FACEMASK WITH INTEGRATED MONITORING SYSTEM

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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ABSTRACT

From 2020, the entire world is facing a pandemic situation caused by Coronavirus (COVID-19). Until a perfect vaccine or medicine is manufactured, the only way to be secure is following the basic hygienic rules such as social distancing, wearing a mask, hand sanitizer and by taking antibiotics, etc. By using our Smart Mask system, it is possible to secure healthy people from those who are infected and to analyze the medical parameters of the user who use it. It measures the temperature, heartbeat rate, blood oxygen level of the user and it is processed by a microprocessor which gives the designed information to the GSM module. If the person wearing this mask undergoes cardiac arrest or breathing trouble or any other critical conditions, the GSM module sends SMS to the person's guardian and medical associate (Doctor and his team of medical expertise), so they can trace the person's location and send medical help to save his life as soon as possible. Hence it is designed in a way that everyone can buy it in an affordable price and it's comfortable to wear it too.

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LIST OF ABBREVIATIONS

AC	-	Alternating Current
ADC	-	Analog-to-Digital Converter
DB	-	Data Bus
DC	-	Direct Current
DSP	-	Digital Signal Processing
ECG	-	Electrocardiography
EMC	-	Electromagnetic compatibility
FTDI	-	Future Technology Devices International
GPL	-	General Public License
GPRS	-	General Packet Radio Service
GSM	-	Global System for Mobile Communication
HTTP	-	Hypertext Transfer Protocol
ICT	-	Information and Communication Technology
IDE	-	Integrated Development Environment
IP	-	Internet Protocol
IR	-	Infrared
IT	-	Information Technology
KB	-	Kilobyte
LTE	-	Long Term Evolution
MCU	-	Microcontroller Unit
MERS	-	Middle East Respiratory Syndrome
PCB	-	Printed Circuit Board
PWM	-	Pulse Width Modulation
RF	-	Radio wave Frequency
RW	-	Read/ Write

RX	-	Reception
SARS	-	Severe Acute Respiratory Syndrome
SCL	-	Serial Clock
SDA	-	Serial Data
SDK	-	Software Development Kit
SIM	-	Subscriber Identity Module
SMS	-	Short Messaging Service
SPI	-	Serial Peripheral Interface
SPO2	-	Oxygen Saturation
SRAM	-	Static Random-Access Memory
UART	-	Universal Asynchronous Receiver Transmitter
USB	-	Universal Serial Bus
WHO	-	World Health Organization
WSN	-	Wireless Sensor Network
TCP	-	Transmission Control Protocol
TX	-	Transmit

CHAPTER 1

INTRODUCTION

1.1 AIRBORNE DISEASES

Airborne diseases are illnesses spread by tiny pathogens in the air. These can be bacteria, fungi, or viruses, but they are all transmitted through airborne contact. In most cases, an airborne disease is contracted when someone breathes in the infected air and a person also spreads the disease particularly by sneezingand coughing, and through phlegm. These facts make controlling the diseases more difficult. Particles that cause airborne diseases are small enough to cling to the air. They hang on dust particles, moisture droplets, or on the breath untilthey are picked up. They are also acquired by contact with bodily fluids, such as mucus or phlegm. Once the pathogens are inside the body, they multiply until someone has the disease.

1.2 COMMON AIRBORNE DISEASES

The common cold: The condition called “a cold” is usually caused by a rhinovirus. There are many rhinoviruses, and the strains change to make it easier to infect humans.

Varicella-zoster: This virus causes chickenpox and spreads easily among young children. The rash is typically widespread on the body and is made up of small red spots that turn into itchy blisters, which scab over in time. Chickenpox is spread for about 48 hours before a rash shows, which is how it infects others so successfully. It is usually spread through the air or by touching the rash.

Mumps: This virus affects the glands just below the ears, causing swelling and, in some cases, loss of hearing. Vaccination is considered important to prevent the disease.

Measles: This illness is caused by contact with a person who has measles virus, or by inhaling particles from their sneezes or cough. As with mumps, vaccination is essential for preventing the spread of this disease.

Whooping cough (pertussis): This is contagious, bacterial illness that causes the airways to swell. The hacking cough that results is persistent and generally treated with antibiotics early on to prevent damage.

1.3 CORONA VIRUSES AND COVID-19

Coronaviruses cause a range of illnesses, including COVID-19. They typically affect the respiratory tract, but their effects can extend well beyond the respiratory system.

At the end of 2019, scientists identified a coronavirus outbreak in China. Experts named the newly identified virus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and the illness that it causes coronavirus disease 19 (COVID-19).

There are many types of coronavirus. Some cause mild illnesses, such as the common cold. Others can cause severe acute respiratory syndrome (SARS) or the Middle East respiratory syndrome (MERS), which can be life-threatening.

1.4 TRANSMISSION

Coronavirus infections are contagious, and some of these viruses, including the one that causes COVID-19, spread easily between people. Researchers believe that the viruses transmit via fluids from the respiratory system. Transmission may happen when a person:

- coughs or sneezes without covering their mouth, dispersing droplets containing the virus into the air.
- has physical contact with someone who has the infection.
- touches a surface that contains the virus, then touches their nose, eyes, or mouth.

Ways of preventing transmission include:

- wearing a face-covering in public.
- avoiding touching the face, especially the mouth and nose.
- always coughing or sneezing into a tissue, then disposing of it and washing the hands right away.
- regularly and thoroughly washing the hands.

During the ongoing COVID-19 pandemic, people should also do the following, even if they are well:

- Stay home whenever possible.
- Avoid contact with others.
- Wear a face-covering in public.
- Stay at least 6 feet away from others in public.

