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Epidemic Healthcare Kiosk:
A Social Economic Remote Solution Using IoT

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ABSTRACT

One of the most difficult tasks for the physicians is to analyze, manage, and plan suitable diagnoses and treatments for society, especially in an epidemic situation like Corona virus disease (COVID-19). Hence, the mortality rate shoots up. The ultimate reason for such pathetic situation is due to large mass of people being infected, lack of physicians and testing staff, and the threat of physicians themselves being infected while testing patients. This article proposes a solution to tackle this major issue worldwide. This article portrays the methodology of an IoT-interfaced epidemic healthcare kiosk (EHK)-intelligent monitoring system to plan and manage epidemics. The EHK is a non-invasive data acquisition system that consists of several sensors that can record the physiological measurements of the EHK user. The measured parameters are computed using quantum machine learning techniques. The proposed ideology can reduce the mortality rate, control the epidemic, and moreover, provide safety to citizens and physicians.

KEYWORDS

COVID-19, Epidemic, Epidemic Healthcare Kiosk (EHK), Economic Telemedicine, IoT, Mortality Rate, Quantum Machine Learning

1. INTRODUCTION

Life is all about living to face challenges. There have always been such challenges and threats in planet Earth. The possibilities of new infectious diseases outbreak is also on the rise, referred as Pandemic. Such Pandemic like COVID-19 has already created havoc throughout the world. The devastation continues to spike the mortality rate in every piece of land causing significant social, economic, and political disorder. Jones et al. (2008) suggested in 2008, that the likelihood of pandemics has amplified over the past century due to increased global travel and integration, urbanization, changes in land use, and greater exploitation of the natural environment. Healthcare sources and their personnel are not immune to infection. In fact, they are at a higher increased risk for contracting pandemic because of their constant exposure to infected patients. In the midst of COVID-19 pandemic and the devastated world healthcare system, technology for healthcare providers is promising as an efficient and sustainable elucidation for control, precaution, prevention and management to stem the spread of such pandemic.

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Modern science and technological developments, IoT and cloud computing are promising with various blueprints of IoT based health care solutions and devices. The (IoT) Internet of Things is a network around the world of physical devices associated to the internet for data collection and data sharing. Super computers, super thin integrated circuits (IC) and wireless communication networks have integrated with IoT and Cloud services. Cloud computing services have become one of the most used services in planet Earth. Cloud computing involves servers for storing all kinds of information and databases using inter-networking (internet), suitable softwares, analytic engineering, and intelligence. Wireless Sensor Networks (WSN) are the back bone to any technology that involves modern techniques of IoT and cloud computing. Wikipedia defines Wireless Sensor Network (WSN) as a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. Wireless Sensor Networks (WSN) are a network of intelligent devices or sensors. These networks typically run low power devices and consist of one or more sensors which could be different type of sensors or actuators. The extension of Wireless Sensor Networks (WSN) is another promising technology, the Wireless Body Area Sensor Networks (WBASN) which is specifically meant for healthcare sector for patient monitoring. Wireless Body Area Sensor Networks (WBASN) is some sort of wearable sensors, one or many worn by the patient to enable data acquisition, measurement and to report the patient's physiological parameters and health status. These modern methodologies of IoT, Cloud Computing, Wireless Sensor Networks (WSN) and Wireless Body Area Sensor Networks (WBASN) when come together for proving a healthcare solution, it enables for a much higher level of digital intelligence to the planet Earth's atmosphere. This amalgamation of technologies can trigger new innovations in any field and anything from as small as a plant seed to something as huge as a space ship. These technologies are utilized for collecting and transmitting medical parameters in real-time (Elhoseny et al., 2018). Continuous monitoring of physiological signals is also possible with these latest technologies. Medical data acquired can be transmitted and stored in cloud and to Physicians from around the world for continuous monitoring and the patients can be updated through the internet. This article portrays an ideology of an IoT interfaced Epidemic Healthcare Kiosk (EHK) – intelligent monitoring system to plan, manage and stop epidemic turning into pandemic. The EHK is just like a currency transaction machine, the ATM machine, which can be installed in cities, towns and villages throughout a country. Any layman can use the EHK facility by proper authentication and validation of registered personal information (Yang et al., 2019). The details of the user are authenticated and the information is stored in the cloud database (Yang et al., 2018). The EHK is a non- invasive data acquisition system which consists of several sensors which can record the physiological measurements of the EHK user. The measured parameters and the user details are stored in the cloud database using IoT for physician analysis, treatment, patient management and tracking, isolation of abnormal patients and for future reference. The epidemic control board can initiate necessary medical interventions on those patients who were found to be abnormal and provide the society an economic telemedicine. EHK limits person-to-person interaction, thereby decreasing the risk of transmission of epidemic between healthcare professionals and patients. The proposed ideology can reduce the mortality rate, control the epidemic and moreover provide safety to citizens and physicians. This offers a solution for humanity to attain better control over pandemic and consequently reduce the mortality rate and infection spread.

