FACEMASK MONITORING SYSTEM

Caroline S.[1], Sam Alaric J. [2], Yohannes Bekuma[3]
[1]Assistant Professor, Department of ECE, St. Xavier's Catholic College of Engineering Nagercoil – 629003
[2,3]Assistant Professor, Department of ECE, Wollega University, Ethiopia
Corresponding Author mail id :caroline@sxcce.edu.in

Abstract: The entire world is suffering from a pandemic situation due to Coronavirus (CoVID-19). Maintaining social distancing, using sanitizers, consuming antibiotics and following the basic hygienic principles are few effective and easy to use ways to protect ourselves from airborne diseases or infectious agents. Wearing mask is one of the prevention measures to limit the spread of certain respiratory diseases, including SARS, 2019- nCoV etc.Transmission of the viruses occurs through respiratory droplets that are released when people speak, sneeze, or talk. Normal existing Masks acts as a barrier and prevents these droplets from spreading into the surrounding air. This paper proposes a new type of mask which is equipped with sensors to measures the temperature, heartbeat rate, blood oxygen level of the user. This approach is possible to secure healthy people from those who are infected and used to analyze themedical parameters of the user who wears it. The sensed parameters are processed by a microprocessor whichgives the designed information to the GSM module. When a person wearing this maskundergoes cardiac arrest or breathing problem or any other critical conditions, theGSM module sends SMS to the person's guardian and medical associate (Doctor andhis team of medical expertise), so they can trace the person's location and sendmedical help to save his life as soon as possible. This is designed in a way thatit is cost effective affordable price and comfortable.

Keywords: CoVID-19,Severe Acute Respiratory Syndrome (SARS), GSM module

I. Introduction

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

Coronaviruses cause a range of illnesses, including CoVID-19. Theytypically affect the respiratory tract, but their effects can extend well beyondthe respiratory system.At the end of 2019, scientists identified a coronavirus outbreak in China.Experts named the newly identified virus as Severe Acute Respiratory SyndromeCorona Virus 2 (SARS-CoV-2) and the illness that it causes Corona Virus Disease19 (CoVID-19).Symptoms include mild illnesses, such asthe common cold and can also cause Severe Acute Respiratory Syndrome (SARS)or the Middle East Respiratory Syndrome (MERS), which can be life-threatening.

The 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 respiratorysystem. Transmission may happen when a person coughs or sneezes without covering their mouth, dispersing dropletscontaining the virus

into the air, has physical contact with someone who has infection, touches a surface that contains the virus then touches their nose, eyes, ormouth.

Various ways of preventing transmission include wearing face-covering in public, avoid touching the face, especially the mouth and nose, always coughing or sneezing into a tissue, then disposing of it and washingthe hands right away.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.

The principle mode by which people are infected with SARS-CoV-2 (thevirus that causes CoVID-19) and also other airborne diseases is throughexposure to respiratory droplets carrying the infectious virus. Controlling arespiratory infection at the source by a face mask is a well-established strategy.The universal use of face mask is ameans of source control in public places during the CoVID-19 pandemic.Extreme forms of social distancing are not sustainable, and the completelockdown of cities or even whole countries is extremely devastating to theeconomy.

The main idea is to prevent the CoVID-19 virus from the further spread by protectingthe people from exposure to the virus and helping the affected to diagnosethemselves and seek immediate medical care. It is necessary to takeprecautionary steps to minimize exposure to virus. As the saying goes,“Prevention Is Better Than Cure”, this paper is not limited to the prevention ofCoVID-19 and can be further used to minimize the risk of being infected byany form of airborne diseases as it helps in identifying one’s infection and alsowarn other people.

A wireless health monitoring system or patient monitoring systeminvolves monitoring of patient’s vitals remotely utilizing devices that transferspatient data to remote locations wirelessly. A wide variety of sensors are usedto monitor the patient vitals ranging from heart rate, bodytemperature, ECG, Respiration, Non-invasive blood pressure, oxygensaturation, etc. The deployment of wireless health monitoring removes thegeographical barriers in getting specialist care. The wireless health monitorsnot only transmit the vital physiological signs to the medical personnel but alsosimplifies the measurement and as a result raises the monitoring efficiency ofpatients. It also brings down the measurement time and helps in obtaining careat the golden time during emergencies which can lead to better treatmentoutcomes.

The World Health Organization (WHO) defines Telemedicine as, “Thedelivery of healthcare services, where distance is a critical factor, by allhealthcare professionals for the exchange of valid information for the diagnosis, treatment, andprevention of disease and injuries, research and evaluation and for thecontinuing education of healthcare providers, all in the interests of advancingthe health of individuals and their communities.” Telemedicine is the exchange ofmedical information from one location to another using electroniccommunication, which improves patient health status.