1.5 PREVENTION AND CONTROL

The principle mode by which people are infected with SARS-CoV-2 (the virus that causes COVID-19) and also other airborne diseases is through exposure to respiratory droplets carrying the infectious virus. Controlling a respiratory infection at the source by a face mask is a well-established strategy. For example, symptomatic patients with cough or sneezing are generally advised to put on a face mask, and this applies equally to patients with pulmonary tuberculosis (airborne transmission) and influenza (predominantly droplet-transmitted). We strongly advocate universal use of face mask as a means of source control in public places during the COVID-19 pandemic.

Extreme forms of social distancing are not sustainable, and the complete lockdown of cities or even whole countries is extremely devastating to the economy.

Keeping this in mind we have decided to help society using our project. Our idea is to prevent the COVID-19 virus from the further spread by protecting the people from exposure to the virus and helping the affected to diagnose themselves and to seek immediate medical care. Medicines or vaccines for COVID-19 have not been perfected yet, so our only option is to take precautionary steps to minimize our exposure to the virus. As the saying goes, “Prevention Is Better Than Cure” our project is not limited to the prevention of COVID-19 and can be further used to minimize the risk of being infected by any form of airborne diseases as it helps in identifying one’s infection and also warn other people. Our project includes the use of a patient health monitoring system and telemedicine for the effective care of the wearer.

1.6 HEALTH MONITORING SYSTEM

A wireless health monitoring system or patient monitoring system involves monitoring of patient’s vitals remotely utilizing devices that transfers patient data to remote locations wirelessly. A wide variety of sensors are used in the devices to monitor the patient vitals ranging from heart rate, body temperature, ECG, Respiration, Non-invasive blood pressure, oxygen saturation, etc. The deployment of wireless health monitoring removes the geographical barriers in getting specialist care. The wireless health monitors not only transmit the vital physiological signs to the medical personnel but also simplifies the measurement and as a result raises the monitoring efficiency of patients. It also brings down the measurement time and helps in obtaining care at the golden time during emergencies which can lead to better treatment outcomes.

1.7 TELEMEDICINE

The World Health Organization (WHO) defines Telemedicine as, "The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for the diagnosis, treatment, and prevention of disease and injuries, research and evaluation and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities." Telemedicine is the exchange of medical information from one location to another using electronic communication, which improves patient health status. Telemedicine has multiple applications and can be used for different services, which include wireless tools, email, two-way video, smartphones, and other methods of telecommunications technology.

CHAPTER 2

LITERATURE SURVEY

Breakell, A. and Townsend-Rose, C., “The clinical evaluation of the Respi-check mask: a new oxygen mask incorporating a breathing indicator”, Emergency Medicine Journal [1] proposed that Respiratory rate is one of the most important physiological parameters, being a component of most medical and nursing records and clinical scoring systems. Despite advances in pulse, blood pressure and oxygen saturation monitoring, visual observation alone is used to monitor the respiratory rate in clinical practice and this method is entirely accurate. The new respi-check sensor can be incorporated into any currently available oxygen mask. The sensor is a clear viscal indicator of the patient's respiratory activity and breathing pattern. The authors did a study to investigate the correlation between the respi-check sensor and simultaneous chest auscultation in determining the respiratory rates in adults. Clinical accuracy was assessed by analysis of the differences between respiratory rates determined using sensor and traditional method and mean difference was within acceptable limits.

Chen, Y., et.al, “Body Temperature Monitor and Alarm System Used in Hospital Based on 1-Wire and Wireless Communication Technology," [2] proposed that body temperature measurement has a very important role in clinical diagnosis and treatment. The old method has many disadvantages like increased measurement time, low precision etc. which is hard to accurately monitor patient body temperature in real time. Aiming to this problem, paper introduces a kind of body temperature distributed monitoring system. Multi temperature sensors DS18B20 were connected to realize body temperature signal collection, SCM AT89C52 processes measurement signal and drives field display and alarming equipment work. By wireless transceiver chip, the system completes signal wireless transmission from work slave station to work central station, and connects upper RC through USB adapter PD1USB012. Our experiments show that system wireless communication is better and temperature measure error is less than ±0.1°C which matches the clinic medical requirement well.

Huang, Y. P. et.al, "Respiratory Rate Monitoring Gauze Mask System Based on a Pyroelectric Transducer," [3] proposed that Continuous monitoring of respiratory activity has important applications in sleep studies, sports training, early detection of sudden infant death syndrome and patient monitoring. During breathing, air temperature is different between inspiration and expiration. Therefore, the respiratory rate can be derived from sensing the temperature variation. This paper presents a gauze mask type respiratory rate monitoring system with a flexible piezo film sensor to sense the respiratory flow. The pyroelectric response is faster than traditional temperature-sensitive devices (thermistors and thermocouples). The advantages of this respiratory rate monitoring system are rapid response time, low cost and case of implementation.

Javadpour, A., et.al, “A temperature monitoring system incorporating an array of precision wireless thermometers," 2015 International Conference on Smart Sensors and Application [4] proposed that Wireless body sensor networks have received continuous attention as the viable alternative in achieving continuous health monitoring systems. This paper proposes a continuous temperature monitoring system using a pair of wireless thermometers and communication infrastructure. In order to coordinate the thermometers communication and also to collect the measurements data, a central node was also implemented. A computer software is developed in order to visualize the measurements in addition to detecting increase and alerting high body temperature. The agreement between the experimental data and reference temperature values is significant.

