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RESEARCH ARTICLE

A Smart IoT-Based Healthcare Model for Cholera Observation (SIHCO)

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ABSTRACT

The Internet of Things has played an important role in the field of health care and many solutions for health care people from the elderly, people with special needs, and patients with chronic diseases, by monitoring health care through wearable devices or remote monitoring devices. To test a model to monitor cholera patients from entering into a dangerous situation that may lead to fulfillment by monitoring patients and monitoring the environment surrounding patients This model consists of several components that can be divided into inputs, which are the devices through which data are received and collected; the Arduino control unit performs the processing process, in addition to linking the input devices (sensors) to the output devices and communication devices, as well as explaining and clarifying the components and devices. The values were taken in three stages at different times and by generating them randomly by the pot-HG data entry used in the model, and it was noted that there were actual values through the SIHCO model for each of the MAX10300 extractors used to measure systolic and diastolic blood pressure mercury, as well as the heartbeat and determine its mechanism of action based on the specific symptoms of cholera or diseases that contain similar symptoms, and the MQ-2 sensor responsible for examining toxic gases that have an effect was also displayed. The model proposed in this study provides checking the q (HB) through the heart rate sensor and measuring the blood pressure (PB) through the sensor MAX30100 as well as examining the environment surrounding patients, whether it is the intensive care rooms or the inpatient room, this model works by Arduino with the Proteus program through which the model was designed.

INTRODUCTION

Modern technology is revolutionizing various sectors, including education and healthcare. In education, tools such as online learning platforms and interactive software are making education more accessible (Al-khresheh et al.,2024; Mohamed et al., 2024; Mohamed, 2023; Mohamed et al.,2023). Particularly the Internet of Things (IoT) is revolutionizing various sectors, including education and healthcare. The Internet of Things (IoT) and intelligent equipment are a rapidly evolving model that transforms traditional life into a high-tech style by integrating hardware, software, hardware, and computing for data exchange and communication (Ullah et al., 2024). This includes health care for people with special needs or those with chronic diseases and their needs for remote care and monitoring (Tai et al., 2024). The rapid increase in development, the lack of access to medical resources, and the desire for telemedicine in low- and middle-income countries made the IoT an interesting topic in the field of healthcare systems (Ullah et al., 2024). The IOT provides many health services that help improve the quality of life, on the one hand, others The Internet of Things still faces many challenges and issues that need to be addressed to achieve its full potential (Tai et al., 2024)This document is a The Internet of Things (IoT) and Intelligent equipment's are a rapidly evolving model that transforms traditional life into a high-tech style by integrating hardware, software, hardware, and computing for data exchange and communication. This includes health care for people with special needs or those with chronic diseases and their needs for remote care and monitoring. The rapid increase in development the lack of access to medical resources, and the desire for telemedicine in developing countries made the Internet of things an interesting topic in the field of healthcare systems. The Internet of things provides many health services that help improve the quality of life, on the one hand, others The Internet of Things still faces many challenges and issues that need to be addressed in order to achieve its full potential. Cholera is a highly contagious disease and is endemic in many parts of Africa, Asia and conflicting countries. The war has led to an increase in environmental pollution due to long wars, and the past few years have witnessed an outbreak of cholera in Yemen.

The patient becomes infected with cholera by drinking contaminated water and beverages or eating contaminated food (Subchan et al., 2019), The transmission of cholera is also associated with inadequate access to safe drinking water and a lack of healthy living conditions. Areas with semi-urban camps are at risk of disease because people do not have clean water and proper sanitation facilities there. The consequences of any humanitarian crisis can increase the risk of cholera transmission due to exposure to cholera bacteria. Infected carcasses have not been reported as a source of the epidemic. According to the World Health Organization, cholera cases have been increasing continuously for several years. For example, in 2017, approximately 1,227,391 cases were reported in 34 countries, including 5,654 deaths (Romero-Leiton et al., 2021).The disease continues to spread in Yemen today in what has become the largest documented cholera epidemic in modern times. According to the report of the Yemeni health authorities, it is estimated that from September 28, 2016, to March 12, 2018, 113,683 suspected cholera cases (attack rate 3-69%) and 2,385 deaths (risk of death 0-22%) were reported across the country. The epidemic consisted of two distinct waves with an increase in transmission in May 2017, consistent with an average Rt of more than 2 in 13 of 23 governorates. Microbiological analyzes suggested that the same strain of Vibrio cholerae O1 Ogawa spread in both waves. We found a positive, nonlinear association between weekly precipitation and suspected cholera in the following 10 days; The relative risk of contracting cholera after a week of 25 mm 1424 rainfall (95% CI 131-155) compared to a week without rain (Camacho et al., 2018).Cholera is a disease that continues to pose a threat to public health globally and is an indicator of inequality and a lack of social development in countries. For this reason, control strategies must be investigated. In this work, the optimal control problem related to cholera is formulated by creating and designing a model based on IoT and Arduino board to monitor patient health. The effectiveness and efficiency of the proposed controls were determined through a cost-effectiveness analysis. The results showed that patient monitoring is the most adequate, cheapest, and most effective form of disease control (Adewole & Faniran, 2022).

The Internet of Things (IoT) is a new paradigm that has transformed the traditional way of life into a high-tech way of life. Smart cities, smart homes, pollution control, energy savings, smart transportation, and smart industries are among these transformations due to the Internet of Things. Many important thesis studies and surveys have been conducted to advance technology through the Internet of Things. However, the Internet of Things still faces many challenges and issues that need to be addressed to realize its full potential. Therefore, these challenges and issues must be viewed from various aspects of IoT such as applications, challenges, enabling technologies, social and environmental impacts, etc.

The Internet of Things (IoT) is a network in which many devices are connected, and these devices can communicate over the network. Through this global network, we can get information through sensors related to it. Using the network, we can access this information anywhere in this world. The Internet of Things can connect physical objects to the Internet and can provide an opportunity to build systems based on different technologies such as Near Field Communication (NFC) and Wireless Sensor Network (WSN). Sensors in the wireless sensor network sense the environment and send information to the base station(Hameed et al., 2020).

There are many different methodologies in IoT such as healthcare systems, monitoring environments, IoT-based irrigation systems, smart healthcare systems, and traffic control. In the healthcare system, the Internet of Things provides a tool for health monitoring. Health data can be accessed with the help of the Internet of Things using sensors. Health care is a system used to improve health and help treat diseases Health-related problems or complications are increasing day by day, among them problems related to chronic diseases or widespread and growing epidemics(Landaluce et al., 2020).Wireless technology has helped in health monitoring through the use of various technologies such as wearable sensors, portable telehealth, wireless communication, and expert systems (Kumar et al., 2020). Because of the lack of sanitation, awareness of diseases, and adequate access to healthcare systems, people are losing their lives. In any case, the Internet of Things (IoT) helps detect diseases and treat patients. Conflicting countries need to develop health models that contribute to reducing the spread of diseases such as cholera and limiting its spread through the Internet of things technology and telemedicine. Telemedicine refers to the practice of remote patient care when the provider and patient are not physically present with each other (Manning & Gillespie, 2022).Telemedicine is simply defined as "the delivery of health care services from a distance". Although telemedicine brings with it many benefits, it has some downsides as well(Syed et al., 2021). In this study, we contributed to the establishment of Model in order to monitor infected patients with chlorosis to maintain their health condition and not to go out to the dangerous state by monitoring dangerous symptoms. Cholera disease has many symptoms divide in two parts common symptoms (watery diarrhea, nausea/vomiting, dehydration) and severe symptoms(low blood pressure and rapid heart rate), In this model we are dependent on the severe symptoms of cholera only (low blood pressure and rapid heart rate) that monitoring patient to that's infected by cholera This model is designed to monitor the health status of patients by monitoring blood pressure, and heartbeat, and since these symptoms are dangerous symptoms for people with cholera, this model works to monitor these symptoms in addition to monitoring and examining the environment surrounding patients by examining methane gas, liquefied petroleum gas or carbon dioxide and alerting that the surrounding environment is healthy and unpolluted. This model also works to display the results through various means of display such as screen, virtual terminal, oscilloscope, and this model can be developed in the future to send data through the Android application to send critical results to the doctor or hospital or to the Ministry of Health.

