechanism for controlling some aspect of a machine or a process, Buttons are typically made out of hard material usually flat or shaped to accommodate the human finger or hand so as to be easily depressed or pushed. Buttons are most often biased switches, although many un-biased button still require a spring to return to their un-pushed state.in this project construction two push buttons are used, one is used to switch among the diseases and select the surveyed disease, while the other one is used to send SMS for disease notification. The push button is shown in figure.3.94

Figure 3.13: The Push Button

‘

3.1.13 SOFTWARE DEVELOPMENT/DESIGN

This project construction consist of two major parts, i.e. the “Hardware” which made up the microcontroller, voltage regulators, LCD display, GSM module etc. and the “software” which is a program that controls the Hardware of the entire project which is the Atmega328P in this case.

The software is a computer program called “source code”. In computing, source code is any collection of computer instructions written using some human-readable computer language usually as text. The source code of a program is specially designed to facilitate the work of computer programmers, who specify the actions to be performed by a computer mostly by writing source code.

The source code cannot be executed directly by the microcontroller or many other computer machines unless it is compiled into a lower level machine language such as an “object code” or (hex file). The compiler used for compiling the source code for this project construction is the Arduino Integrated Development Environment (IDE) compiler.

4.0 RESULTS

The results of the components used are shown in table 4.1

Table 4.1 Results of component used

COMPONENTS USED	**DESIGN VALUE**	**STANDARD VALUE**	**MEASURED VALUE**
RESISTORS			
R1 R2 R3 R4 R5 R6	3.062KΩ 5.62KΩ 5.62KΩ 3.062KΩ 3.19KΩ 3.19KΩ	3.3KΩ 5.6KΩ 5.6KΩ 3.3KΩ 3.2KΩ 3.2KΩ	3.21KΩ 5.59KΩ 5.57KΩ 3.25KΩ 3.17KΩ 3.19KΩ
CAPACITOR			
C1 C2 C3 C4 C5	2216.46µf 0.3134µf 0.3134µf 22pf 22pf	2200µf 0.4µf 0.4µf 22pf 22pf	2197.7µf 0.387µf 0.387µf 21.89pf 21.97pf
TRANSISTOR			
	NPN	NPN	NPN
Q1 & Q2	β = 200	β = 200	β = 196
CRYSTAL OSCILLATOR	16MHz	16MHz	15.9MHz
GSM MODULE	+5V	+5V	+4.9V
LCD DISPLAY	+5V	+5V	+4.92V
LM7805	+5V	+5V	+4.95V
Atmega328p	+5V	+5V	+4.93V

The results of tested power supply unit of +5V and +12V for output voltage under no-load and full-load conditions were as follows:-

I. Under no-load: the voltage of +5V supply section was measured to be 4.95V, while that of +12V supply is measured to be 11.89V

II. At full-load: the +5V supply section was measured to be 4.85V and that of the +12V section was measured to be 11.41V.

Therefore, voltage Regulation (V.R) is given as:

V. R = (V_{NL}-V_{FL})/V_{NL} X 100% -4.1

Where,

V_{NL}=No-load voltage

V_{FL}=Full-load voltage

For units operating on +5V

V. R = (4.95-4.85)/4.95 X 100%

V. R= 2.02%

For unit operating on +12V

V. R = (11.89 - 11.41)/11.92 X 100%

V. R = 4.03%

From the results obtained above, the performance of the power supply unit is satisfactory.

The whole project circuit was coupled together and tested as a single unit and the result is shown in table 4.2

Table 4.2 Test results of the project

BUTTON 1 (select Disease)	**BUTTON 1 (select Disease)**	**GSM MODULE STATUS**	**LCD DISPLAY UNIT**	**GSM MOBILE PHONE (SMS)**
NONE	NO	OFF	NO DISEASE DETECTED	NO SMS RECEIVED
MALARIA OUTBREAK!	YES	ON	“MALARIA OUTBREAK! BEWARE!!!”	SMS RECEIVED
CHOLERA OUTBREAK!	YES	ON	“CHOLERA OUTBREAK! BEWARE!!!”	SMS RECEIVED
MENINGITIS OUTBREAK!	YES	ON	“MENINGITIS OUTBREAK! BEWARE!!!”	SMS RECEIVED
LASSA FEVER OUTBREAK!	YES	ON	“LASSA FEVER OUTBREAK! BEWARE!!!”	SMS RECEIVED
MEASLES OUTBREAK!	YES	ON	“MEASLES OUTBREAK! BEWARE!!!”	SMS RECEIVED

4.1 DISCUSSIONS

The table 4.2 shows the working process of the microcontroller based SMS notification system for disease surveillance. When the project is powered ON the LCD displays "NO DISEASE DETECTED" and no SMS is sent to the mobile phone. Now, if a disease is selected such as Malaria, cholera, Meningitis etc. and send it using the send Button or can be sent automatically after 5 seconds. Then the LCD displays the selected disease and the mobile phone receives it as a SMS text.

The pictorial view of the final project construction as the time of testing is clearly shown in the figure 4.1

Figure 4.1: The final project construction

The pictorial view of the SMS received from the GSM module for all the five (5) sample diseases used for the construction to make a notification is clearly shown in the figure 4.2

Figure 4.2: Screenshot of SMS received

CONCLUSION

The design of microcontroller based SMS notification system for disease surveillance comprises of two push buttons, one is used to select the disease and the other is used to send an SMS for the selected disease to create awareness whenever an outbreak occurs. This is achieved with the aid of the GSM module (SIM900A) used, which is responsible for sending the SMS when connected to the mobile network, it runs base on the AT command (attention command) that work on the UART protocol to send the desired SMS text to the designated phone numbers.

This design work is meant to design and implement a microcontroller based SMS Notification system for disease surveillance. At the end of the project, this aim is was achieved because an SMS of the selected disease is received by the designated Mobile phone numbers.

The Microcontroller based SMS notifications system for disease surveillance is capable of sending five(5) types of different communicable disease outbreak which include MALARIA, CHOLERA, MENIGINTIS, LASSA FEVER as well as MEASLES to 10 different mobile phone users. For further design enhancement of this project, the following recommendations should be considered,

i. The number of government identified priority disease to be send to make notifications should be more than five (5) as used in this project.
ii. The number of recipient who will receive the SMS text notification for the outbreak should also be increased to be more than ten(10) as used in this design

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