Kalavakonda, R. R., et.al, "A Smart Mask for Active Defense against Coronaviruses and Other Airborne Pathogens,"[5] proposed that in thecurrent COVID-19 pandemic, we have observed a ubiquitous adaptation of face masks due to their necessity in the prevention of the spread of viruses. Facemasks, in their current iterations, provide protection to the wearer by filtering out viruses and other pathogens from the air before it enters the mouthor nasal passage. This is an example of passives filtering/ defense. The proposed mask provides an active defense by reducing the concentration of thepathogens in the air using a cold mist spray that loads the pathogens and causesthem to fall to the ground. In addition, a commercial particulate matter sensor actively monitors the airborne particles for pathogens and intelligently activates the actuator to release the mist spray. The sensor also relays information continuously to the user's smartphone via an app that provides various alerts, including the need to recharge and/ or decontaminate the mask.

Khan, T. and Chattopadhyay, M. K. "Smart health monitoring system," [6] proposed that Smart Healthcare is important for people who need continuous monitoring which cannot be provided outside hospitals. This paper presents a smart health monitoring system that uses biomedical sensors to check a patient's condition and uses the internet to inform the concerned. The biomedical sensors are connected to an Arduino UNO controller to read the data which in turn is interfaced to an LCD display to see the output. Data is uploaded to the server to store. Then it is converted to JSON link for visualizing it on a smartphone. An android application has been designed in order to easily see the patient's information by their doctors and family members.

Krishnan, D. S. R., Gupta, S. C., and Choudhury, T. "An IoT based Patient Health Monitoring System," [7] proposed a patient health monitoring system which uses sensor technology and internet to communicate to the loved ones in case of emergencies. This system uses a temperature and heartbeat sensor for tracking a patient's health. Both the sensors are connected to Arduino UNO. To track the patient health microcontroller is in turn interfaced to a LCD display and Wi-Fi connection to send the data to the database. In case of any abrupt changes in patient heart rate or body temperature alert data is sent about the patient using IoT. This system also shows patients temperature and heartbeat traced live data with timestamps over the internetwork. Thus a patient health monitoring system based on IoT uses the internet to effectively monitor patient health and if the patient gets critical a recovery team is sent.

Mansor, H., et.al, "Body temperature measurement for remote health monitoring system," [8] proposed the application of a remote health monitoring system where doctors can monitor patient’s vital signs via the web. It is used to monitor a patient in a distant place. The temperature of the patient is measured in real-time; so a doctor can notice the patient if he has any irregularities. In this system they use WLAN, which transmits data from patients who are seated or rested in a clinical word to the doctor's office. So a doctor can check without going to the clinical ward and they use the same system for the data transmission from home to doctor's office and the temperature is comparable with a commercial thermometer.

Mohammad, B., et.al, "Portable wireless biomedical temperature monitoring system: Architecture and implementation," [9] proposed that the device is used provide a solution for monitoring babies, disable or elderly population body temperature and initiate immediate alarm in case of hazardous cases; such us fever, under heating and change body temperature in defined time and the output is feed to a processor and Bluetooth interface and stored in memory and output is displayed in LCD display; and it can also monitor pulse rate and oxygen saturation. The system is extended for interfacing with other devices such as cell phones to enable remote monitoring. An android application to showcase the concept was also developed.

Raji, A., et.al, "Respiratory monitoring system for asthma patients based on IoT,"[10] proposed that among the various vital signs of our body – which are the basic measurement of bodily functions – the respiratory indicators are the most important, especially for patients admitted to intensive care units. Furthermore, the number of chronic obstructive pulmonary disease and arthritis is increasing rapidly, so people require a monitoring system that can continuously monitor them. However, this requires them to be in the hospital at all times, thus limiting their mobility. The proposed system uses LM35 temperature sensor and monitors patient's respiration continuously based on voltage value of inhaled and exhaled air, NRF24101 is used to transmit data from home to medical centre. Once the threshold is reached, the alarm is generated along with a message in a webpage. Thus doctors can identify patient's conditions without delay and using data mixing techniques, people can understand their conditions without professional help.

Rathore, D. K., et.al, "Wireless patient health monitoring system," [11] proposed that this paper contains a wireless system which enables real-time health monitoring at multiple patients. In health care centers patient's data such as heart rate need to be constantly monitored. The proposed system monitors the heart rate and other such data of the patient's body. A transmitting module is attached which continuously transmits the encoded serial data using the Zigbee module. A receiver unit is placed in the doctor's cabin which receives and decodes the data and continuously displays it on a user interface visible on PC/Lap. Thus, doctors can observe and monitor many patients at the same time. System also continuously monitors the patient's data and in case of any potential irregularities in the condition of the patient the alarm system connected to the system gives on audio and visual warning signals that the patient of a particular room requires immediate attention. In case the doctor is not in his chamber, the GSM module connected in the system also sends a message to all the doctors of that unit giving the room number of the patient who needs immediate care.

Sethumadhavan, A. et al., "Design of Smart Air Purifier Facial Mask," [12] proposed that Air pollution is a menacing issue in this current era. The air people breathe is full of harmful particles resulting in many non-infections respiratory diseases. In the wake of COVID-19 pandemic people have started to realize the importance of personal hygiene and a mask is turning out to be an eminent requirement. Realizing the dangers of the harmful particles in air and taking into account everyone wearing a mask a design of smart mask is proposed in this paper. This mask uses HEPA filters to filter out dust particles larger than 0.3microns in size. It keeps out harmful particles in the air. It also uses carbon fibres to filter out harmful gases, fumes, chemicals and odours which HEPA fails to do. The inclusion of bacteria killing UV light proves the perfect protection provided by the mask. In comparison with ordinary masks, this mask will protect the wearer from any kind of air communicable diseases.