II. Literature Review

Respiratory rate is one of the most important physiological parameters, being a component of most medical and nursing records and clinical scoring systems [1]. 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. 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.

Body temperature measurement has a very important role in clinical diagnosis and treatment [2]. 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. This 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. Experiments show thatsystem wireless communication is better and temperature measure error is less than ±0.1°C which matches the clinic medical requirement well.

Continuous monitoring of respiratory activity has important applications in sleep studies, sports training, early detection of sudden infant death syndrome and patient monitoring [3]. 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 ease of implementation.

Wireless body sensor networks have received continuous attention as the viable alternative in achieving continuous health monitoring systems [4]. 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 to collect the measurements data, a central node was 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.

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 [5]. 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 passive 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.

Smart Healthcare is important for people who need continuous monitoring which cannot be provided outside hospitals [6]. 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.

A patient health monitoring system which uses sensor technology and internet to communicate to the loved ones in case of emergenciesis proposed [7]. 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.

The application of a remote health monitoring system where doctors can monitor patient's vital signs via the web is proposed [8]. 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.

The device is used to 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 [9]. 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.

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 [10]. 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.

A wireless system which enables real-time health monitoring at multiple patients [11]. 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 11 message to all the doctors of that unit giving the room number of the patient who needs immediate care.

Air pollution is a menacing issue in this current era [12]. 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.

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 [13]. 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.

Wireless sensor network (WSN) is a significant technology used in many areas including the health sector [14]. Wireless mesh networks (WMN) have better range and also reduce the capacity. In this paper a scheme that is a wireless sensor-based mesh 12 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.

III. Proposed Methodology

Figure1 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.

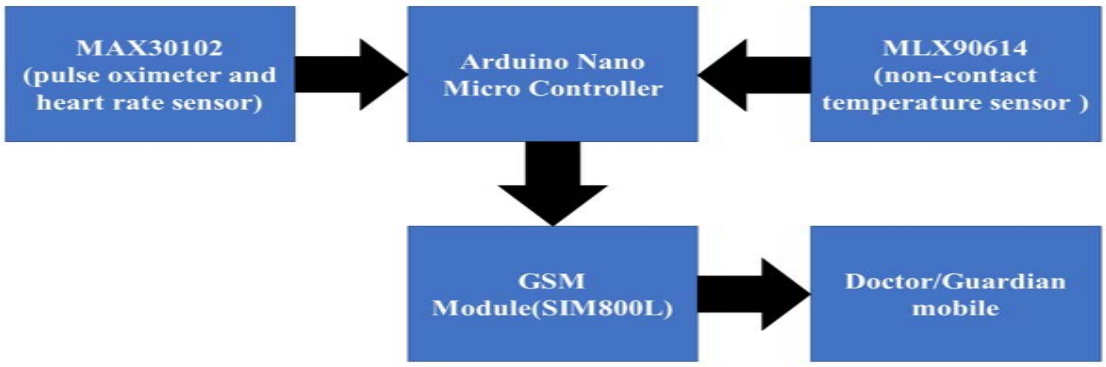

Figure 1 Block diagram of Facemask

The circuit diagram of our project is shown in figure 2. Microcontroller controls and monitors the whole system by getting signals from sensors. Both the 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.