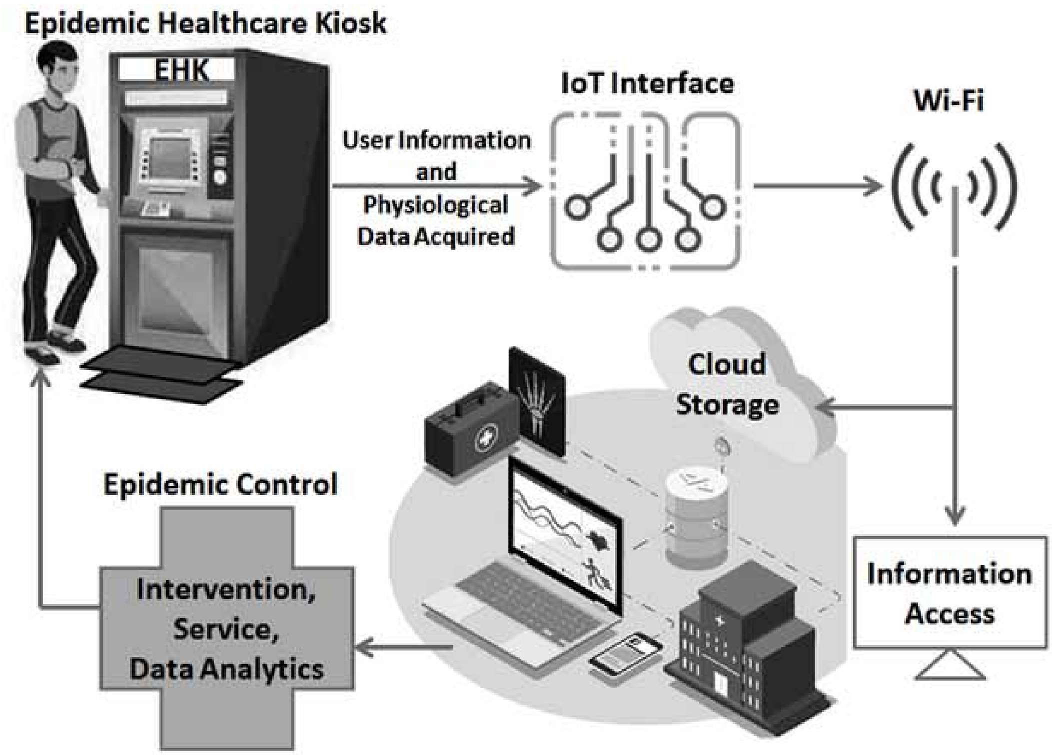
2. RELATED WORKS

Though not related any pandemic or epidemic, several research works have been reported in the context of the problem with few medical parameters data acquisition systems. Researchers have provided solutions to telemedicine and remote healthcare and have also developed health kiosk models. These research works have also made use of the technologies of IoT, Cloud Computing, Wireless Sensor Networks (WSN) and Wireless Body Area Sensor Networks (WBASN). Bahadin et al. (2016) reported a Healthcare Kiosk model for the management of patients. This kiosk model was reported for the benefit of specific patients with chronic disease. Bahadin et al. (2017) reported a follow-up medical consultation by using a health kiosk model. A study of 95 participants with well-controlled chronic cardiovascular diseases was conducted. Patients used the kiosk instead of consulting the physician. All patients who utilized the kiosk were also assessed by a nurse. The kiosk assessment and the nurse assessment were compared to verify the evaluation. Riyanto Sigit et al. (2015) reported a healthcare kiosk for evaluating the condition of human heart. The model was specific for cardiac parameters and measurement. Guiqin Sun et al. (2011) proposed a low-cost community healthcare kiosk model for chronic disease monitoring. The kiosk provided data acquisition parameters like ECG, blood pressure, temperature, blood oxygen saturation and weight monitoring. Yongqiang Lyu et al. (2015) proposed a blueprint and optimization technique for a healthcare kiosk. The work was intended for improving the quality of data acquisition system. The methodology decreased the measurement noise and provided a best possible fit and positioning for the measurement devices. Blake Lesselroth et al. (2011) reported a patient kiosk model simulation specifically designed for patients checking in for a medical appointment and to provide a medication adherence history, which is later on accessible electronically in the health record. David De Vault et al. (2014) proposed an artificial intelligent virtual human interviewer for healthcare. This virtual interaction would automatically assess the distress indicators like anxiety, depression and post traumatic stress disorder (PTSD). John R. Squilla et al. (2006) published a patent titled “Medical Kiosk with Multiple Input Sources” in the United States of America. This was reported for the use of electronic patient records management in conjunction with medical kiosk. L Yehia et al. (2015) reported a classical survey of various medical and healthcare applications with reference to wireless medical sensor network (WMSN). The survey also reported on the techniques and methodologies that can be adapted to implement the same in an IoT environment. The security concerns of healthcare applications using IoT systems and their probable solutions were also discussed in this exhaustive survey. Jara et al. (2014) reported an IoT enabled system for drug recognition and user interaction system. This methodology was proposed with the motive to study the side effects of drugs on patients. A database was developed for various drugs and related data of composition and elements present with their respective side effects. The patient health record was developed regarding personal information, medication, healthcare history, do’s and don’t’s of drugs. The outcome of the methodology was to suggest the patients with proper medical solutions regarding drug prescription. The data elucidated was cross mapped with the patients’ health record for this purpose. The proposed methodology utilized several modern techniques of IoT. The patients peopleile phone were made use for identification and authentication with barcode and RFID techniques. Mohammed et al. (2014) proposed and developed a peopleile application software called “ECG Android App”. This proposal was meant for patients to check their cardiac health condition by seeing the ECG waveform in their smart phone. Moreover, the ECG data acquired for every patient from their smart phone was transmitted to the cloud and a separate medical database and health record for each patient was maintained in the cloud server. These data from cloud were utilized for possible physician analysis and healthcare services. This methodology proved to be very useful to reduce the number of people coming to healthcare services and hospitals thereby reducing the stress for patients as well as the physicians. Istepanian et al. (2011) reported a novel methodology in the year 2011 called m-IoT. The methodology was reported that internet protocol (IP) version 6 low power wireless personal area network (6LoWPAN) was used with 4G network. This was also one among the diabetic patient monitoring system for continuous self glucose level monitoring using glucometer sensor. Santos et al. (2015) proposed a device “AMBRO”, which is yet another IoT methodology with peopleile communication. This technique utilized sensors like, accelerometer and heart rate monitoring along with global positioning system (GPS). The methodology was reported for patient monitoring to detect fall and to control heart rate. GPS was used for locating the patient. These data were transmitted to the proposed device continuously with a gap of 5 minutes duration. The transmission technique that was imposed with the system is through peopleile gateway. Hussain et al. (2015) proposed a peopleile application software framework in the year 2015. This research work was proposed for real time patient health monitoring system specifically for elderly and disabled. The proposed methodology was reported to monitor heath abnormalities of this confined segment of patients. A GPS module was also reported to have been used for locating such patients and providing them the necessary healthcare services.