Suganthi, J., et.al, "Medical alert systems with TeleHealth & telemedicine monitoring using GSM and GPS technology," [13] proposed that in this system we use the previous data of the patient and compared with new data which is obtained once the patient recovers from a surgery or any critical situation. The patient is monitored from their home. In case of any irregularities the doctor monitoring the data takes the necessary actions. In the event of a critical situation the doctor traces the location and sends a recovery team. This device should always be worn by the patient. It can also be installed on the vehicle so the individuals can be traced in the event of an accident.

Vijayalakshmi, B. and Ram Kumar, C. "Patient monitoring system using Wireless Sensor based Mesh Network," [14] proposed that Wireless sensor network (WSN) is a significant technology used in many areas including the health sector. Wireless mesh networks (WMN) have better range and also reduce the capacity. In this paper a scheme that is a wireless sensor-based mesh network, which is an integration of both technologies has been used for monitoring the patients. The patient's temperature, heartbeat and pressure are monitored using a bio-medical kit. An LED displays the information to the nurse. This information is also sent to a mesh node through Zigbee technology. Mesh node is generally a PC used by the duty doctor to monitor all the words. From the mesh node. SMS is sent to specified doctors through GSM connection. With the help of this message doctors can attend to patients.

CHAPTER 3

SYSTEM ANALYSIS

3.1 INTRODUCTION

This chapter discusses the system analysis of our project. The proposed system, block diagram, circuit diagram, hardware requirements and the program executed in our project are discussed below.

3.2 PROPOSED SYSTEM

This system consists of microcontroller, sensors and GSM module. In this system the sensors detect the changes in the temperature, heart rate, oxygen saturation and send the signals to microcontroller. The microcontrollerdoes calculations on the data obtained from the sensor. It regularly checks for the ideal amount of heart rate, blood oxygen and temperature. The microcontroller uses the GSM module to alert the doctors and also emergencycontacts in case that the heart rate, blood oxygen and temperature falls below or exceeds the ideal value.

3.2.1 Block Diagram

A block diagram is a diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks. Block diagrams are typically used for higher level, less detailed descriptions that are intended to clarify overall concepts without concern for the details of implementation. Figure 3.1 shows the block diagram of Facemask. The microcontroller Arduino Nano is the heart of the circuit. The reading obtained from MAX30102 and MLX90614 are processed by the microcontroller and the output is fed to the GSM module. The GSM module sends message to the wearer and the doctor.

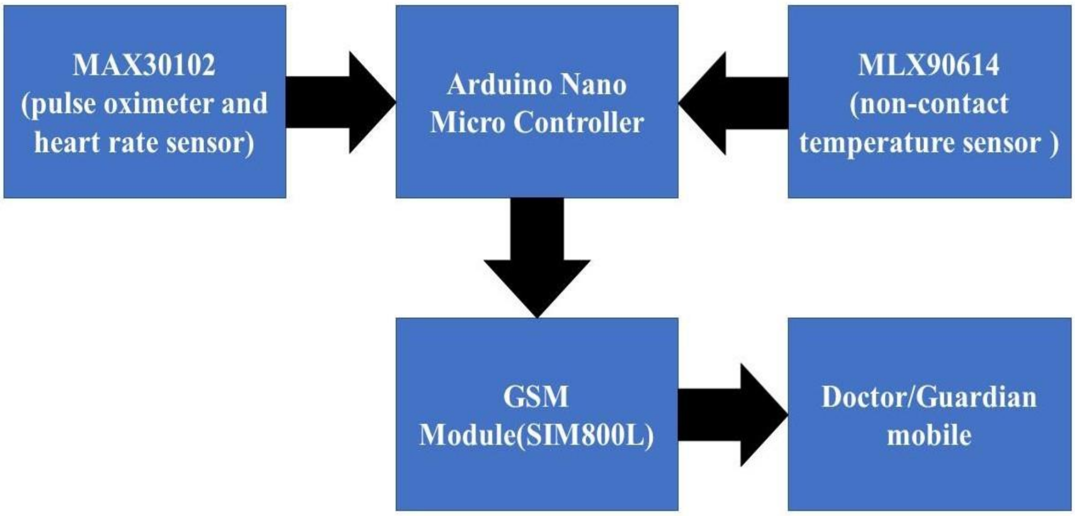

Figure 3.1 Block diagram of Facemask

3.2.2 Circuit Diagram

A circuit diagram (electrical diagram, elementary diagram, electronic schematic) is a graphical representation of an electrical circuit. A pictorial circuit diagram uses simple images of components, while a schematic shows the components and interconnections of the circuit using standardized symbolic representations. The presentation of the interconnections between circuit components in the schematic diagram does not necessarily correspond to the physical arrangements in the finished device.The circuit diagram of our project is shown in figure 3.2. Microcontroller controls and monitors the whole system by getting signals from sensors. Boththe heart rate, pulse oximetry sensor and the temperature sensor get values depending on changes and send data signals to the microcontroller. The Arduino Nano is the heart of the circuit. The readings from the sensors are processed by the Arduino. The data is monitored continuously for any irregularities and sent to the wearer. In case of emergencies alert signal is sent to the doctor and also the emergency contact using GSM module so that help can be obtained immediately.