I. PROPOSED MODEL DESIGN

A. Research gap analysis

Based on the comparison between previous studies and mentioned in Table 6 and our study of IIHTs, the researcher touched on building a model based on observing patients through heart rate symptoms using Arduino. Establish a bridge of communication between patients and caregivers/physicians involved, but he uses only his system to monitor the heartbeat. The researcher (Bhuyan & Sarder, 2021) also presented the design and simulation of oxygen pulse examination and data analysis using the Arduino and Proteus simulation software and focused on the measurement of oxygen saturation. As Digarse and Patil (2017) developed a new approach with Arduino for monitoring heart rate, blood pressure, and pressure, and used the Arduino IDE software with the Think speak platform to monitor blood pressure and heart rate without determining the symptoms. The Author (Islam et al., 2020) presented a system to monitor the heart rate, body temperature, and room temperature, but did not mention the exact disease that the system monitored. The Bharath Singh J, et al., 2021) Presented a model for water quality problems to prevent the spread of diseases, such as cholera and typhoid, but his model did not focus on cholera symptoms.

The IIHTs model focuses on monitoring the infected case with cholera according to the symptoms of cholera as low blood pressure and fast heart rate pulse, which is very dangerous for cholera patients and may cause death; the environment surrounding the patient affects the cholera patient, so the IIHTs check the gases of the environment and alarm the doctor if healthy or unhealthy. Across form

B. The research contribution

Researchers have made many contributions to health care, the Internet of Things, and themonitoring of patients with special needs, the elderly, and those with chronic diseases (Adewole and Faniran, 2022 & Romero-Leiton et al., 2021). Analyzed and treated cholera and detected environmental pollution to reduce the spread of the disease by examining standing water or environmental pollution (Zade et al., 2018 & Leo et al. 2019). Researchers (Jaber et al. 2022), (Paganelli et al., 2022) & (Akbarzadeh et al., 2021) have also been provided in the field of healthcare system monitoring of COVID-19 patients to reduce the spread of the disease by monitoring patients remotely without approaching infected people using IoT technology. Through the results of previous studies, in this research, we found that there is a gap in the field of health care for those who are infected with cholera and need to monitor their health care, either in hospitals or homes, by providing a model that contains three layers: the patient's health status is monitored by tracking the dangerous symptoms of low blood pressure and increased heartbeat using sensors, monitoring the environment surrounding patients, and verifying the absence of gases. Toxic substances such as methane and carbon dioxide may further aggravate the patient's condition.

This study makes the following important contributions:

- Developing a monitoring model for health care services using Arduino Uno.
- Building a programmable model through dynamic integration, configuration, and control of clinical sensors in the field of health care and their systems.
- We implemented a prototype of the model and evaluated it through the Proteus system and the Arduino Uno system

C. Research Methodology

Our first task was to identify health complications associated with cholera surveillance. Once we did, we looked for sensors to detect these issues and start working on the system. The system's orientation is centered on three stages, through which we seek to cover the health aspects of the patient and monitor the health status at the same time. The model examines the surrounding environment of patients by sensing gas tracking, which facilitates the maintenance of a clean environment through the MQ-2 gas sensor. The model also monitors the symptoms in patients, which may be very dangerous symptoms that need to be monitored continuously for patients and display the results and warnings through multiple screens or graphs and displays for each state of the environment, heart rate, blood pressure, or oxygen saturation in the blood, when the symptoms approach the expected risk of patients.

We integrated the following sensors: a heartbeat pulse (HBP sensor), Oxygen Oximeter (spo2 max30100edf) sensor), gas detection sensor (MQ-2), and ESP826an 6 sensor connected to an Arduino Uno. These sensors are used to measure the heartbeat pulse and Environment and MAX30100 for heart rate and SPO2 measurements.

The sensors ESP8266 used to sense data are collected and transferring it to the cloud server so that the data can be accessed by users with smart devices and computers, enabling doctors to make a decision. The LCD monitor was connected to an Arduino Uno and displayed the value of the environment.

This model works using the Proteus program and has been linked using the Arduino so that it works as a simulation of the physical reality hardware, all sensors and electrical circuits are defined and linked in the Proteus program and then the libraries of these sensors are called to the Arduino program with the definition of the virtual port of the linking process so that we can send the results to the output devices. All steps will be in Appendix A.

D. Proposed model Aarchitecture

To perform health analyses of people with cholera blink, we need to design a structure that is standard enough to process many types of data, such as blood pressure, heart rate, and environmental data surrounding the patient. This model contains the inputs, or what we call the sensor dome or input layer; then, the data are analyzed and processed through the Arduino, and the data are displayed through multiple projectors, the local display, and sending the data to the cloud (Figure 1).

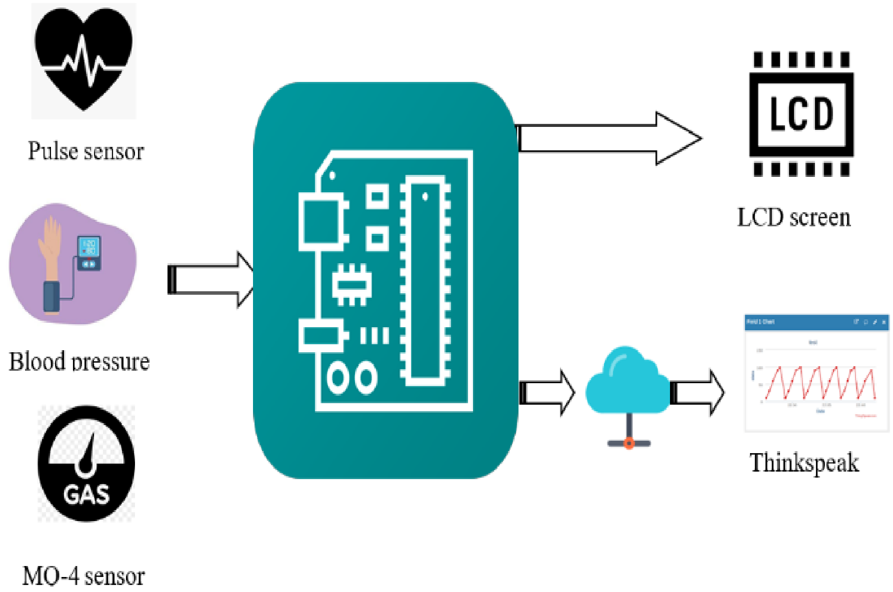

Figure 1: Proposed model architecture

E. Proposed model design

The proposed model will be described, hardware components and their main functions will be explained and the design process flow will be described as in the figure 2.

