

**CYBER PHYSICAL SYSTEMS**

**Smart Rural Healthcare Monitoring System**

Cyber Physical Systems, CISCOLab

A Report on the e Project Smart Rural Healthcare Monitoring System

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| TEAM Name : **Smart Rural Healthcare Monitoring System** |
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| Project Title : Rural Healthcare Monitoring System |
| **1. Introduction**  1.1  With improvement in technology and miniaturization of sensors, there have been attempts to utilize the new technology in various areas to improve the quality of human life. One main area of research that has seen adoption of the technology is the healthcare sector.    **The existing system includes various healthcare devices** like pedometers, heart rate monitors etc. which tell you about your respective body condition e.g your heart beat or how many steps you walked in a day.    **The problems that are generally faced in this sector include** –         People in need of healthcare services find it very expensive and this is particularly true in developing countries.         People in rural areas are unaware of how to use certain healthcare equipment.         They overwork themselves physically as the major source of their income might be physical labour.         They might smoke and drink too much.         The healthcare devices available in the market collect data that is of no use to the people in rural areas because they don’t know how to analyse it. (e.g. They won’t know what heart rate is too high to be normal.)         The people in rural areas are more prone to accidental disasters like fires and water overflows in dams. This is also an aspect of rural healthcare which is being completely ignored.  1.2 Problem Statement  Coding and implementing a chat-bot from scratch which specializes in medical and health data can be challenging. A chat-bot which can be talked with, which can be used in rural areas in particular is a bit more challenging. Our problem statement is the economic and efficient standalone healthcare unit development and its adaptability in various environments.  We are aiming to make a project which can not only diagnose diseases but also help patients with health problems, make appointments, get information on illnesses and how to prevent them. |
| **2. Overview and Planning**  2.1 Proposed System Overview  In our project we are developing a healthcare technology through a medical chatbot irrelative of the traditional healthcare system and it’s Beneficial using a cloud systems which helps in sending the requests from the patients to the cloud which helps in a faster diagnosis of the diseases. Firstly, we are processing the data using a high performance computing system which is parallel processing and hence helps in giving three result in an efficient and faster way.Basically, interfacing HPC and parallel processing helps in providing the results or output faster.An additional feature in this project is the iris scanner which diagonisis chronic diseases in a smarter way with the help of DSLR,a macro lense and using an indirect bio lense. And in addition to this we have also incorporated a complete medical datasets into the HPC which further adds to the easy diagonisis of any major diseases or any sort of medical issues. And we are using various sensors for a basic healthcare monitoring like heartbeat, blood pressure, pulse and temperature. Overall, our project involves in out ruling the traditional healthcare system by introducing a technological and a versatile rural healthcare management system using HPC for its efficiency and other resources .  2.2 Challenges  Healthcare is a sector where precision and accuracy are mandatory. The challenges that are/will be faced in this project are:   1. Knowledge of making a chat-bot which can speak and can take speech inputs 2. Resources availability 3. Finding the suitable technique to build the chat-bot 4. Implementing NLP and learning algorithms 5. Collecting appropriate medical datasets 6. Iris scanning procedure 7. Complete implementation with smooth flow in the first testing stage   2.3 Assumptions  The assumptions that we have are:   1. The microprocessor we use will be compatible with the HPC. 2. The blood pressure monitor can be connected with the computer and the results can be displayed in the computer monitor. 3. The iris scanning procedure is adaptable and can be automated in future.   2.4 Architecture Specifications  2.4.1 High-level:  The main components of the project are:   1. HPC with a monitor 2. 2 microprocessors- Arduino or raspberry pi3 3. Health care sensors- heartbeat, blood pressure and temperature 4. A webcam and microphone 5. A DSLR and extra components           2.4.2 Low-level:  The HPC is connected with a monitor. The AD8232 ECG Heart Beat Sensor Module and MAX30205 Human Body Temperature Sensor Kit are connected to the microprocessors to get analog data of the heartbeat and temperature of a person. The analog data is converted into digital with the help of ADS1115 16-Bit ADC – 4 Channel with Programmable Gain Amplifier.  