3. MATERIALS AND METHODS

The schematic blueprint of the proposed methodology of an IoT interfaced Epidemic Healthcare Kiosk (EHK) – intelligent monitoring system to plan and manage epidemic is depicted in figure1. The Epidemic Healthcare Kiosk (EHK) is facilitated in a disinfected sealed chamber for public utilization. The EHK is just like a financial transaction machine, the ATM machine, which can be installed in cities, towns and villages throughout any geographical region. Any layman can use the EHK facility by proper authentication and validation of registered personal information. The details of the user are authenticated and the physiological data acquired from users are fed to an IoT interface. The EHK is a non- invasive data acquisition system which consists of several sensors, which can record the physiological measurements of the EHK user using Quantum machine learning. The measured parameters and the user details are stored in the cloud database using IoT and wireless communication. The cloud service offers Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) to the host EHKs Cloud-IoT healthcare application. Data comes from various EHKs around a geographical region. The proposed IoT based Epidemic Healthcare Kiosk as shown in figure 1, involves a three layer IoT architecture comprised of the lower Identification layer, the middle Gateway layer and the upper Cloud server layer. Message Queue Telemetry Transport (MQTT) protocol has been utilized in this work since it is much easier to connect other devices to the internet and cloud servers and supports interoperable platforms. Interoperable platforms are both software and hardware which are compatible with any system. Interoperable platforms or interoperability is a characteristic of a product or system, whose interfaces are completely compatible, to work with other products or systems, at present or even in the future, without any restrictions. Moreover, MQTT can be implemented with fewer overloads and minimum power consumption. The objective of MQTT protocol is to gather all the physiological data from the data acquisition sensors of the EHK system and execute transmission of these information to the cloud servers. These data and information stored in the cloud server can be accessed by the authorized physicians and officials of the epidemic control board for physician analysis, treatment, patient management and tracking, isolation of abnormal patients and for future reference. The epidemic control board can initiate necessary medical interventions on those patients who were found to be abnormal and provide the society an economic telemedicine for the respective patients. The Amazon web services (AWS) Cloud server services were utilized for cloud storage of data and parameters. Thus people are no longer required to go to the hospital for consultation during any Epidemic. This proposed framework provides extensive applications especially to field of healthcare and to all the stakeholders involved in various fields at different levels. The IoT interfaced Cloud server provides all the necessary data to the Physicians for clinical analysis, diagnosis, interpretation and interventions for the betterment of patients and to the society, which very vital during an Epidemic. The people themselves can assess their health condition and request for necessary healthcare attention from the hospitals where they feel comfortable, trust worthy and better healthcare solutions. The following sub-sections provide the technical details of various block schematics involved in the system.