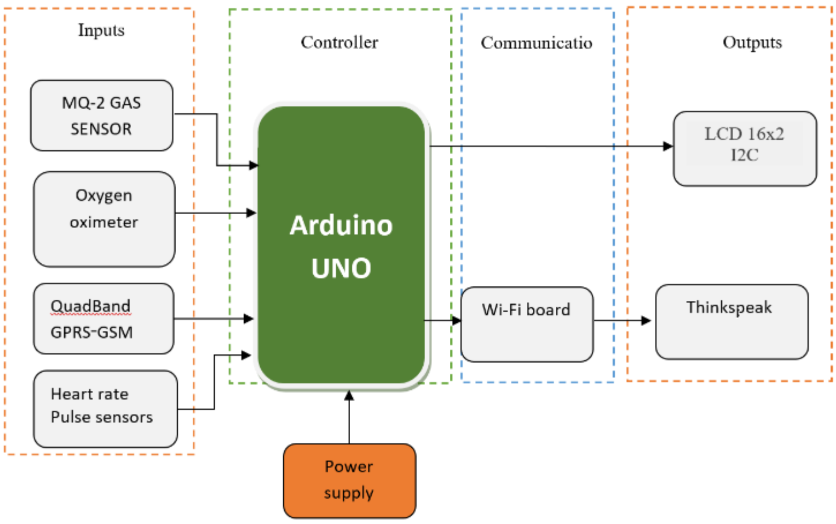

Figure 2: Proposed model diagram

F. The proposed model components

THIS MODEL CONSISTS of several components that can be divided into inputs, which are the devices through which data are received and collected; the Arduino control unit performs the processing process, in addition to linking the input devices (sensors) to the output devices and communication devices, as well as explaining and clarifying the components and devices.

G. Proposed model Inputs

The input devices are the main part of this model, through which we will enter blood pressure data by the blood pressure sensor (MAX10300), as well as the pulse rate by the pulse rate sensor, as well as examine the environment surrounding patients through the MQ-4 sensor, as explained in this section.

H. Blood pressure

Recently, considerable research has been conducted to develop a reliable system for measuring continuous blood pressure. Discovering a critical level of blood pressure in patients means that it is necessary to continue measuring pressure, and there are blood pressure measurement techniques such as oscilloscope, gold standard technique, and push-to-talk technique (PTT) that cannot be relied upon.

I. Heart rate

The heart rate is the number of heart beats per minute and it must be within a certain range in order to determine the normal range for it (Table 1). An increase or decrease in the heart rate has a very significant impact on the heart and on all parts of the body. The number of beats ranges between 60 and 100 beats per minute (bpm) in adults and differs in adults. Athletes and the elderly, and the heart rate may reach less than 60 sometimes bpm. (Ali M.M. et al 2020).

Table 1: The normal resting heart rates at different ages according to the NIH

Ages	Normal heart rate (bpm)
Up to 1 month	70 -190
1 to 11 months	80 - 160
1 to 2 years	80 - 130
3 to 4 years	80 - 120
5 to 6 years	75 - 115
7 to 9 years	70 - 110
Over 10 years	60 - 100

J. Pulse rate sensor

The pulse sensor is one of the important sensors for measuring the blood pulse and monitoring the heartbeat by detecting the blood flow and analyzing it into digital signals by placing it on the tip of the finger or the ear just above the vein (figure 3 & table 2). The pulse sensor has three pins and an LED in the center of the sensor unit. There is also a circuit to remove noise that may affect the sensor readings (Pendurthi et al., 2021).

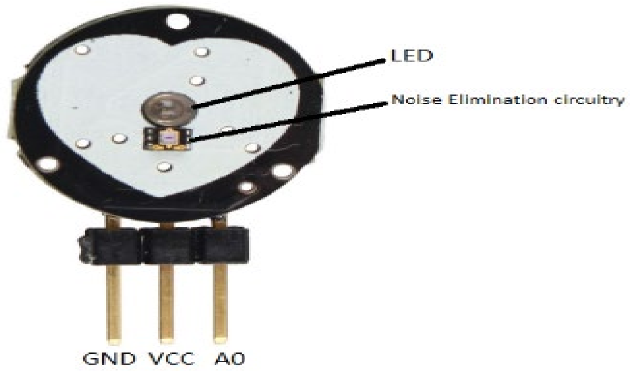

Figure 3: Pulse rate sensor pinout.

Table 1: Pulse rate sensor pin configuration

Pin number	Pin name	Wire color	Description
Pin 1	Ground	Wire with Black Color	connected to the GND terminal
Pin 2	(VCC)	Wire with Red Color	connected to the supply voltage (+5V, +3.3V)
Pin 3	(Signal)	Wire with Purple Color	connected to the pulsating o/p signal.

K. Gas sensor

The MQ-4 is a toxic gas detector sensor is one of the most important sensors that detect toxic gases such as carbon monoxide, methane, and liquefied petroleum gas (Table 3). It converts analog signals into digital data by an analog converter that was built into the PIC, and then the names of the gases are displayed on the output devices associated with the system from In percentages according to the program conditions, the gas sensors (MQ-4, MQ-2, MQ-7) are used to detect gas leaks at smaller or larger levels. (Bangade et al., 2016).

Table 2: Specifications of gas detector sensors

Model No.	MQ-4
Type of Sensor	Semiconductor
Detect Gases	Natural gas, Methane gas
available space	200-1000ppm

L. Controller

The Arduino controller is an important part of the management and connection of input and output devices and communication devices, and this controller works to process data and display the output devices connected to it directly or through wireless means of communication the following is an explanation of the components of this Arduino chip and its components:

M. Arduino board

Arduino Uno R3 is one of the programmable Arduino platforms used to develop applications that run in a standalone environment or a connected environment (Figure 4). This chip can be programmed using the Arduino Integrated Software Development Environment (IDE). This chip is used in all areas that can be controlled by connecting a lot of sensors and programming them to perform different tasks or purposes in the educational, medical, agricultural, environmental and other fields.(*Arduino Uno Board*).

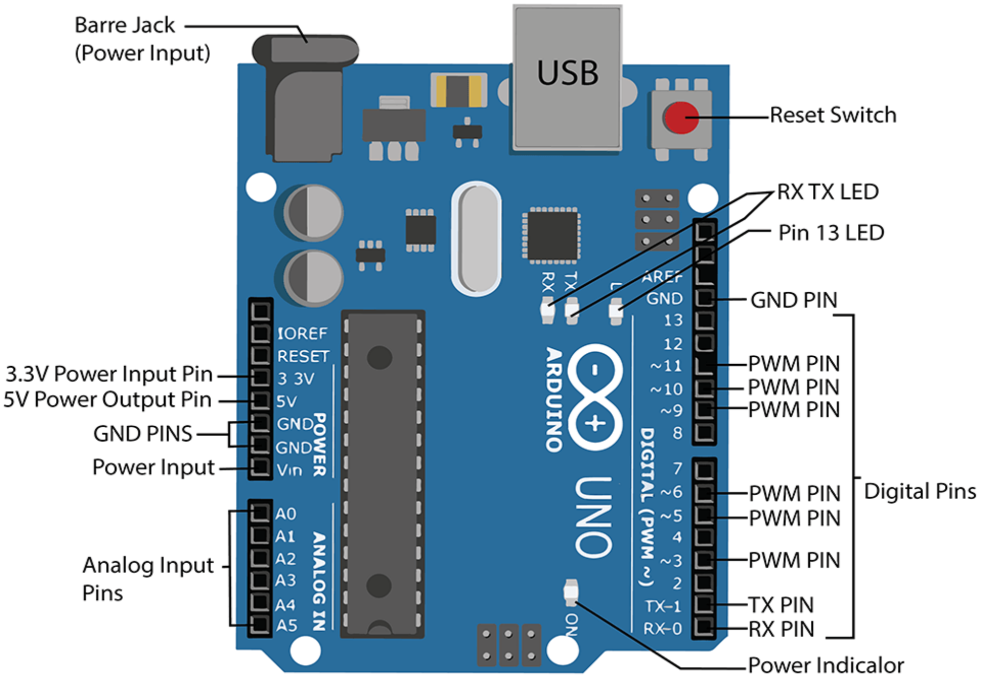

Figure 4: Arduino UNO board (*Arduino Uno Board*)

N. Proposed model outputs

This section shows the output tools used in the proposed model.

O. *LCDs*

The LCD display is one of the output units that are used to display information or output from the Arduino microcontroller, which differ in sizes and types and may be either 4-bit, which requires seven input and output pins from Arduino, or 8-bit, which requires 11 pi (Figure 5).