The Advanced Up-Arm Blood Pressure, Heart Rate Monitor can be connected to the HPC via a USB cable and the results can be displayed on the monitor to display and can be saved into digital records.  The DSLR camera and the prime lens are mounter on the camera adaptor, with an indirect BIO lens to get the retina image of the human eye, which can then be processed to get diagnosis of the person.  The HPC also has a webcam and a microphone for the image of the patient and for the speech input of the patient.    2.5 Realistic Constraints and Standards  Realistic constraints that will be faced are:   1. The mounting of the camera along with the lenses and learning and adapting the procedure to take the retina photography. 2. Automation of the above   The standard of the present smart healthcare system are:   1. The availability of a medical chat-bot that can be communicated via texts or an app 2. The availability of a wearable heath-monitoring device 3. A microprocessor along with various sensors which can monitor almost all heath conditions of a human. 4. Developing Iris scanning techniques. |
| **3. Hardware and Software – Requirements**     |  |  |  |  | | --- | --- | --- | --- | | Product Name | Make | Cost of each | Quantity | | HPC- HP Z2 Tower G4 Workstation | HP | Ru. 72,039 | 3 | | AD8232 ECG Heart Beat Sensor Module | Omatom Power | Ru. 2,500 | 3 | | MAX30205 Human Body Temperature Sensor Kit | Maxim Integrated | Ru. 3,719 | 3 | | Canon EOS Digital Rebel XTi (a.k.a. 400D) 10.1 Megapixel, SLR, Digital Camera Body (Black) | canon | Ru. 7,781.05 | 1 | | Canon EF-S 60mm F/2.8 USM Prime Lens for Canon DSLR Camera | Canon | Ru. 58,816 | 1 | | Indirect BIO lens- 20 D | Volk | Ru. 23,942.57 | 1 | | Advanced Up-Arm Blood Pressure, Heart Rate Monitor with USB Port, Data Analysis Software | NatureSpirit | Ru. 4,891.73 | 3 | | Logitech C310 HD Webcam (Black) | Logitech | Ru. 1799 | 3 | | Oraima Flexible Goose Neck 3.5 mm Mini Microphone for Table Top, Desktop Notebook Computer (Black) | Oraima | Ru. 350 | 3 | | ADS1115 16-Bit ADC – 4 Channel with Programmable Gain Amplifier | Robu.in sku= 43582 | Ru. 373 | 3 | |
| **4. System Implementation ( Test Bed- Already completed works)**  4.1 Module Development –Code  #include <SoftwareSerial.h>  //flame  int buzzer = 8;  int flame\_sensor = 4;  int flame\_detected;  //water  const int read = A1;  int value;  //shock  int vibswPin = 9;  int ledPin = 13;  int val = 0;  void setup() {  Serial.begin(9600);  pinMode(buzzer, OUTPUT);  pinMode(flame\_sensor, INPUT);  pinMode(vibswPin,INPUT); //initialize vibration switch as an input  pinMode(ledPin,OUTPUT); //initialize ledPin switch as an output  }  void loop()  {  //flame  flame\_detected = digitalRead(flame\_sensor);  if (flame\_detected == 1)  {  Serial.println("Flame detected...! take action immediately.");  digitalWrite(buzzer, HIGH);  delay(200);    }  else  {  Serial.println("No flame detected. stay cool");  digitalWrite(buzzer, LOW);    }  //water  value = analogRead(read); //Read data from analog pin and store it to value variable    if (value<=540){  Serial.println("Water level: 0mm - Empty!");  }  else if (value>540 && value<=565){  Serial.println("Water level: 0mm to 5mm");  }  else if (value>565 && value<=609){  Serial.println("Water level: 5mm to 10mm");  digitalWrite(buzzer, 20);  delay(1000); // wait for a delayms ms    digitalWrite(buzzer, 0); // 0 turns it off    delay(1000);  }  else if (value>609 && value<=637){  Serial.println("Water level: 10mm to 15mm");  }  else if (value>637 && value<=645){  Serial.println("Water level: 15mm to 20mm");  }  else if (value>645 && value<=670){  Serial.println("Water level: 20mm to 25mm");  }  else if(value>691)  {  Serial.println("Water level: 25mm to 30mm VERY HIGH WATER LEVEL, HIGH RISK");    }  //shock  val = digitalRead(vibswPin); //read the value from vibration switch  if(val == HIGH) //without vibration signal  {  digitalWrite(ledPin,HIGH); //turn on the led  }  else  {  digitalWrite(ledPin,LOW); //turn off the led  }    delay(5000);  }  //Smoke  int sensorPin = A0;  int sensorValue = 0;  int led = 13;  void setup()  { // declare the ledPin as an OUTPUT:  pinMode(led, OUTPUT);  Serial.begin(9600);  }  void loop()  {  Serial.println("Welcome to IoT Class ");  sensorValue = analogRead(sensorPin);  Serial.println(sensorValue);  delay(5000);  if (sensorValue>400)  {  digitalWrite(led,HIGH);  }  else  {  digitalWrite(led,LOW);  }  }  //heartbeat  int led\_Pin = 13; // initializing the led pin  int output\_Pin = A0; // initializing the sensor output pin  //initializng other variables  double alpha = 0.75;  int period = 200;  double change = 0.0;  void setup ( ) // Code written in it will only run once.  {  pinMode (led\_Pin, OUTPUT); // declaring led pin as output  Serial.begin (9600); // setting baud rate at 115200  }  void loop ()  {  // initializing other variables  static double oldValue = 0;  static double oldChange = 0;  int rawValue = analogRead (output\_Pin); // Reading the sensors values  double value = alpha \* oldValue + (1 - alpha) \* rawValue; // calculating values using the formula  Serial.print (rawValue); // printing the sensor output value on the screen  Serial.print (",");  Serial.println (value); // printing the heart beat value on the screen  oldValue = value;  delay (period);  }  4.2 Output/Results    The sensors which we used efficiently worked. The flame sensor rang the alarm when a spark or flame was created, the water sensor accurately measured the water level, shock sensor made the LED glow in case of a sudden movement -which might be the cause of an accident- which then alerts an ambulance. The heartbeat sensor recorded the heartbeat and can be used to calculate the BP too. The smoke sensor effectively notifies when smoke was detected, which can then be uses to detect smoke from either a fire or from continuous smoking and the GPS sensors sends the precise location from which an accident, or a patient will be detected to be present. Thus these can used to:   * Notify when a fire or smoke is detected to help put off and notify the nearest fire brigade. * Notify about the water level to either shift or release or preserve water accordingly. * Notify the ambulance immediately with the precise location of an accident when an accident is detected through shock sensor. * Monitor over the heartbeat and BP of an individual and notify the healthcare personnel nearest in case of abnormality.   Flame sensor output:    Shock sensor output:    Water sensor output:    Heartbeat sensor output:      4.3 Discussion     1. In the first stage, where we have the access to the primary resources to bring this project to life. So far, we could experiment on how efficiently the flame, water, smoke, heartbeat, GPS and shock sensor worked. And it showed satisfying results. 2. In the second stage, we made a basic chat-bot which could be communicated by text input with a speech output. 3. For the third and the upcoming stages, we are aiming to make a medical chat-bot which will be speech – to – speech which can diagnose a patient’s disease or illness, make appointments, contact doctors online and prescribe medicines. It includes an iris scanner which can increase the accuracy of the chat-bot. A basic heath monitor will be included as well which will monitor a patient’s heartbeat, blood pressure , pulse and temperature.       **5. References**  **An Analytical Method for Diseases Prediction Using Machine Learning Techniques**  **BY:-** Mehrbakhsh Nilashi , Othman bin Ibrahim , Hossein Ahmadi , Leila Shahmoradi  (Some lines are taken from this paper)  **Understanding:**  In this research, PCA(Principal Component Analysis), EM (Expectation-Maximization), CART (Classification and Regression Trees) , and fuzzy rule-based techniques are used.  EM clustering is used as an unsupervised classification method to cluster the data of experimental dataset into similar groups. Fuzzy rule-based method is used to learn the prediction models. And PCA for dimensionality reduction because as per them, the greatest source of difficulties in using classification methods is the existence of multi-collinearity in many sets of data.  In the first step, the data is pre-processed. In the second step, EM clustering processing steps are performed to cluster the data and then we apply PCA to reduce the dimensionality of the data and filter out potential noise. We then apply CART for discovering the decision rules from the data. Next, prediction models are constructed by fuzzy rule-based method in each cluster.  In fuzzy methods, there are several step by step procedure to get the required output; that are input fuzzification, generating Membership Functions (MFs), extracting fuzzy rules and output defuzzification.  **Pros:**  As per them, the results of the following research indicated that the method which combines clustering, PCA, and fuzzy rule-based techniques obtain good prediction accuracy.  Compared to the big healthcare data, the nature of the data in the datasets used by them is not complex.  **Cons:**  As per them,  The methods used here take more data processing time, so new methods in order to overcome the challenges of data processing time can be helpful.  Big healthcare data include multi-spectral, heterogeneous, imprecise and incomplete observations (e.g., diagnosis) which are derived from different sources, therefore new methods are needed and relying solely on conventional machine learning techniques may not be a sophisticated way of predicting diseases.  More attention should be paid to the datasets for disease classification and prediction using the incremental machine learning approaches.  --------------------------------------------------------------------------------------------  **Classifying smoking urges via machine learning**  **BY:-** Antoine Dumortier, Ellen Beckjord, Saul Shiffman, Ervin Sejdic´  (Some lines are taken from this paper)  **Understanding:**  Smoking is the largest preventable cause of death. Advances are made in modern electronics and machine learning that can help us deliver real-time intervention to smokers in many ways. In this paper, author has used two machine learning approaches - Bayes discriminant analysis and decision tree learning, to help smokers quit smoking. The features included by them are situational such that it gives helps to stop the urge of smoking based on three classification approaches which are evaluated by observing sensitivity, specificity, accuracy and precision. Dataset was collected from 300 participants who wants to quit smoking. The method proposed by the authors showed 86% accuracy in classifying various urges of smoking.  **Pros:**  As per the authors,  The machine learning approaches may be useful in guiding predictive mobile interventions, as well as providing a more accurate support to existing smoking cessation.  Patients would be able to update their situation more often than they initially did.  More observations would conjointly contribute to increase the amount of available data and thus improving the accuracy of the machine learning algorithms.  The main positive aspect we could get from it would be the ability to provide real-time intervention before a patient relapse, and without requiring any medical intervention.  These kind of algorithms could be implanted into mobile systems for smoking cessation purposes.  **Cons:**  As per them, the only limitation is the available dataset. With additional and more recent data, new investigations could be conducted and the new features could increase the classification’s accuracy.  -----------------------------------------------------------------------------------------------------------  **A MACHINE LEARNING MODEL FOR IMPROVING HEALTHCARE SERVICES ON CLOUD COMPUTING ENVIRONMENT**  Cloud computing is being emerging as the important factor in the Healthcare development due to its high performance compared to the other sources by using virtualization technique. Virtual machines plays an important role in reducing the requests time and therefore assists in increasing the maximum cloud utilization. Nowadays, major problem faced in the health Centre is the time delay. A VMs optimization model is proposed using PPSO algorithm to improve the performance of HCS applications. Second, a CKD diagnosis and prediction model is proposed to reduce the execution time of Chronic kidney disease prediction requests processing and speeding up reply to CKD prediction requests coming from stakeholders, and maximizing utilization of cloud resources. For this process to take plays cloud broker plays an important role and helps in sending requests to the cloud  The proposed architecture has four major components: stakeholders’ devices, stakeholders’ requests (tasks), cloud broker and network administrator. Stakeholders uses a variety of methods to obtain medical information through cloud computing to obtain different medical services through various diseases. Network administrator is responsible for running the algorithm which helps in the maximum resource utilization. In order to calculate the execution time of the stakeholders requests PPSO algorithm is uses CPU utilization, turn-around time and waiting time. Firstly, CloudSim is used to implement the proposed PPSO algorithm to find optimal selection of VMs. The first implementation is the default CloudSim where first task takes the first VM; the second task takes the second Virtual machine.  The proposed model has a high flexibility through changing the number of processors, tasks, VMs and etc easily. The robust of the proposed model is clear concerning the efficiency of PPSO that out- performed the efficiency of default CloudSim package and the state-of- the art techniques and it succeeded to select the optimal VMs in cloud environment. This algorithm helps in reducing the execution time of the requests and the maximum utilization of the resources. If the probability of the result of the patient is zero, then it means there is a greater risks of chronic kidney diseases. Finally, as a result the accuracy level of the proposed model is compared to the normal method. The results show that the proposed model greatly improves the CKD prediction accuracy by 64% .  By determining the optimal VMs on cloud computing, HCS applications will be able to reduce the execution time .This paper proposes a new model for HCS in a cloud environment using PPSO to determine optimal selection of VMs. In addition, a hybrid model for predicting CKD based on cloud environment is proposed.  -----------------------------------------------------------------------------------------------------------  **A Review on IoT Healthcare Monitoring Applications and a Vision for Transforming Sensor Data into Real-time Clinical Feedback**  Ageing populations and the increase in chronic diseases all over the world demand efficient healthcare solutions for maintaining well-being of people. One of the most important strategy which drives away the concept is IOT technology which provides a huge demand in future related works in healthcare maintenance. This helps in decreasing the pressure on hospital systems and healthcare providers, reduce healthcare costs, and improve homecare especially for patients with chronic diseases and the elderly. This paper explores the use of IoT-based applications in medical field and proposes an IoT Tiered Architecture in order to transform sensor data into real-time clinical feedback. This includes various fields like *sensing, sending, processing, storing, and mining and learning*. This will help to develop useful and effective solutions for pursuing systems development in IoT healthcare applications. The result of the review found that the growth of IoT applications for healthcare is in areas of *self-care, data mining, and machine learning*.  The main aim of the research is to firstly, provide an overview of present technologies that support IoT- based applications. Secondly, to propose IoTTA for the design and development of solutions for integrating various technolo- gies in healthcare systems. Finally, suggest scenarios where IoTTA can be applied. IoT technology is often applied to developments in remote health monitoring solutions, for those who require regular attention such as patients with chronic conditions, disabilities, and elderly .When a particular emergency case is detected, the ambulatory team can reach out the patient. Consequently the hospital prepares for the clinical treatment, and the medical personnel send situation-aware instructions for providing first aid.  Sensing layers involves various sensors to record the health conditions of various patients. The most commonly used parameters are body temperature, blood pressure, pulse rate, and respiratory rates. Local communication between sensing layer and processing layer, is normally implemented by Bluetooth . Bluetooth is a low cost, low power consumption technology to transmit data over short distances at the frequency of 2.4GHz. finally,this paper outlines the health issues that the traditional healthcare models are facing in our ageing society, which includes the increase in chronic diseases and rise in hospital and clinical services costs. To decrease pressure on hospital systems and healthcare providers, improve the quality of care and reduce healthcare costs, effective and efficient medical systems need to be developed. Remote healthcare monitoring systems based on IoT technology has tremendous potential.  -----------------------------------------------------------------------------------------------------------  **Diagnosis of hypothyroidism using a fuzzy rule-based expert system**  **BY:-** Sajadi NA, Borzouei S, Mahjub H, Farhadian M  (Some lines are taken from this paper)  **Understanding:**  It is an important thing that diseases should be diagnosed as early as possible, along with which accuracy for the same is required. In this papers, the author has diagnosed a type of thyroid disorder, hypothyroidism using fuzzy rules and logic. Hypothyroidism is very common now-a-days; people of all age groups can have this problem. So it is important to diagnose certain diseases like this as soon as possible in the right way. Here, the author uses a classifier based on the fuzzy rule system for prediction and obtains an accuracy of 97% which is better than the accuracy obtained in logistic regression models. Thus, the designed model gives us an acceptable and predictive performance for diagnosis of hypothyroidism in people.  **Pros:**  People don’t need to go to the doctor, each and every time for the diagnosis.  It can be useful for the young specialist doctors for helping in diagnosis.  It can also be useful by students for self-learning and self-evaluation.  **Cons:**  No particular cons are found, except it fails in 3% cases.  A clubbed review of 5 research papers:   1. Applying Chatbots to the Internet of Things: Opportunities and Architectural Elements 2. Design and Implementation of Health care system based on IOT 3. ECG- Remote Patient Monitoring Using Cloud Computing 4. PFID Technology Combined with IOT Application in Medical Nursing System 5. A Proposal for Mobile E-Care Health Service System Using IOT for Indian Scenario   **ABSTRACT**:  The aim of this paper is to provide system for monitoring the patient by using Sensors and IoT. Mostly in rural areas real time monitoring of a person was not able at any time. Handling different patient in short period by doctors at same time and consulting the doctor frequently again and again those issue are problematic and costly.  HealthCare monitoring is a key to enrich the living hood and standardised life in rural region. This will work by data likes temperature of body and the pulse rate of a person on the request made by authorised person and display in a graphical format on a page. The evaluation includes like performance, implementation and analysis details. To propose an architecture and scheme of smart healthcare system based on Internet of Things (IOT) in order to overcome the disadvantages of the present hospital information system, such as the fixed information point, inflexible networking mode, the key technologies and construction of smart hospital is presented based on understanding of the connotation and architecture of smart healthcare.  