Figure 1. Proposed Methodology

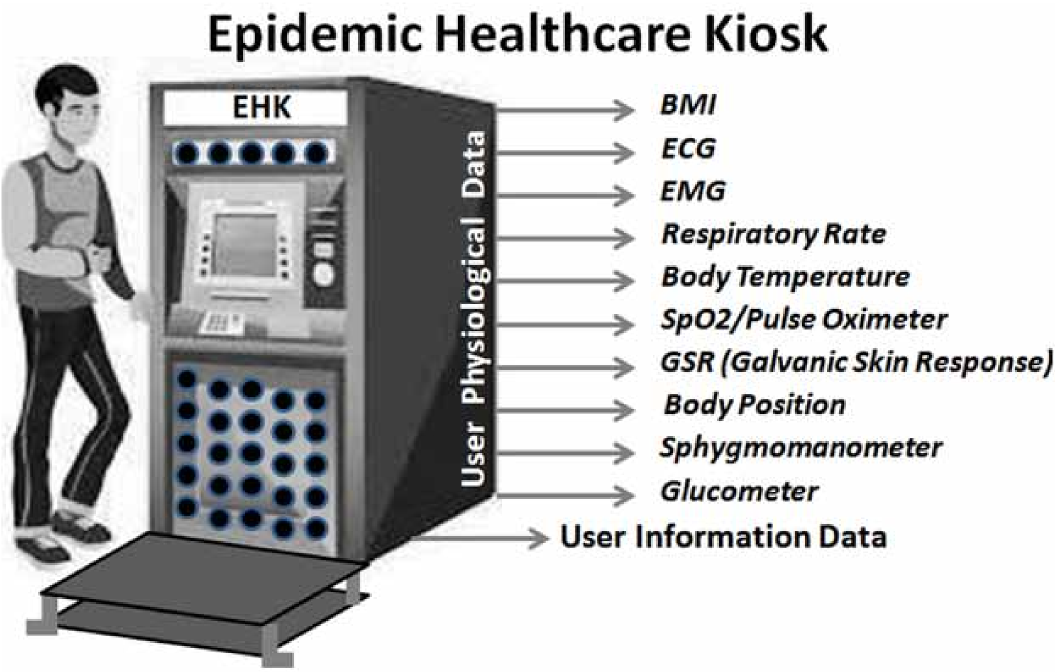


3.1 The Epidemic Healthcare Kiosk Model (EHK)

The model of a typical epidemic healthcare kiosk (EHK) is shown in figure 2. This EHK is an intelligent monitoring system to plan and manage epidemic. The EHKs are to be installed in secured, sealed and disinfected chambers to avoid the spreading of epidemic. The EHK is a non- invasive data acquisition system which consists of several sensors which can record the physiological measurements of the EHK user.

The sensors that are incorporated in the EHK are carefully chosen considering the well known physiological measurement guidelines (AAMI, 2009). Based on the possible symptoms and human indications during any epidemic situation, the proposed EHK is designed to offer ten such parameters for a single user. These parameters include, Body Mass Index (BMI), Electrocardiogram (ECG), Electromyogram (EMG), Respiratory Rate, Body Temperature, Pulse Oximeter / SpO2, Galvanic Skin Response (GSR), Body Position, Sphygmomanometer and Glucometer. Additional sensors like saliva sensor and other devices can be incorporated depending upon a epidemic testing. The EHK also consists of an in-built IoT interface (AAMI, 2009) and wireless connectivity to establish a network of EHKs in a geographical region. The measured parameters and the user details are stored in the cloud database using IoT and wireless communication.

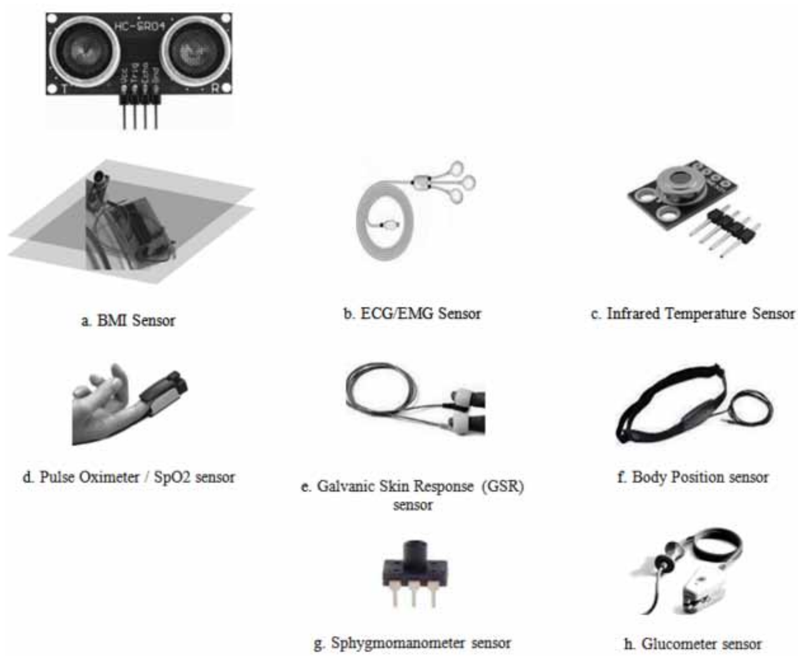
Figure 2. Epidemic healthcare kiosk (EHK) model