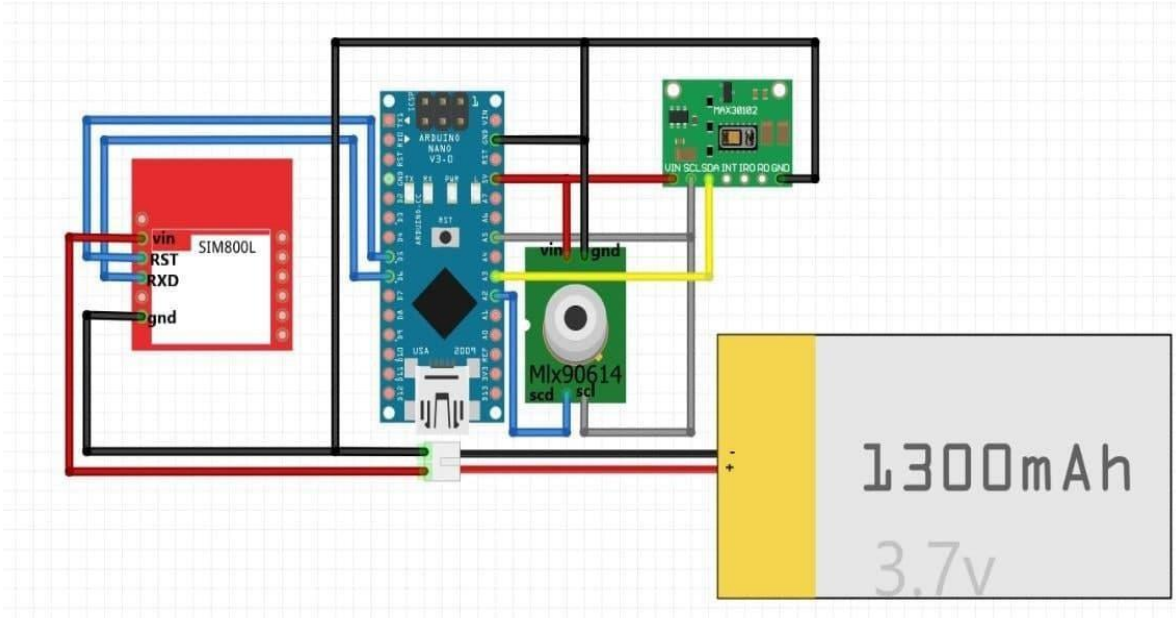

Figure 3.2 Circuit Diagram

3.2.3 Hardware Requirement

The hardware required in our project are Sensors, GSM Module and, Arduino NANO board. The sensors used in our project are MAX30102 and MLX90614. The GSM Module SIM800l is used to send messages to the doctor and the wearer. All the components used in our project can be grouped as follows.

- Sensors
  - Heart rate and pulse oximeter (MAX30102)
  - Temperature Sensor (MLX90614)
- GSM Module
- Arduino Nano
- Power Supply

3.2.4 Software Description

• Arduino IDE

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board. Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

3.3. ALGORITHM

1. Read values for temperature, pulse rate and blood oxygen level from the sensors.
2. Send the monitored values to the hospital systems in specified time intervals.
3. Using the recorded values, determine if the wearer is unwell using the following criteria:
    - If the temperature is high, wearer has fever.
    - If blood oxygen levels are too low and pulse rate is fluctuating, wearer is suffering from immediate breathing problems.
4. Take the appropriate action depending upon the seriousness of the issue:
    - Detection of breathing issue will lead to dialing Emergency Services and SMS the person’s guardian or primary caretaker.

CHAPTER 4

IMPLEMENTATION

4.1 INTRODUCTION

This chapter discusses the various hardware components used in our project. In our project we have used Arduino Nano, GSM/ GPRS module, Non-Contact IR Temperature Sensor, Pulse Oximeter & Heart-Rate Sensor. The features of these hardware components are discussed below.

4.2 SENSORS

A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing. In our project we use two sensors, namely proximity sensor, vibration sensor.

4.2.1 Non-Contact IR Temperature Sensor

The MLX90614 is a Contactless Infrared (IR) Digital Temperature Sensor shown in figure 4.1 can be used to measure the temperature of a particular object ranging from -70° C to 382.2°C. The sensor uses IR rays to measure the temperature of the object without any physical contact and communicates to the microcontroller using the I2C protocol.

The MLX90614 sensor can measure the temperature of an object without any physical contact with it. This is made possible with a law called Stefan-Boltzmann Law, which states that all objects and living beings emit IR Energy and the intensity of this emitted IR energy will be directly proportional to the temperature of that object or living being. The MLX90614 sensor calculates the temperature of an object by measuring the amount of IR energy emitted from it.

The MLX90614 Temperature sensor is manufactured by a company called Melexis. The sensor is factory calibrated and hence it acts like a plug and play sensor module for speeding up development processes.

The MLX90614 consists of two devices embedded as a single sensor, one device acts as a sensing unit and the other device acts as a processing unit. The sensing unit an Infrared Thermopile Detector called MLX81101 senses the temperature and the processing unit is a Single Conditioning ASSP called MLX90302 converts the signal from the sensor to digital value and communicates using I2C protocol. The MLX90302 has a low noise amplifier, 17-bit ADC and a powerful DSP which helps the sensor to have high accuracy and resolution.

The sensor requires no external components and can be directly interfaced with a microcontroller like Arduino. The power pins (Vdd and GND) can be directly used to power the sensor, typically 5V can be used, but there are other versions of this sensor which can operate on 3.3V and 7V as well. The capacitor C1 is optional and is used to filter noise and provide optimum EMC. The signal pins (SCL and SDA) for used for I2C communication can be connected directly to microcontroller operating on 5V logic.

Figure 4.1 Non-Contact IR Temperature Sensor

4.2.2 Pulse Oximeter & Heart-Rate Sensor

MAX30102 Sensor which is an integrated pulse oximetry and heart-rate monitor module is shown in figure 4.2. The MAX30102 includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. This highly sensitive device operates on a single 1.8V power supply and a separate 5.0V power supply for the internal LEDs. Communication is through a standard I2C-compatible interface. This sensor can be shut down through software with zero standby current, allowing the power rails to remain powered at all times. The MAX30102 can be used to measure the heart rate and the blood oxygen level simultaneously.