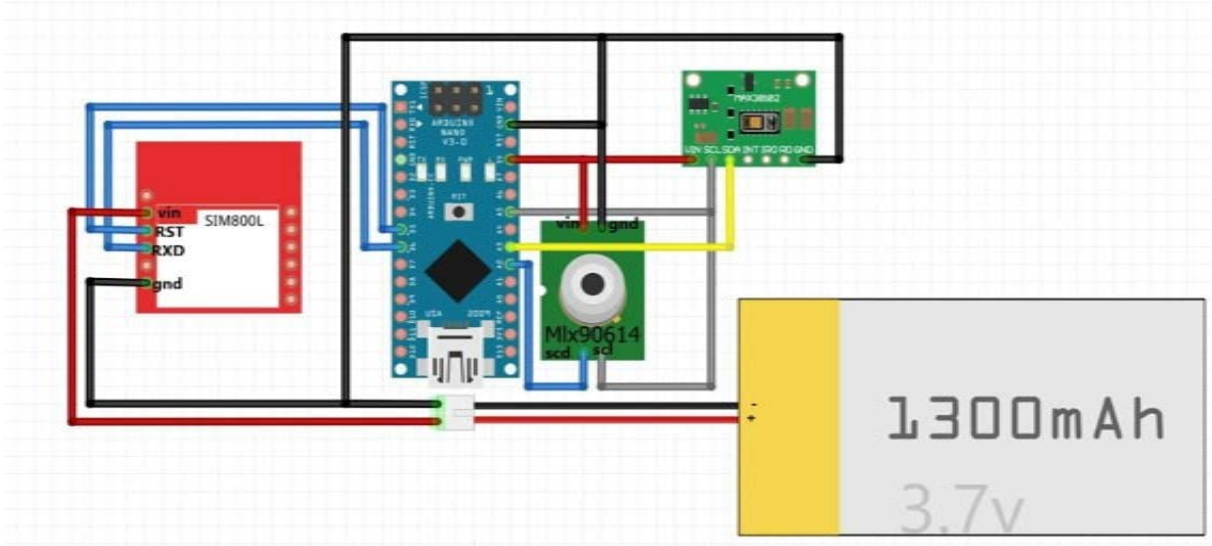

Figure 2 Circuit Diagram

IV Algorithm

- ✓ Read values for temperature, pulse rate and blood oxygen level from the sensors.
- ✓ Send the monitored values to the hospital systems in specified time intervals.
- ✓ 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.
- ✓ Take the appropriate action depending upon the seriousness of the issue:
  - Detection of breathing issue will lead to dialling Emergency Services and SMS the person's guardian or primary caretaker.

V Results

Figure 3 is the experimental model that was designed using the specified hardware modules. The monitored report is sent out via the GSM module with an interval of 1 hour as can be seen in Figure 4.

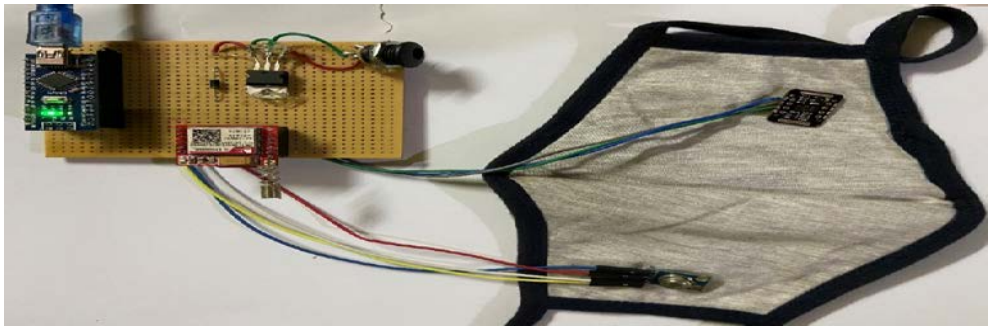

Figure 3 Experimental Model of the Proposed System

Figure 4 Vital parameters of a healthy person

When the detected parameters are not in their healthy range for atleast 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 5 Vital parameters of a person suffering from fever

In Figure 5, we can see the message that will be sent in case the temperature goes beyond the normal range of 36 to 38 degrees Celsius.

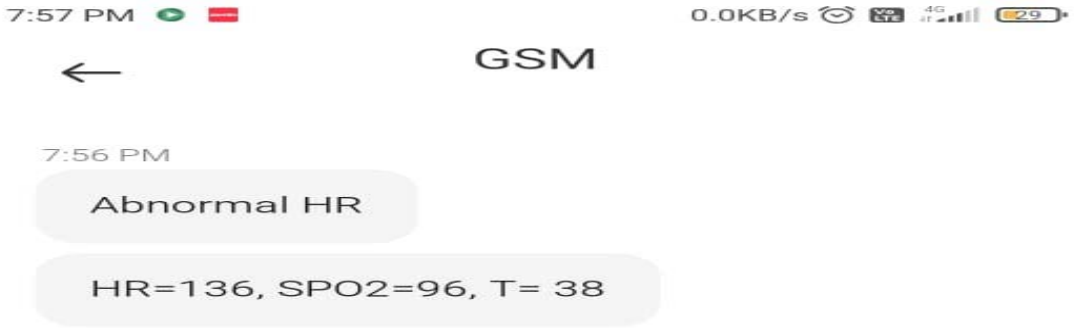

Figure 6 Vital parameters of a person with an abnormal heart-rate

Similarly, an example of the message sent out in case of abnormal heartrate detection is given in Figure 6. Normal human heartrate is between 60 – 100 bpm and can climb up to 130 during intense activity.

VI 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.