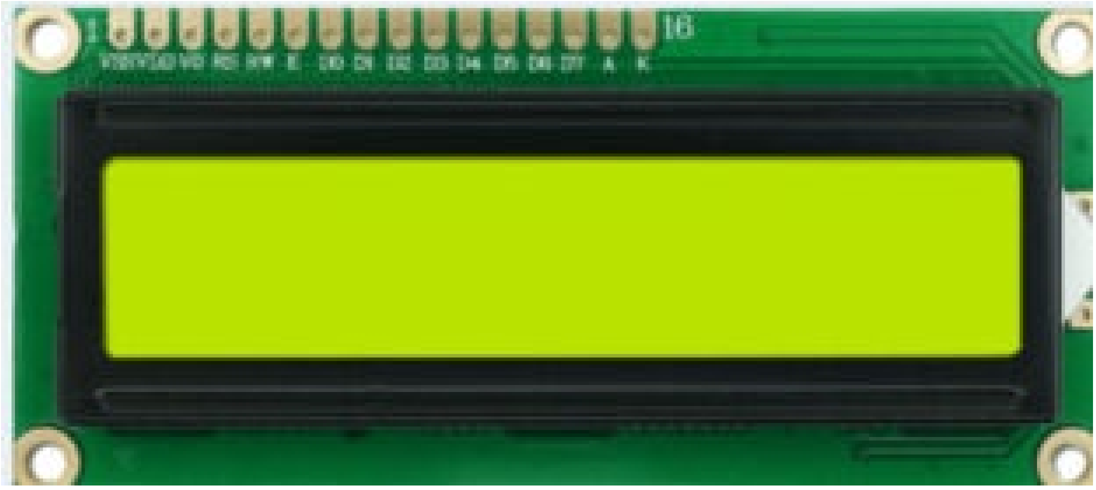

Figure 5: LCD

P. Virtual terminal

The virtual terminal is a tool in Proteus that is used to display data coming from the serial port and send it to the serial port through a built-in tool called Hyper Terminal that is used to connect Proteus to Arduino to display the output on the virtual terminal (O. Olamide 2012)

Q. Oscilloscope

Proteus provides an oscilloscope, which is one of the basic tools used for the purpose of analysis. It has four input channels and a frequency of 2MHz for sampling (Shakhreet and Shakhreet - 2015).

R. Performance metrics

In this paper, we tried to s a low-cost monitor for Cholera patients through blood pressure and heart rate sensors and examining the patient's environment and dormitory room. In this system, it is possible to measure blood pressure and heart rate, continuously scan the patient's inpatient room, and be treated in time for severe disease. Actual vs. estimated heart rate data is displayed over a repeated period within 24 hours, and it is said that this monitor provides a lot of support to know the patient's current condition if there is no doctor or clinic nearby.

S. Blood pressure measurement

Systolic, and diastolic blood pressure and bias level for each measurement of blood pressure of essential measures in this work, accuracy is to compare the prediction of recommendations and results, and recall and deviation or bias, when the doctor takes the patient's blood pressure using the mercury meter, he does not care whether the patient suffers from (82/123 mm Hg, or 79/121 mm Hg) but the doctor's attention when the patient suffers from (82/123 mm Hg or 97/136 mmHg) so here the exact accuracy is less essential. Still, his prediction must be typical and often correct. Doctors may not trust such devices that work on learning algorithms that produce whether blood pressure is "normal" or "high" without reference to close measurement of the patient, and this is the most realistic professional goal for doctors, so accuracy is the predictive value of the region and positive, in SIHCO model we take the values that are and determine the low blood pressure significantly through the sensor Mx10300, which calculates systolic and diastolic blood pressure.

T. Heartbeat measurement

Rapid heartbeat or low level dramatically affects the patient's health, resulting in other symptoms; bradycardia is a decrease in the speed of the heartbeat. In adults at rest, the heart rate is usually between 60 and 100 beats per minute. Therefore, the heart rate is less than 60 beats per minute, so the heart cannot pump enough oxygen-rich blood to the body's organs, leading to severe weakness, shortness of breath, fatigue, and other non-critical symptoms. A rapid heartbeat of more than 100 beats per minute may lead to multiple heart disorders.

The SIHCO model continuously and systematically 24/7 monitors the rapid and low heart rate of cholera patients.

U. Environments measurement

Air purity from toxic gases such as methane, carbon dioxide, and hydrogen from emergency inpatient rooms, intensive care, and hospitals. Low energy cost and takes only a few minutes to be within a small percentage of the data. In general, the preheating time of the MQ-2 gas sensor can be used for both gas detection and also measure the level of butane and hydrogen gas in ppm

II. MODEL IMPLEMENTATION

This section mentions the internal description of the project and the proposed mathematical model, workflow, implementation and specifications of the system. Cholera disease has many symptoms divided into two parts severe symptoms (low blood pressure and rapid heart rate), and common symptoms (watery diarrhea, nausea/vomiting, dehydration) In this model, we are dependent on the severe symptoms of cholera only (low blood pressure and rapid heart rate) that monitoring patient to that's infected by cholera.

A. Design development

This model was designed by Proteus 8 professional software to simulate the devices and sensors in Arduino and the work on them (Figure 6). The sensor elements are downloaded and then linked to each other according to their input, and output, we connected them with a power supply With the right electrical power for sensors and Arduino ship, the Arduino microcontroller is linked with the Arduino IDE program, and then they are linked through a virtual portal that works as a simulation of the basic port in the computer until the outputs are displayed on the output media.

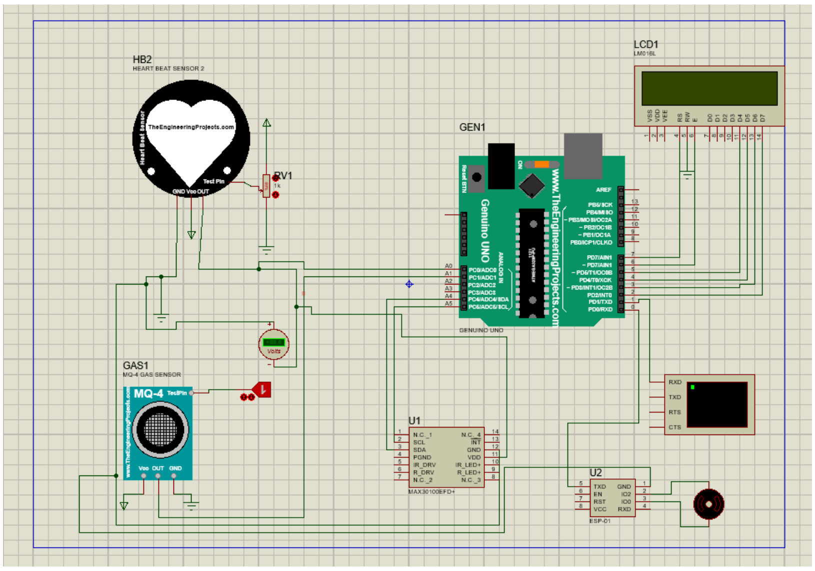

Figure 6: Model schematic.

We used Arduino IDE 2.0.1 software to write and identify devices, using the C language, which defined the libraries of all devices and sensors Heart rate, blood pressure, and gas test, with the Arduino Uno chip Then activating a virtual portal COM3, COM4 the outputs and values were displayed on the display screen and the virtual means of display. This system is designed as three steps detection of the environment, scan Heartbeat pulse and spo2, and blood pressure.