The MAX30102 uses a method called photoplethysmography to measure the heart rate of someone. This method shines light on the skin and the perfusion of the blood is measured. One of the practical aspects of this approach is that it is possible to differentiate between the light reflected by the blood of an artery (produces an AC output) and other components of the body such as bones and tissues (produces a DC output). The photo-diode in the sensor thenconverts the light to current that we can use as comprehensible data. The heartrate sensor measures the heart rate in Beats Per Minute using an optical LED light source and an LED light sensor. The light shines through skin, and the sensor measures the amount of light that reflects back. The light reflections willvary as blood pulses under the skin past the light. The variations in the light reflections are interpreted as heartbeats. To counter difficulties such as skin tone differences, LEDs with different wavelengths are used. In the MAX30102there is an extra green LED for this purpose.

The MAX30102 also acts as a pulse oximeter. Pulse Oximeters are low cost non-Invasive medical sensors used to continuously measure the Oxygen saturation (SPO2) of hemoglobin in blood. It displays the percentage of blood that is loaded with oxygen.

The principle of pulse oximetry is based on the differential absorption characteristics of oxygenated and the de-oxygenated hemoglobin. Oxygenated hemoglobin absorbs more infrared light and allows more red light to pass through whereas deoxygenated hemoglobin absorbs more red light and allows more infrared light to pass through.

Each pulse oximeter sensor probe contains two light emitting diode, one emitting red light and the other emitting near infrared light. It also has a photo-detector. The photo-detector measures the intensity of transmitted light at each wavelength. Using the differences in the reading, the blood oxygen content is calculated. The probe is placed on a suitable part of the body, usually a fingertipor ear lobe.

Two different methods are used for transmitting light through the transmitting medium. In MAX30102 we use reflectance method. In Reflective method the LED & the photo-detector are placed on the same side i.e. next to each other. In the reflective method, there will be some fixed light reflection back to the sensor due to finger. With each heart-beat there will be an increase in blood volume in the finger which will result in more light reflection back to the sensor.

If we observe the waveform of the received light signal, it will consist of peaks at each heartbeat. A fixed low value reading is there in between the heart beats. This value can be considered as constant reflection and this difference of the peak subtracted from the constant reflection value is the reflection value due to blood flow at heart beat.

In both above cases, the troughs/peaks in reflected light occur at each heartbeat and the duration between two spikes can be used to measure the persons Heart Rate. Hence a typical heart beat sensor module consists of only one Transmitter LED (mostly infrared) and one photo-detector.

Depending on the amount of Oxygenated hemoglobin or de-Oxygenated hemoglobin, the ratio of red light absorbed Vs Infra-red light (R/IR) absorbed will change. There is a look-up table than can convert this ratio into SpO2 value. Typically, R/IR ratio of 0.5 equates to approximately 100% SpO2, a ratioof 1.0 to approximately 82% SpO2, while a ratio of 2.0 equates to 0% SpO2.

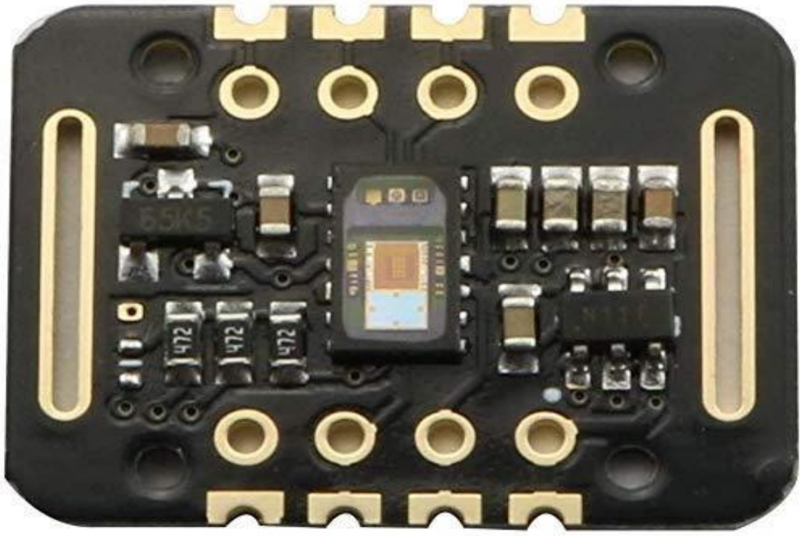

Figure 4.2 Pulse Oximeter & Heart-Rate Sensor

4.3 GSM/GPRS MODULE

SIM800L GSM/GPRS module as shown in figure 4.3 is a miniature GSM modem, which can be integrated into a great number of IoT projects. This module is used to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more. To top it off, the module supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world.

At the heart of the module is a SIM800L GSM cellular chip from SimCom. The operating voltage of the chip is from 3.4V to 4.4V, which makes it an ideal candidate for direct LiPo battery supply. This makes it a good choice for embedding into projects without a lot of space.

All the necessary data pins of SIM800L GSM chip are broken out to a 0.1″ pitch headers. This includes pins required for communication with a microcontroller over UART. The module supports baud rate from 1200bps to 115200bps with Auto-Baud detection. The module needs an external antenna to connect to a network. The module usually comes with a Helical Antenna and solders directly to NET pin on PCB. The board also has a U.FL connector facility in case you want to keep the antenna away from the board.