3.2 Sensors and Physiological Parameters

The Body Mass Index (BMI) provides a measurement of the user's leanness or corpulence with reference to their height and weight, and specifically to quantify tissue mass. It is an important general indicator of whether the user has a healthy body weight respective to their height. An automated BMI calculator system is incorporated that does not need the user to input anything (Nam et al., 2018). The users are required to stand on a platform as indicated in figure 2. The various sensors employed for the model is shown in figure 3. The BMI sensor is shown in figure 3(a). The system utilizes load cells for weight estimation along with an ultrasonic sensor for height calculation controlled by a microcontroller. Based on the estimated values, the system calculates BMI and displays the values to user. The measurement is also stored in the cloud database using IoT and wireless communication. The Electrocardiogram (ECG) is used to assess the electrical and muscular activity of the heart. The specification of ECG sensor utilized; SENSPRO-ECG1-30-30-30 a low noise ECG data acquisition with ratings; Gain: 1000, CMRR: 100dB, Range: $\pm$1.5mV (with VCC = 3V), Input Impedance: >100GOhm and Bandwidth: 0.5-100Hz. While the Electromyogram (EMG) measures the electrical activity of the skeletal muscles during rest and during contraction. This can help in detecting medical abnormalities like; activation level, analyze the biomechanics of human movement for diagnosis of neuromuscular diseases and control. These two parameters can be measured using a 3 lead sensor shown in figure 3(b). The EHK is enabled with this sensor for data acquisition. The respiratory rate measurement is accomplished by using the concept proposed by Carlo Massaron et al. (2018). A Camera is employed for contactless monitoring of breathing patterns and respiratory rate focusing the region below Adams Apple of the Neck. The analysis is done by using the recorded video sequence. The body temperature measurement is done by using an infrared body temperature sensor (Massaron, 2018), depicted in figure 3(c). This sensor enables accurate contactless temperature measurement in the EHK. The most common applications for this sensor are measurement of ear temperature, forehead temperature or skin temperature. MLX90514ESF infrared (IR) temperature sensor has been used for the investigation and experimentations. This sensor is placed on the top position of the EHK, suitable to manage all variations of height of the users. This is one of the vital sensors of the EHK. This parameter is also one of the vital symptoms of the present pandemic COVID-19. The Pulse Oximeter / SpO2 sensor shown in figure 3(d), offers a noninvasive technique for measuring the concentration of oxygen in human blood. In other words, Haemoglobin (Hb) is a protein found in the red blood cells that carries oxygen in human body. Haemoglobin levels differ from person to person and men usually have higher level than women. This sensor can also measure the pulse rate of the user. The pulse oximeter probe that was used for experimentation in this research work had an absorption wavelength of 905 nm, pulse rate of 30-245bpm and 3 feet long. The Galvanic Skin Response (GSR) sensor shown in figure 3(e) is employed for measuring the electrical conductance of the skin. The GSR sensor is used to measure sweat gland activity, which is related to emotional arousal (Xu et al., 2014). The GSR sensor spots strong emotions of the user, by attaching two electrodes to two fingers on one hand of the user (Parkka et al., 2006). The specifications of the Galvanic Skin Response (GSR) sensor that was tested for experimentation in this research work had an Input Voltage rating of 5V/3.3V, the Sensitivity of the sensor could be adjusted by means of a potentiometer that comes along with the kit including external finger cots for data acquisition. Body Position Sensor shown in figure 3(f), is capable of monitoring five different user positions (standing/sitting, supine, prone, left and right.). Body Position Sensor uses a triple axis accelerometer to obtain the user position. The body position sensor that was utilized for our experimentations was offered by eHealth medical development platform. The Sphygmomanometer sensor shown in figure 3(g) is employed to monitor and record the blood pressure of the user. The MPS20N0040D-D Sphygmomanometer Pressure Sensor 0-40kPa DIP-6 for Arduino M&O is being utilized for the EHK. Glucometer sensor shown in figure 3(h) is employed for glucose monitoring (Bakker et al., 2011; Gia et al., 2017). The sensor consists of clip to be fixed in a finger of the user. This sensor is an additional feature of the EHK to enable diabetic users to analyze their body condition during specific epidemic.

Figure 3. Sensors for Epidemic healthcare kiosk (EHK)



3.3 Quantum Machine Learning

Quantum neural network (QNN) has been employed for data processing and acquisition. Quantum neural networks model is deployed to speculate the given data set. QNN can exponentially increase the amount of computing power and the degrees of freedom for a computer, which is limited for classical computers. A quantum neural network has computational capabilities to decrease the number of qubits used, number of steps and computational time. Conventional Back propagation learning algorithm has been engaged for the tested convolution neural network (CNN) architectures. Back propagation algorithm was implemented with a definite size of twelve in a batch. The activation function that was imposed in this work is the linear activation function. In convolution neural network (CNN), it was obligatory for all the convolutional and the first 2 fully connected layers. The softmax function was used to create the last fully connected layer. The learning rate for initial signal patterns was 0.07 which is referred as the unsupervised learning rate. This initial learning was established for 900 epochs. The supervised learning rate was about 0.08 with 870 epochs. For data convergence the learning rate was set to 0.8 with regularization 0.2 to prevent over-fitting of data and momentum $3x10^{-4}$ to control the learning speed during training phase. The learning rate for initial signal patterns was 0.05. This initial learning was established for 800 epochs. The supervised learning rate was about 0.07 with 860 epochs.