B. Oximeter oxygen (Spo2)

Monitoring oxygen levels in human blood and measuring pulse oxidation through medical electronic instruments that measure the oxygen saturation (Spo2) of arterial blood and pulse rate by smart wearable tools and technologies, medical devices allow rapid detection of oxygen status and hypoxia that can lead to death, hypoxia Blood tends to cause hypoxia in the blood, which is an abnormally low concentration of oxygen in the blood, and one of the dangerous symptoms of cholera patients or For people with chronic diseases, this project covers the basic principles of oxidation (Table 4).

Table 4: Threshold values of SpO2 level.

SpO2 (%)	Recommended
>95	Normal
85-94	Hypoxic
<85	Severely hypoxic

Whereas:

$$Normal \ = f(x) = \begin{cases} 0, & x < 99 \\ 1, & x > 95 \end{cases}$$

$$Hypoxic = f(x) = \begin{cases} 0 & x < 94 \\ 1 & x > 85 \end{cases}$$

$$Severely\ hypoxic = f(x) = \begin{cases} 1, & x < 85 \\ 0, & x > 95 \end{cases}$$

Designing oximeters and introducing the concept of oximetry through the tools used to design pulse oximetry, simulation software using Proteus, Arduino, a set of circuits, and the max30100edf pulse tester and blood oxygenation (Shakhreet & Shakhreet, 2015).

SpO2easures the effectiveness of breathing in patients, and it consists of two components, S indicates saturation and P indicates pulse, and indicates the amount of oxygen carried by red blood cells. The average saturation reading varies from one person to another according to age as table 5. The pulse oximeter (MAX30100)) with rapid diagnosis to measure and monitor oxygen and oxygen levels. (Evangeline & Lenin, 2019).

Table 5: Observation of blood pressure values and levels.

Categories	Systolic	and/or	Diastolic	
Normal	< 120 mm Hg	and	< 80 mm Hg	
Elevated (at risk, or prehypertension)	120-129 mm Hg	and	< 80 mm Hg	
Hypertension stage 1	130-139 mm Hg	or	80-89 mm Hg	
Hypertension stage 2	> 140 mm Hg	or	> 90 mm Hg	
Hypertensive crisis (emergency situation)	> 180 mm Hg	and/or	> 120 mm Hg	

We used the max30100 sensor to simulate and examine the spo2 and blood pressure as flow chart 1 the sensor Initializing pulse oximeter using Arduino code (Serial. print("Initializing"); Serial.print("Initializing pulse oximeter.."); Serial.println ("HeartRate , SpO2");) to read the input signal the check the value and validate the sensors is run success or not if { Serial. Println ("FAILED"); else { Serial. Println ("SUCCESS"); }) then read values and print the output for heart rate and blood pressure.

C. Blood pressure

Blood pressure (BP) in the arteries of the conditions of the ritual that lead to cardiovascular disease, and increased or decreased blood pressure (HBP) leads to many diseases and complications, may lead to a heart attack or stroke or kidney damage, and has no clear symptoms or warning signs that are often called "silent killer" and that one of the dangerous symptoms in cholera patients is low blood pressure, which leads to the entry of patients into a coma or heart attack (Table 5). In this paper, we describe the cholera patient monitoring system by providing a monitoring device for dangerous symptoms in patients and monitoring blood pressure BP in terms of decrease as a basic criterion for the symptoms of cholera patients, the system depends on the method of waveforms of vibrational pressure with data displayed and sent to cloud computing using think speak.

This max 30100 (Sensor) measures blood pressure and simulates a blood pressure monitor that has a bracelet that is inflated by an automatic diaphoretic pump, which stops the pulse when inflated enough, the reading is expressed in terms of required pressure either electronically or on an analog dial To move the mercury around the tube against gravity using millimeters of mercury. Risk factors occur when blood pressure rises and falls according to the following:

D. Hight blood pressure

Men are more likely to develop high blood pressure before the age of 55, and women are more likely to develop high blood pressure after the age of 55. Age plays a major role in blood pressure increases with age, and people who are overweight or obese are more likely to have high blood pressure as well. Because blood circulates through the blood vessels to supply the cells with oxygen and nutrients, and to increase circulation, there is higher pressure on the vessel wall due to lack of physical activity, smoking, drinking alcohol, and consuming too much salt (sodium). or low potassium and risk-raising stresses that lead to chronic diseases such as kidney disease, diabetes, and sleep apnea, all of which are dangerous for your blood pressure. (figure 7).

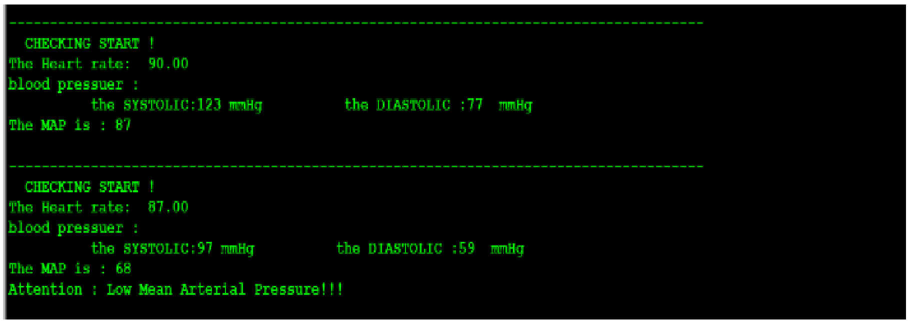

Figure 7: Blood pressure and heartbeat pulse using a virtual terminal window.

E. Low blood pressure

Low blood pressure poses many risks for people over the age of 65, who are most susceptible to this disease. Children or young adults also experience a rapid drop in blood pressure, accompanied by dizziness, blurred vision, or fainting. This is called neutral hypotension. Some were affected. Medications that lower blood pressure, including diuretics, pregnancy, standing in the heat, prolonged standing, etc. (Figure 8).

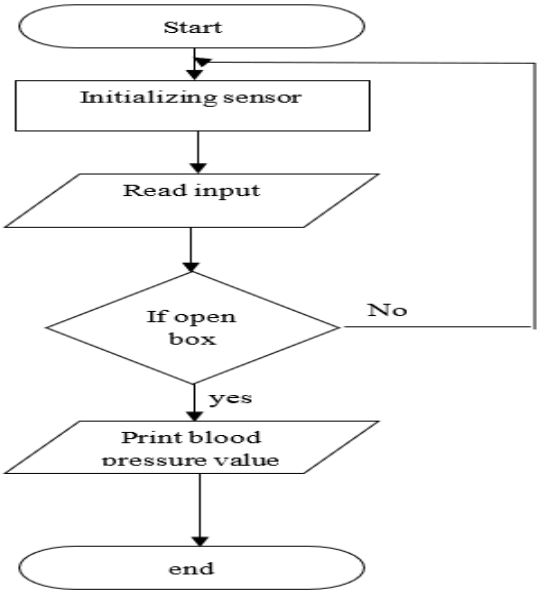

Figure 8: Blood pressure flow chart

A person with mild hypotension also experiences fatigue, fainting, or dizziness. More severe forms of hypotension affect the flow of oxygen-rich blood to the body's major organs. The flow chart explains how the sensor works to generate the values of blood pressure and initializing the sensor to turn on the start receiving values from the inputs, then verify that the sensor is working to print the outputs for the blood pressure values as shown in Figure 8.

F. Heart beat pulse

The Heart Beat Sensor Integrated front end is suitable for heart rate monitoring through the bioelectricity signal of the heart fence (Figure 9 &10). It aims to monitor various vital signs and is a simulated front end for heart rate monitoring, characterized by low power consumption and individual bullets. A heart rate sensor is used to measure the heartbeat, which is usually between 60-100 beats per minute. Heart rate is the heart rate measured by the number of heart contractions per minute, the figure shows the heartbeat sensor schematic.