There's a SIM socket on the back. Any activated, 2G micro SIM card would work perfectly. Correct direction for inserting SIM card is normally engraved on the surface of the SIM socket. This module measures only 1 inch² but packs a surprising amount of features into its little frame. Some of them are listed below:

- Supports Quad-band: GSM850, EGSM900, DCS1800 and PCS1900
- Connect onto any global GSM network with any 2G SIM
- Make and receive voice calls using an external 8Ω speaker & electret microphone
- Send and receive SMS messages
- Send and receive GPRS data (TCP/IP, HTTP, etc.)
- Scan and receive FM radio broadcasts

Transmit Power:

Class 4 (2W) for GSM850

Class 1 (1W) for DCS1800

- Serial-based AT Command Set
- FL connectors for cell antennae
- Accepts Micro SIM Card

Figure 4.3 GSM/GPRS Module

4.4 ARDUINO

Arduino is a freely available electronics service based on easy-to-use hardware and software. Arduino boards can be able to read inputs - light up a sensor, a finger on a button, or a Twitter message - and turn it into an output - controlling a motor, switching on an LED, broadcasting something online. The board can be controlled what to do by sending a set of instructions to the microcontroller on the board. To do so, Arduino programming embedded C language (based on Wiring), and the Arduino Software (IDE), basedon processing is used.

Arduino was invented at the Ivrea Interaction Design Institute as an integrated tool for fast prototyping, aimed at students and professionals without a background in electronics and programming because of its simplest behavior. As soon as it reached a growing community, the Arduino board starts to change and flexible for the new needs and challenges, comparing its offer from simple 8-bit boards for IoT applications, wearable, 3D printing, and embedded environments and so on. All Arduino boards and the chip ATmega 328 were completely open, grooming users to build them independently and eventually adapt them to their particular needs. The software is open-source and it is growing through the support and usage of users worldwide.

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.

Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators. You can tell your Arduino what to do by writing code in the Arduino programming language and using the Arduino development environment. We use Arduino Nano to implement our project.

4.4.1 Arduino Nano

The classic Arduino Nano is the smallest board to build your projects with as shown in figure 4.4. The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source. The ATmega328 has 32 KB, (also with 2 KB used for the bootloader. The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

Each of the 14 digital pins on the Nano can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 k ohms. The pin diagram of Arduino Nano is shown in figure 4.5. In addition, some pins have specialized functions:

Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.

External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Nano has 8 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 Volts, though is it possible to change the upper end of their range using the analog Reference () function. Analog pins 6 and 7 cannot be used as digital pins. Additionally, some pins have specialized functionality:

I2C: A4 (SDA) and A5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

There are a couple of other pins on the board: AREF. Reference voltage for the analog inputs. Used with analog Reference ().

Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

The Arduino Nano can be programmed with the Arduino software (download). Select "Arduino Duemilanove or Nano w/ ATmega328" from the

Tools > Board menu (according to the microcontroller on your board). The ATmega328 on the Arduino Nano comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The microcontroller can be programmed through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar.

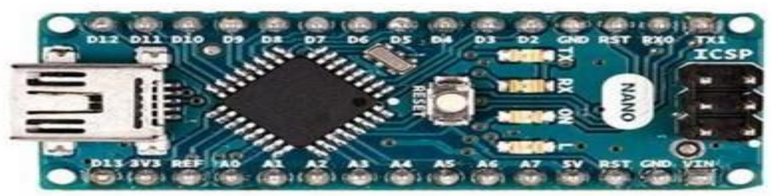

Figure 4.4 Arduino Nano

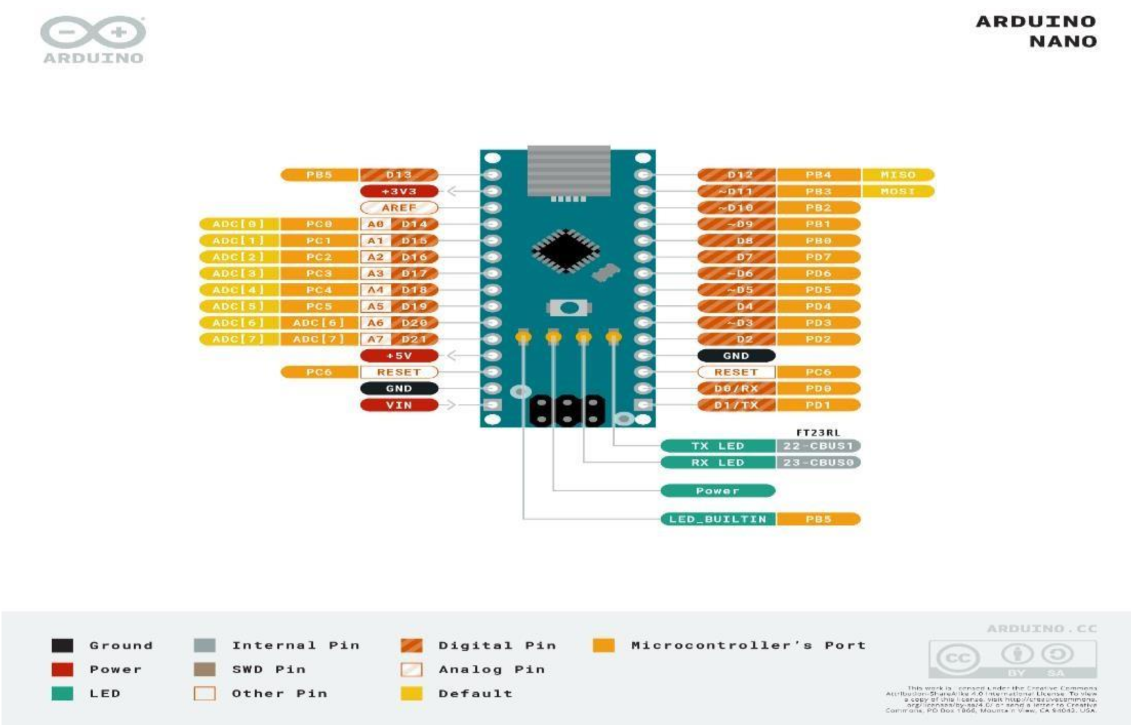

Figure 4.5 Pin Diagram of Arduino Nano

CHAPTER 5

SOFTWARE REQUIREMENTS

5.1 INTRODUCTION

This chapter discusses the software requirements of our project. In our project we have used the Arduino IDE to write and upload programs to our Arduino Nano. The features of the Arduino IDE are discussed below.