3.4 The IoT Interface

The science and technological developments in the field of IoT are utilized to design and develop an IoT interface for transmission, storage and cloud computing. The EHK system comprises ten sensors (possibly be extended) connected to the user. These sensors communicate with a data concentrator and processor. The concentrator has the responsibility of collecting each of the data sensed by the various sensors following a particular sampling rate. The Arduino interfacing microcontroller shown in figure 4 has been utilized as the data concentrator with applied scheduling using protothreads (Atzori et al., 2010; Broll et al., 2009; Istepanian et al., 2011; Schimpf, 2012). Protothreads are small programming routines. Protothreads provide cooperative multitasking in a system and also provide smooth program execution. Protothreads offer sequential flow control without complex state machines or full multi-threading. These protothreads occupy minimal memory. This interfacing and data concentrator shapes the Body Area Network (BAN) of the EHK system (Kumar & Lee, 2012; Paschou et al., 2013; Yehia et al., 2015). The features of Arduino are tabulated in table 1. The Arduino data concentrator is also capable for small range wireless communication methodologies like Zigbee, WLAN, 6LoWPAN, Bluetooth and wired USB serial communication to communicate with the data processing unit, a mini computer (Ghasemzadeh & Jafari, 2011; Gubbia et al., 2013; Li et al., 2013). This interfacing part of the EHK functions in two modes, the local operation mode and remote operation mode. The local mode of operation involves data collection from sensors, data processing, displaying the information and data transfer to cloud storage (Jiang et al., 2014; Miorandi et al., 2012; Wang et al., 2014) for later access by physicians and authorized personnel of the epidemic control board. The remote mode of operation involves immediate information access by nearby physicians and authorized personnel of the epidemic control board.

Figure 4. Arduino Interfacing Microcontroller (adapted from Google)

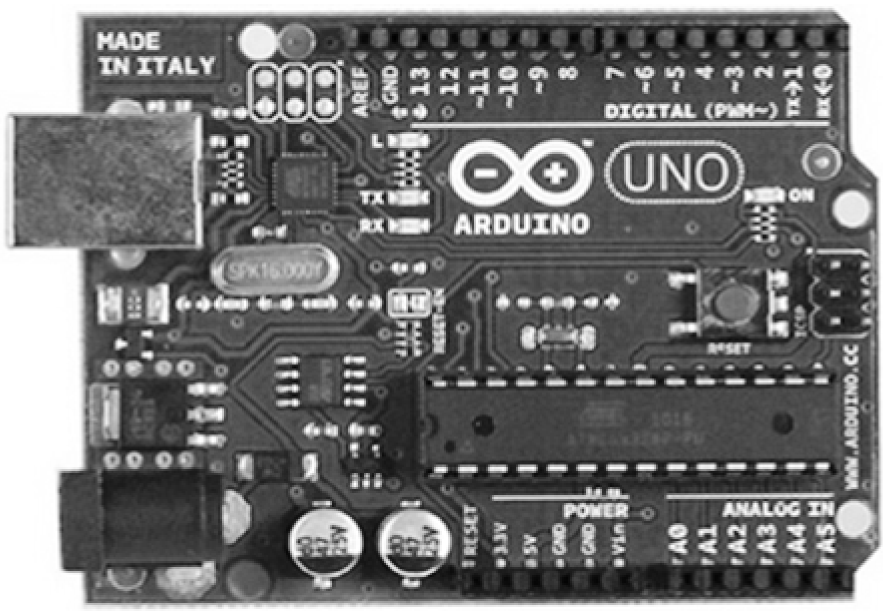


Table 1. Arduino Interfacing Microcontroller Features (adapted from Google)

Features	Specifications
Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 Ma
DC Current for 3.3V Pin	50 Ma
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

The proposed IoT based Epidemic Healthcare Kiosk as shown in figure 1, involves a three-layer IoT architecture comprised of the lower Identification layer, the middle Gateway layer and the upper Cloud server layer. The responsibility of the lower layer, the Identification layer is to identify sensors and devices, collect the necessary data from the sensing elements and devices and to transmit the gathered data to the immediate upper layer. The responsibility of the middle layer, the gateway layer is to link with the Cloud server. The gateway layer establishes a stable connection with the cloud server, manages the connectivity and transmits the gathered sensed data and information to the Cloud server. The upper Cloud layer is responsible for sorting and storing the data in a retrievable format in remote servers or local servers. Data and other information can be retrieved from these servers through internet. Thus, the proposed methodology offers a easily configurable and flexible architecture for heterogeneous devices and things connectivity with IoT.