The flow chart explains how the sensor works to generate heart rate values, configure the heart rate sensor, read the input signals and check the input to respond, the output and values are printed in case the response and input is read correctly or the sensor is checked to check the input again as shown in Figure 11.

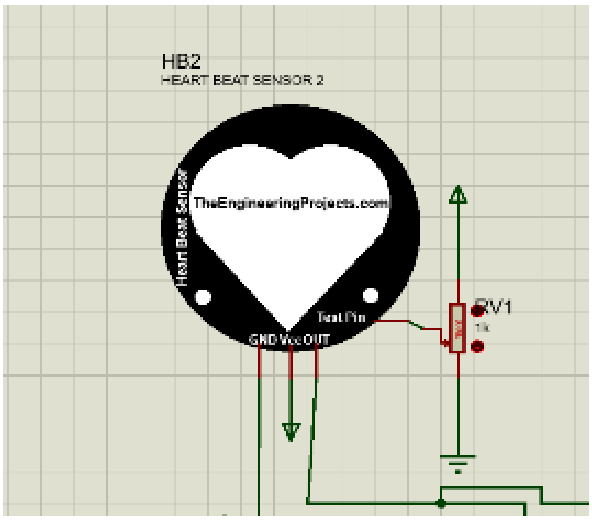

Figure 9: Heartbeat sensor schematic

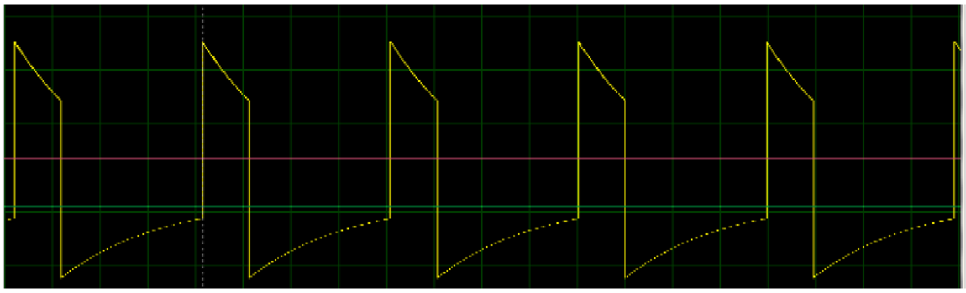

Figure 10: Heartbeat pulse using a digital oscilloscope.

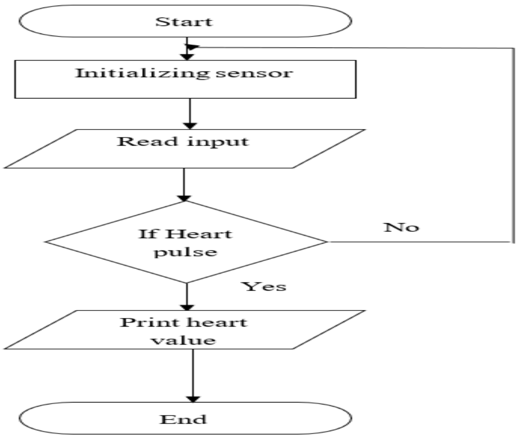

Figure 11: Heartbeat pulse flow chart

G. Gas detection

We used this sensor to examine the environment surrounding the disease in rooms, hospitals, or the care room to see if it contains toxic gases or is unhealthy for patients, which further aggravates their health condition (Figure 12).

Figure: show the sensors of gas (MQ-4) that are used to examine the environment it has logic value (int gas_value = digitalRead(MQPin);if(gas_value==HIGH)) if the value is one(lcd.print("HEALTHY"); lcd.setCursor(3, 1); lcd.print("ENVIROMENT")) that mean gas not detected and the environment is healthy otherwise if the value is zero that is mean the environment is dirty. lcd.print ("DIARTY"); lcd.setCursor(3,1); lcd.print ("ENVIROMENT");) as the figure below:

The flow diagram explains how the sensor works to verify the presence of toxic gases in the environment by deterring the sensor and then receiving the values and checking whether the gases are present in the environment and then printing or sending an alert that the environment is unhealthy and if the gases are not present, a warning is sent that the environment is healthy as shown in Figure 13.

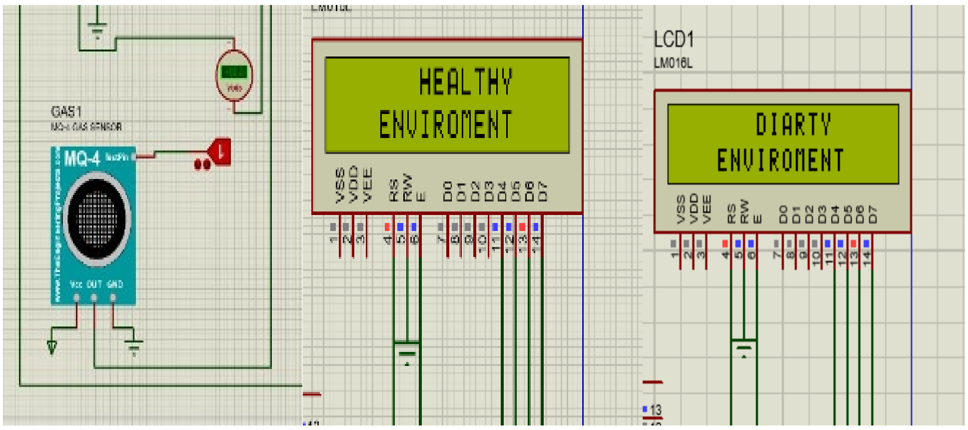

Figure 12: Gas detection sensor (MQ-4)