VII References

1. Breakell, A., Townsend-Rose, C. (2001), “The clinical evaluation of the Respi-check mask: a new oxygen mask incorporating a breathing indicator”, Emergency Medicine Journal: EMJ, 18(5):366-369, DOI: 10.1136/emj.18.5.366.
2. Chen, Y., Zhang, H. and Wang, N.(2008), "Body Temperature Monitor and Alarm System Used in Hospital Based on 1-Wire and Wireless Communication Technology," 2008 International Workshop on Education Technology and Training & 2008 International Workshop on Geoscience and Remote Sensing, Shanghai, China, pp. 401-404, doi: 10.1109/ETTandGRS.2008.80.
3. Huang, Y. P., Young, M. S. and Huang, K. N. (2008), "Respiratory Rate Monitoring Gauze Mask System Based on a Pyroelectric Transducer," 2008 2nd International Conference on Bioinformatics and Biomedical Engineering, Shanghai, China, pp. 1648-1649, doi: 10.1109/ICBBE.2008.741.
4. Javadpour, A., Memarzadeh-Tehran, H. and Saghafi, F.(2015), "A temperature monitoring

system incorporating an array of precision wireless thermometers," 2015 International Conference on Smart Sensors and Application (ICSSA), Kuala Lumpur, Malaysia, pp. 155-160, doi: 10.1109/ICSSA.2015.7322529.

5. Kalavakonda, R. R., Masna, N. V. R., Bhuniaroy, A., Mandal, S. and Bhunia, S. (2021), "A Smart Mask for Active Defense Against Coronaviruses and Other Airborne Pathogens," in IEEE Consumer Electronics Magazine, vol. 10, no. 2, pp. 72-79, doi: 10.1109/MCE.2020.3033270.
6. Khan, T. and Chattopadhyay, M. K.(2017), "Smart health monitoring system," 2017 International Conference on Information, Communication, Instrumentation and Control (ICICIC), Indore, India, pp. 1-6, doi: 10.1109/ICOMICON.2017.8279142.
7. Krishnan, D. S. R., Gupta, S. C., and Choudhury, T. (2018), "An IoT based Patient Health Monitoring System," 2018 International Conference on Advances in Computing and Communication Engineering (ICACCE), Paris, France, pp. 01-07, doi: 10.1109/ICACCE.2018.8441708.
8. Mansor, H., Shukor, M. H. A., Meskam, S. S., Rusli, N. Q. A. M. and Zamery, N. S. (2013), "Body temperature measurement for remote health monitoring system," 2013 IEEE International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA), Kuala Lumpur, Malaysia, pp. 1-5, doi: 10.1109/ICSIMA.2013.6717956.
9. Mohammad, B., Elgabra, H., Ashour, R. and Saleh, H.(2013), "Portable wireless biomedical temperature monitoring system: Architecture and implementation," 2013 9th International Conference on Innovations in Information Technology (IIT), Al Ain, United Arab Emirates, pp. 95-100, doi: 10.1109/Innovations.2013.6544400.
10. Raji, A., Kanchana Devi, P., Golda Jeyaseeli, P. and Balaganesh, N. (2016), "Respiratory monitoring system for asthma patients based on IoT," 2016 Online International Conference on Green Engineering and Technologies (IC-GET), Coimbatore, India, pp.1-6 , doi: 10.1109/GET.2016.7916737.
11. Rathore, D. K., Upmanyu, A. and Lulla, D.(2013), "Wireless patient health monitoring system," 2013 INTERNATIONAL CONFERENCE ON SIGNAL PROCESSING AND COMMUNICATION (ICSC), Noida, India, pp. 415-418 , doi: 10.1109/ICSPCom.2013.6719824.
12. Sethumadhavan, A. et al. (2020), "Design of Smart Air Purifier Facial Mask," 2020 International Conference on Smart Technologies in Computing, Electrical and Electronics (ICSTCEE), Bengaluru, India, pp. 581-584, doi: 10.1109/ICSTCEE49637.2020.9277073.
13. Suganthi, J., Umareddy, N. V. and Awasthi, N.(2012), "Medical alert systems with TeleHealth& telemedicine monitoring using GSM and GPS technology," 2012 Third International Conference on Computing, Communication and Networking Technologies (ICCCNT'12), Coimbatore, India, pp. 1-5, doi: 10.1109/ICCCNT.2012.6396073.
14. Vijayalakshmi, B. and Ram kumar, C. (2012), "Patient monitoring system using Wireless Sensor based Mesh Network," 2012 Third International Conference on Computing, Communication and Networking Technologies (ICCCNT'12), Coimbatore, India, pp. 1-6, doi: 10.1109/ICCCNT.2012.6396102.