Talking about the IoT protocols, there are several possibilities of data communication in IoT enabled devices using appropriate protocols. The most widely used IoT protocols are; Extensible Messaging and Presence Protocol (XMPP), Constrained Application Protocol (CoAP), Message Queue Telemetry Transport (MQTT), Low-Power Wireless Personal Area Networks (LoWPAN) and the Z-Wave Protocol. Message Queue Telemetry Transport (MQTT) protocol has been utilized in this work since it is much easier to connect other devices to the internet and cloud servers and supports interoperable platforms. Moreover, MQTT can be implemented with fewer overloads and minimum power consumption. The objective of MQTT protocol is to gather all the physiological data from the data acquisition sensors of the EHK system and execute transmission of these information to the cloud servers.

4. RESULTS AND DISCUSSION

The proposed model was simulated on the work desk as shown in figure 5. Thirteen members participated as volunteers for testing the simulation. A sample of these thirteen volunteers Electrocardiogram (ECG) is shown in figure 6. Table 2 portrays the BMI values of the thirteen volunteers. The data acquisition system was investigated using various sensors. The sensor signals and data were acquired by experimenting on the volunteers of this work. The analog to digital conversion (ADC) of sensor signals were accomplished by using a multi-channel ADC, the Texas Instruments ADS8588S device. This ADC is an 8 channel, integrated data acquisition (DAQ) system based on a simultaneous-sampling, 16-bit successive approximation register (SAR) ADC operating at a maximum of 200k SPS per channel. It offered excellent performance with 200-k SPS and maximum throughput on all channels. A step size of 5mv was achieved and imposed for ADC conversion. The support for serial, parallel, and parallel byte communication enabled the device to be interfaced with other components and Arduino at ease. Better and precise results were achieved by setting the sampling frequency at 1kSPS. The proposed four layer IoT architecture comprising of the lower Identification layer, the Gateway layer, the data processing layer and the upper Cloud server application layer was implemented successfully. The MQTT protocol was investigated and tested to gather all the physiological data from the data acquisition sensors of the EHK system and executed transmission of these information to the cloud servers. The Amazon web services (AWS) Cloud server services were utilized for cloud storage of data and parameters. Message Queue Telemetry Transport (MQTT) protocol has been utilized in this work since it is much easier to connect other devices to the internet and cloud servers and supports interoperable platforms. Moreover, MQTT was implemented with fewer overloads and experimentation proved that the protocol's power consumption was considerably low in the order of milli amps. The power consumption depends upon the type of application for which the MQTT protocol has been utilized. The digital data communication ranges of various techniques that were investigated are tabulated in table 3. Wireless communication techniques; 2G and 3G through cellular network offered a data rate of approximately 4500 Kbps. Wi-Fi communication methodology using Wireless transmission protocol standard IEEE 802.11 b/g/n offered a data rate of approximately 950000 Kbps and supports a maximum of 17 meters of communication. Wireless transmission methodology using Zigbee with the protocol standard IEEE 802.15.4 offered a data rate of approximately 230 Kbps and supports a maximum of 257 meters of communication. Bluetooth Wireless transmission methodology offered a data rate of approximately 600 Kbps and supports a maximum of 28 meters of communication. However, the power consumption was heavy using Bluetooth technique of communication. While the low energy Bluetooth also seemed to consume more power and offered a data rate of approximately 900 Kbps and supports a maximum of 10 meters of communication. Cellular networks and Zigbee methodologies seemed to be more advantageous compared to other techniques. However, the techniques utilization depends upon the particular application. The average output power of the various sensors used in EHK was found to be 10.713mW with an output current of 2.893mA.