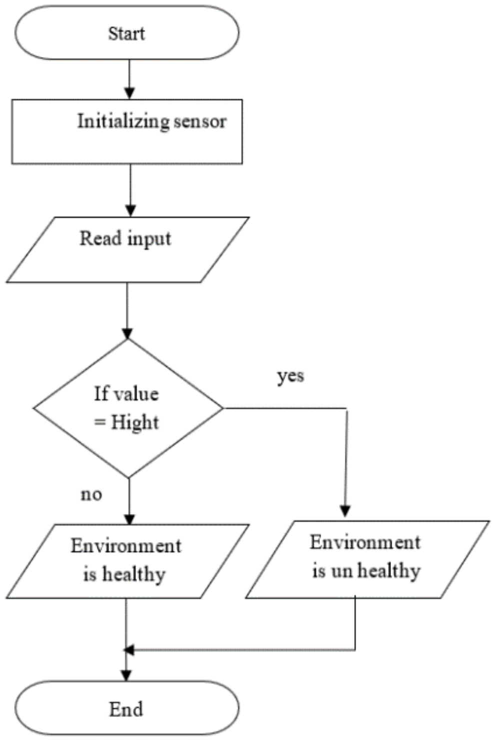

Figure 13: Gas detecting (MQ-4) flow chart

III. RESULTS AND DISCUSSION

A. A comparative study between the proposed model and previous studies.

Through the comparison Table 6 we found that the researcher (Velichko, 2021) provided him with a patient observer and the discovery of the patients with Covid 19 disease based on the patient's indicators by measuring the temperature and by the controller Arduino Uno and it was limited only to those with the temperature only, and the researcher (Evangeline & Lenin, 2019) made a research contribution to the health care system for humans in general by monitoring general symptoms such as temperature, oxygen saturation, falling, movement and heartbeat, and it was not intended for examining A specific disease based on the symptoms of the disease as Arduino Uno was used and the sensor was not used to check the environment from toxic gases, The researcher (Saleem et al., 2020) also presented patient monitoring system during sleep by monitoring sounds and heart rate, and used the Android application and the Arduino Uno controller, as well as the sensors accelerometer, pulse oximeter and microphone amplifier. He did not focus on toxic gases and oxygen purity in the patient's inpatient room. The researcher (Awais et al., 2019) provided a system to monitor the elderly through sensors and wearable devices to examine the fall and movement of the elderly using smartphone technology and RFID technology, and the researcher identifies the sensors for chronic diseases or symptoms in the elderly. The researcher (Ali et al., 2020) also presented the research contribution to monitor health care through sensors to check the pulse, oxygen levels in the blood and body temperature in general for all patients, and used temperature sensors, oxygen oximeter, heart rate, using Ardeunion Uno technology and ThinkSpec cloud platform, and the symptoms were not specifically examined for the disease or the environmental purity of toxic gases was examined. The researcher (P et al., 2021) provided a care system for infants and monitoring some symptoms such as temperature, as well as humidity and the detection of crying in children through temperature sensors and humidity detection, the sound sensor to detect children's crying by the controller Arduino Anno, and the examination of toxic gases in the room and oxygen purity was not addressed. The researcher (Ohana, n.d.) presented the monitoring system for pregnant women and children to monitor some symptoms such as temperature, humidity, pulse rate hazard, monitoring unexpected neurological activities using temperature and humidity sensors (DHT22), AD8232 (ECG sensor),GSR sensor The environment examination and identification of other symptoms such as blood pressure were not addressed. The researcher (Bhuyan & Sarder, 2021) provided a medical care system for Digital Pulse Oxygen Saturation Monitoring to examine the lack of oxygen in the blood through the oxygen oximeter max30100 and the control Arduino Uno and the symptoms of blood pressure were not addressed, as well as checking the purity of oxygen from toxic gases. Based on the Figure illustrated previously, the SIHCO model of intelligent health monitoring using the Internet of Things (IoT) and Arduino was successfully implemented using the Arduino Uno microcontroller. Arduino acts as the primary controller of the project, allowing it to communicate with all the equipment involved. It is able to measure and monitor basic human health using the heart rate sensor, which acts as a sensor to measure the heartbeat, and the MAX30100 sensor, which acts as a sphygmomanometer and oximeter sensor, which measures heart rate and detects oxygen levels in the blood. As well as the MQ-2 sensor, which measures the level of oxygen and gases in the patient's room, in addition, Arduino collects real-time health data via these sensors associated with Arduino. Moreover, Arduino is also responsible for data collection and real-time data display on a 20x4 LCD screen. Or through live viewing media This is useful for healthcare workers who monitor patients on-site. In this comparison, we find that the previous research did not meet the mechanism and methodology used in the proposed SIHCO model, so the research contribution is clear.

Table 6: Existing methodology issue, sensors and applications.

Ref	Issue	Sensors	Applications	Parameters analyzed	Methodology	Environmental Pollution Inspection
(Velichko, 2021)	Classification and analysis of risk factors for the presence of a disease in a patient according to a set of medical health indicators.	• Temperature sensor	Covid-19	• Temperature	• Arduino UNO	Not Available
(Evangeline & Lenin, 2019)	human health monitoring system	• LPC2148 • Accelerometer • microcontroller DAQ • LM35 Temperature • Sensor • ADXL335 Tri-axial • MAX30100 Pulse Oximeter • and Heart-Rate Sensor IC • GPS	General Patient Screening	• Temperature • Heart rate • Oxygen oximeter • Movement and falling	• Arduino UNO	Not Available
(Saleem et al., 2020)	Sleep Quality Monitoring System	• accelerometer, • pulse oximeter • microphone amplifier	monitoring the patient's sleep	• Sound levels • Heart pulse	• Arduino UNO • Android app	Not Available
(Awais et al., 2019)	Elderly Monitoring System	• Wearable sensors	Elderly monitoring system	• Movement and falling	• Smartphone • RFID	Not Available
(Ali et al., 2020)	health monitoring sensor system	• blood saturation levels (SpO2) • heart rate and • body temperature	General Patient Screening	• Temperature • Heart rate • Oxygen oximeter	• Think speak • Arduino uno	Not Available
(P et al., 2021)	Infant Care System	• Temperature • moisture content • cry detection	baby monitoring system	• Body Temperature • Detect moisture content	• Arduino uno	Not Available

				• cry detection and sound		
(Ohana, n.d.)	Health Monitoring System for Pregnant Women & Children	• Temperature and Humidity Sensor (DHT22), • AD8232 (ECG sensor), • GSR sensor	Pregnant Women & Children Health Monitoring system	• to measure temperature, humidity, fetal heart rate, and autonomic nervous activity respectively.	• Arduino uno	Not Available
(Bhuyan & Sarder, 2021)	Digital Pulse Oxygen Saturation Monitoring	• Max30100	low-cost pulse oxygen saturation measurement	• pulse oxygen	• Arduino uno	Not Available

B. Result analysis

The values were taken in three stages at different times and by generating them randomly by the pot-HG data entry used in the model, and it was noted that there were actual values through the SIHCO model for each of the MAX10300 extractors used to measure systolic and diastolic blood pressure mercury, as well as the heartbeat and determine its mechanism of action based on the specific symptoms of cholera or diseases that contain similar symptoms, and the MQ-2 sensor responsible for examining toxic gases that have an effect was also displayed. Great on patients in the inpatient room. The following tables show the stages and data generated through Model SIHCO (Figures 14 – 17).

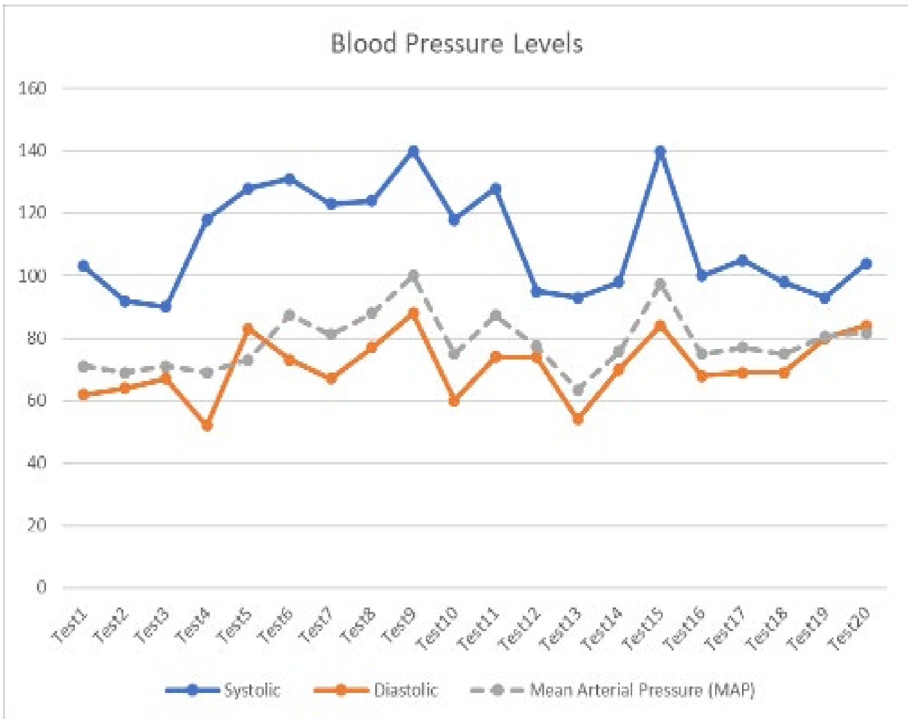

Figure 14: Blood pressure level chart (A)