5.2 ARDUINO IDE

Arduino is a prototype platform (open-source) based on an easy-to-use hardware and software. It consists of a circuit board, which can be programed (referred to as a microcontroller) and a ready-made software called Arduino IDE (Integrated Development Environment), which is used to write and upload the computer code to the physical board. Figure 5.1 shows the Arduino Logo. Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

The key features are:

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE.
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. A USB cable is enough.
- Additionally, the Arduino IDE uses a simplified version of C++, makingit easier to learn to program.

- Finally, Arduino provides a standard form factor that breaks the functions ofthe micro-controller into a more accessible package.

Various kinds of Arduino boards are available depending on different microcontrollers used. However, all Arduino boards have one thing in common:they are programed through the Arduino IDE.

Figure 5.1 Arduino Logo

Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL) permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment based on the Processing language project.

CHAPTER 6

RESULTS AND DISCUSSION

This chapter deals with the experimental results of the proposed method. The main objective of this project is to actively monitor an individual's vital parameters to produce a report that a doctor can use to identify any medical conditions.

6.1 EXPERIMENTAL MODEL ILLUSTRATION AND WORKING

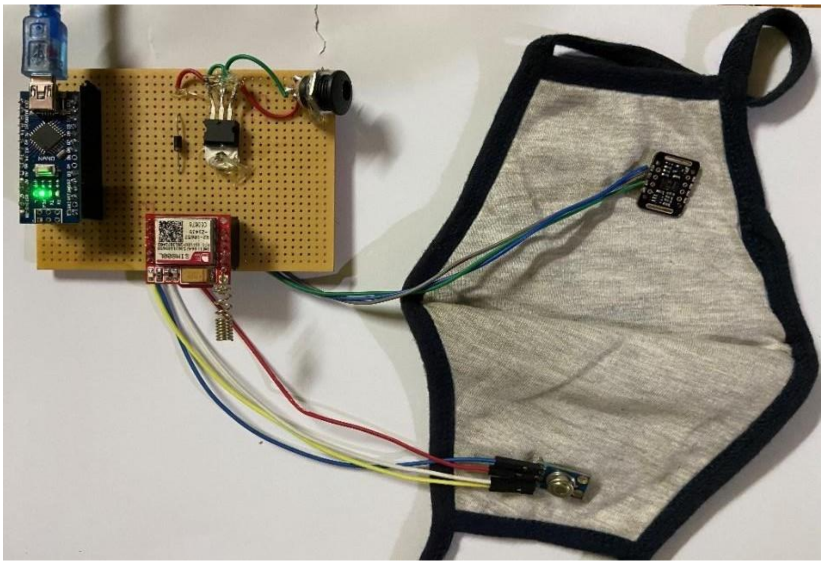

Figure 6.1 Experimental Model of the Proposed System

Figure 6.1 is the experimental model that was designed using the specified hardware modules. The microcontroller was programmed with the code required to execute our objectives.

The monitored report is sent out via the GSM module with an interval of 1 hour as can be seen in Figure 6.2

Figure 6.2 Vital parameters of a healthy person

When the detected parameters are not in their healthy range for at least 200 continuous detected samples (a period of 5 to 8 seconds), a message will be immediately sent out to the concerned doctors to inform them of the same.

Figure 6.3 Vital parameters of a person suffering from fever

In Figure 6.3, we can see the message that will be sent in case the temperature goes beyond the normal range of 36 to 38 degrees Celsius.

Figure 6.4 Vital parameters of a person with an abnormal heart-rate

Similarly, an example of the message sent out in case of abnormal heartrate detection is given in Figure 6.4. Normal human heartrate is between 60 – 100 bpm and can climb up to 130 during intense activity.

6.2. COMPACTNESS OF THE MASK

The current iteration of the model has been put together using components designed for universal purposes and hence the form factor is not as miniature as desired. However, specialized components can be used in order to achieve the desired form factor similar to how smart watches are produced.

6.3. FURTHER IMPROVEMENT

We can further improve upon this model by adding Wi-Fi functionality and interconnecting it with an app on the wearer's smart device. GSM is essential for sending out reports because cell phone signal can be obtained everywhere. However, Wi-Fi functionality allows for the information collected to be used in various ways.

Furthermore, if these masks are commercially manufactured and are adopted by the general populace, a client-server-based system can be implemented to monitor the health trends of various demographics, which can be used to facilitate better healthcare for the population as a whole.

CHAPTER 7

CONCLUSION

This mask is designed in a way to avoid further spread of contagious diseases such as cold, flu, COVID, etc. This mask is designed at an affordable price to save people from dangerous diseases. Current breath monitoring systems are usually immobile and require the patient to be in the hospital. With the help of our mask, we can try to minimize the death rate of people suffering from any breathing or heart dysfunctionality and are unable to call for help on their own. These advanced masks, in addition to providing protection from exposure, can serve as basic units of a networked health monitoring system providing information to the hospitals and government to track the health trends. We can also use the information obtained from monitoring the patient for other medical purposes. The integrated monitoring system is an easy way to monitor a patient or the person who wears the mask in any environment. The temperature and the SPO2 levels can be used to identify the primary symptoms of the COVID-19 virus. In the present times, after the break down of pandemic everyone is limited to and compelled to wear mask for their own protection and for the protection of the people around them. So, our only hope is to wait for a proper vaccine or medicine.

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