Figure 5. Simulation of Kiosk Model

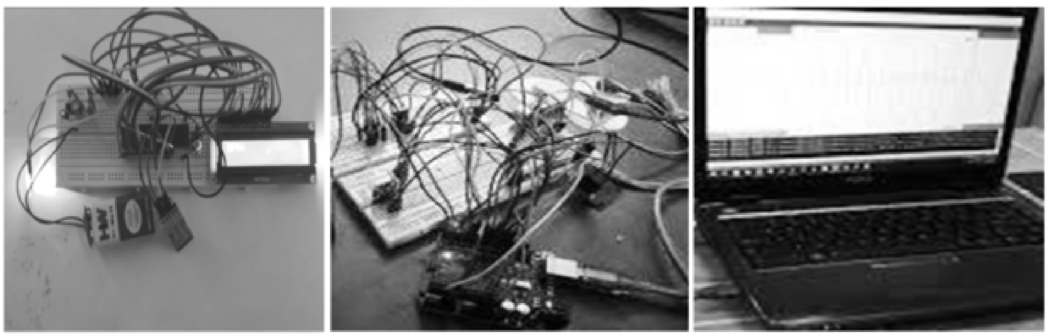
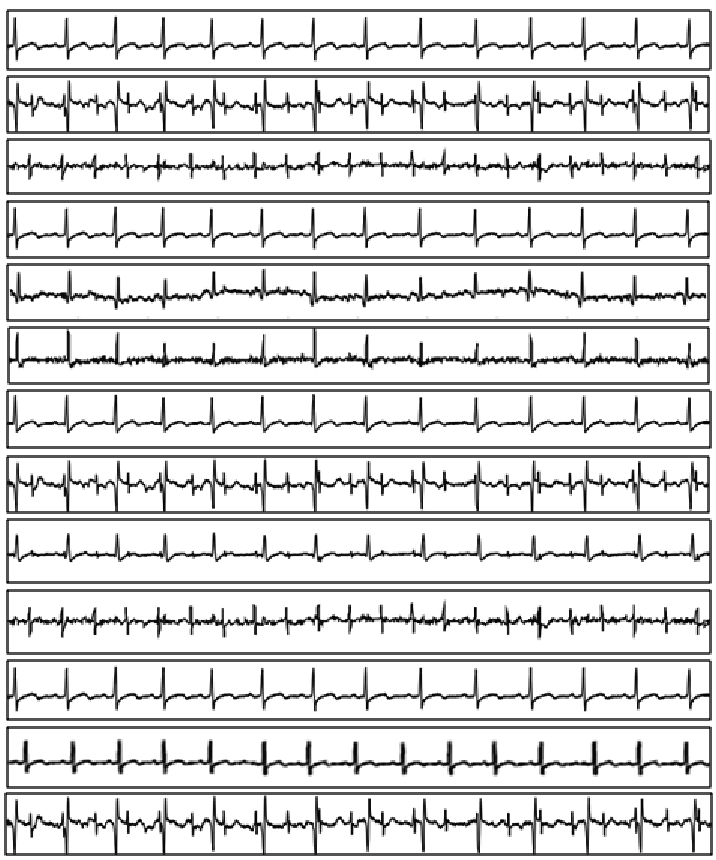


Figure 6. Electrocardiogram (ECG) plots of thirteen volunteers



ECG plots of 13 volunteers, Amplitude -100 μv to +100 μv, Time duration 0 to 20 ms

Table 2. BMI values of thirteen volunteers

BMI	Ht in ft	wt in Kg	Age
case 1	5.23	69.43	34
case 2	5.46	73.41	37
case 3	5.02	71.03	23
case 4	5.35	72.62	40
case 5	5.17	61.82	21
case 6	5.53	74.67	39
case 7	5.61	82.73	48
case 8	5.38	81.68	52
case 9	5.71	63.37	69
case 10	5.73	81.42	46
case 11	5.13	76.92	41
case 12	5.27	82.51	38
case 13	5.61	87.31	64

Table 3. Communication Range

Methodology	Protocol/Standard	Communication range in Meters	Data Rates (Kbps)
2G-3G	Cellular network	Entire network	Approximately 4500
Wi-Fi	Wireless transmission protocol/ IEEE 802.11 b/g/n	17	Approximately 950000
Zigbee	Wireless transmission protocol/ IEEE 802.15.4	257	Approximately 230
Bluetooth	Wireless transmission, power consuming protocol	28	Approximately 600
Low Energy Bluetooth	Wireless transmission, power consuming protocol	10	Approximately 900

5. CONCLUSION

This article portrays a prototype of an Epidemic Healthcare Kiosk (EHK). The experimentation and simulations yielded promising results and hope for the betterment of humanity. The measured parameters and the user details are stored in the cloud database using IoT and wireless communication. The cloud service offers Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) to the host EHKs Cloud-IoT healthcare application. Data comes from various EHKs in a geographical region. These data and information can be accessed by the authorized physicians and officials of the epidemic control board for physician analysis, treatment, patient management and tracking, isolation of abnormal patients and for future reference. The epidemic control board can initiate necessary medical interventions on those patients who were found to be abnormal and provide the society an economic telemedicine for the respective patients. This proposed framework provides extensive applications especially to field of healthcare and to all the stakeholders involved in various fields at different levels.

The IoT interfaced Cloud server provides all the necessary data to the Physicians for clinical analysis, diagnosis, interpretation and interventions for the betterment of patients and to the society, which very vital during an Epidemic. The people themselves can assess their health condition and request for necessary healthcare attention from the hospitals where they feel comfortable, trust worthy and better healthcare solutions. Thus people are no longer required to go to the hospital for consultation. The EHK extends rural outreach – people in rural areas can make use of the EHK during emergency situations especially during an epidemic. The EHK makes life easier for the society, patients and the Physicians. However, the design and development of such kiosk involves a good Graphical User Interface (GUI). This would be the most important factor for user interaction and for guiding the users with the kiosk operations and data acquisition procedures. The GUI would require an introduction or animation like video to educate the users just like a user manual. Moreover, due to lock down and pandemic situations we were not able to investigate case studies. The development of a very good GUI and case studies would be the possibility of future work.

CONFLICT OF INTEREST

The authors of this publication declare there is no conflict of interest.

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