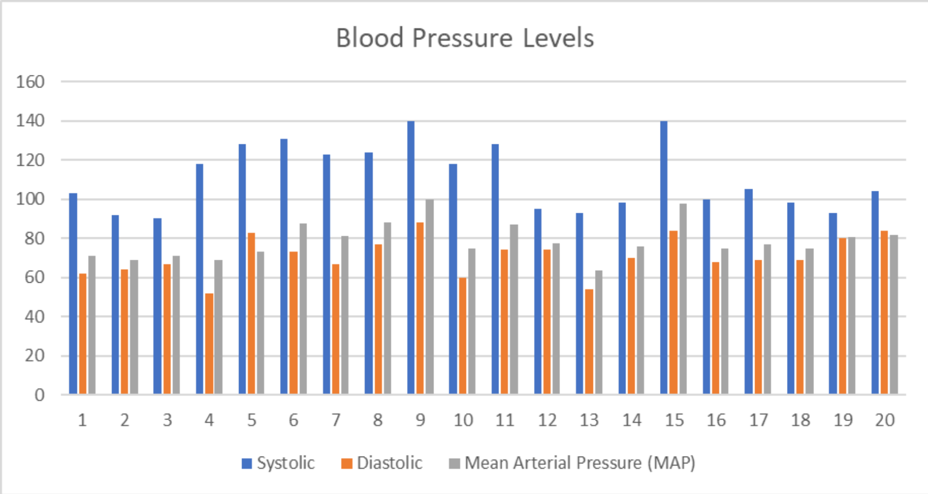

Figure 15: Blood pressure chart (B)

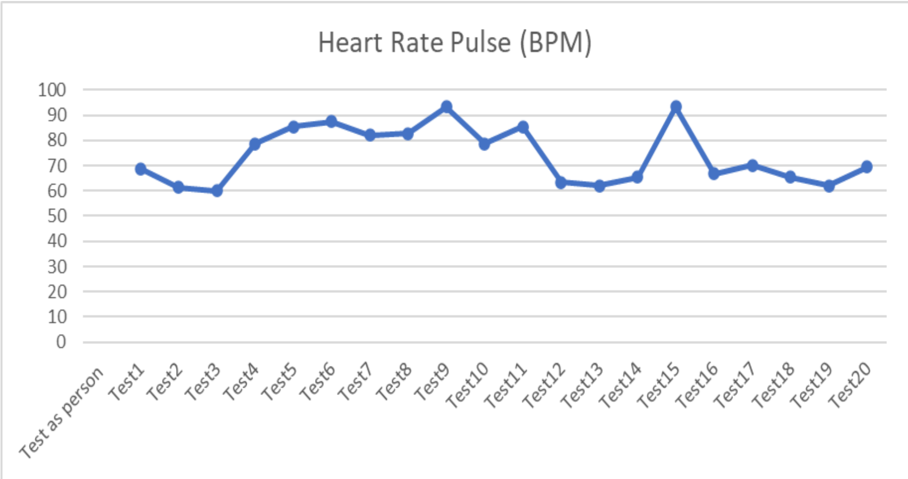

Figure 16: Heart rate pulse chart (A)

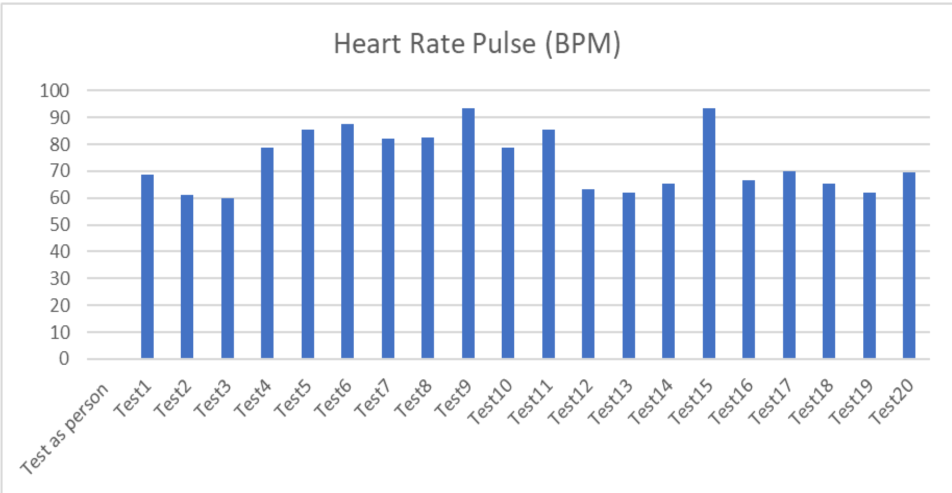

Figure 17: Heart rate pulse chart (B)

We collect the values of Target Blood Pressure Levels and Mean Arterial Pressure (MAP) using the formula MAP = DP + 1/3(SP – DP) or MAP = DP + 1/3(PP) to compare the result from SIHCO model and the real Medical Pressure Measuring Devices Mercury as stages 1 below: collecting data collected from Model SIHCO (Table 7).

Table 7: SIHCO data generated on stage 1

Blood Pressure Levels				**Heart Rate Pulse (BPM)**		
Persons	**Target Blood Pressure Levels**		**Mean Arterial Pressure (MAP)**	**Statues**	**Heart Rate Pulse (BPM)**	
	Systolic	**Diastolic**			**60 – 100 HRP**	**Status**
	120 mmHg	**80 mmHg**				
Test1	103	62	71	Normal	69	Normal
Test2	92	64	69	Low Map	61	Normal
Test3	90	67	71	Normal	60	Normal
Test4	118	52	69	Low Map	79	Normal
Test5	71	79	73	Normal	47	Worst HRP
Test6	131	73	87	Normal	87	Normal
Test7	123	67	81	Normal	82	Normal
Test8	124	77	88	Normal	83	Normal
Test9	140	88	100	High MAP	93	High HRP
Test10	118	60	75	Normal	79	Normal
Test11	128	74	87	Normal	85	Normal
Test12	95	74	77	Normal	63	Low HRP
Test13	93	54	64	Low Map	62	Low HRP
Test14	98	70	76	Normal	65	Low HRP
Test15	140	84	97	High MAP	93	Normal
Test16	128	80	91	Normal	85	Normal
Test17	105	69	77	Normal	70	Normal
Test18	81	69	70	Low Map	54	Worst HRP
Test19	93	80	81	Normal	62	Low HRP
Test20	104	84	82	Normal	69	Normal

IV. CONCLUSION AND FUTURE WORK

A. Conclusion

The Internet of Things has played an important role in the field of health care and has provided many solutions for health care people from the elderly, people with special needs, and patients with chronic diseases, by monitoring health care through wearable devices or remote monitoring devices, and its use has increased recently with the emergence of the Corona pandemic, which helped reduce the spread of the epidemic through direct communication between both patients and doctors.

One of those chronic diseases is cholera disease, an epidemic that is increasingly prevalent in conflicting countries through pollution or through the shortage of drinking water, which caused the death of many infected people during the past years (Camacho et al., 2018), so the model provided to monitor cholera patients from entering into a dangerous situation that may lead to fulfillment by monitoring patients and monitoring the environment surrounding patients, the model proposed in this study provides checking the heartbeat(HB) through the heart rate sensor, and measuring the pressure Blood (PB) through the sensor MAX30100 as well as examining the environment surrounding patients, whether it is the intensive care rooms or the inpatient room, this model works by Arduino with the Proteus program through which the model was designed.

B. Future work

In the future, we can implement this model using less power and cost-effective devices such as LED, replacing the power supply with a rechargeable battery, and developing a smartphone API for real-time data analysis. Overall, our main goal of providing a simple, portable, and cost-effective heart rate and blood pressure measurement solution has been achieved for people with cholera from low- and middle-income countries such as Yemen.

Although the system looks rather bulky, it will be a small device with proper manufacturing in the near future.

You can add an application on mobile devices to monitor symptoms in real time, and you can also add a video-sharing feature for face-to-face consultation between doctors and patients. Some other measures that are very important to determine the patient's condition such as the appearance of other symptoms that differ from the serious symptoms of cholera, etc. can be treated as future work.

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