Furthermore, a scheme of smart hospital is given, and its logic structure, application framework, the construction of basic network environment etc. are described in detail. Experiment proves that deployment of smart hospital can effectively solve the prominent problems existing the diagnosis and treatment of hospital and it brings a positive and profound effect for the present diagnosis and treatment mode in rural areas.  **Scope of Medical Chatbots:**  This paper proposes the use of Intelligent Conversational Agents. We refer to these as simply Chatbots (also known as Chatterbots or bots in general). Interestingly, there are many definitions for Chatbots in close relation with Software Agents (SA), Virtual Agents (VA) or Intelligent Personal Assistants (IPA) in literature and these have often been used in conjunction with each other. The term “Agents” itself has many definitions but among the earliest and most well-known uses of the term is- "A self-contained, interactive and concurrently-executing object, possessing internal state and communication capability."  The scope of Software Agents can be most closely associated with Chatbots and has been well documented in literature. The following key properties have been associated with Software Agents: (1) reactive, (2) proactive and goal-oriented, (3) deliberative (4) continual (5) adaptive (6) communicative, and (7) mobile. The purpose of this paper is not to explore the various types of Software Agents and agent-based systems or its properties but rather propose the solution to challenges faced in IoT through the use of the umbrella term for these Intelligent Conversational Agents, Software Agents or Chatbots as we refer to them. It is also important to note that Software Agent distinguishes itself from Intelligent Agents (also known as Rational Agents).  Intelligent agents are not only computer programs. They can also be machines, humans or anything that is capable of a goal directed behaviour. Typically, Chatbots are classified into two types: (1) Chatbots that function based on Rules (2) Chatbots that function based on Artificial Intelligence. Chatbots that function on rules are often limited as they are only as smart as they are programmed. On the other hand, AI based Chatbots give the impression of being “intelligent” as they are capable of understanding natural language, not just pre-defined commands but get smarter as they interact more due to their ability to maintain different states. Based on this, concepts such as Virtual Agents and Intelligent Personal Assistants (IPA) have come up, which uses natural language processing, as well as speech recognition techniques. For example, Apple Siri, Amazon Alexa, Microsoft Cortana and Google Assistant.  In this paper we present a novel paradigm combining these two disparate concepts in a single solution. However, the studies of these paradigms have largely been separate endeavours. We discuss how using chatbots as intelligent conversational interfaces can be used to address critical problems in IoT. We also propose a high-level conceptual architecture and discuss key elements involved in communicating with an IoT system through Chatbots. To explain in the context of real world applicability, we put forth existing solutions to each of the components in the architecture including frameworks, platforms and specify open-source tools which can be used to build such a system.  **CHALLENGES IN IoT:**  Despite the wide scale efforts to popularize IoT, it still offers many practical challenges. Primarily, IoT systems operate in isolated technology or vendor specific silos which inhibits capability, value, and interoperability and create a widely disparate area. Specifically, by restricting heterogeneous devices (home appliances, mobile phones, embedded devices etc.), sensors and services to communicate with each other across interconnected networks, possibilities of countless applications are hindered.  Secondly, the sheer number of connected things has already started to create problems in application, device and data management in IoT. To address this issue, IoT platforms (such as Cisco IoT, IBM IoT, Microsoft Azure IoT, AWS IoT) offer scalable, distributed cloud based services in order to allow businesses to quickly connect to an established infrastructure, service or software without having to worry about the backend complexities. While IoT Cloud is a step in the right direction, offering many advantages, it still presents many challenges particularly in interoperability which has led to the issues of platform fragmentation.  IoT systems also face a challenge of unifying User Interfaces (UI). It becomes increasingly difficult on users to keep track and access multiple applications, dashboards for every new “IoT object” in their ecosystem. Hence unifying experiences across multiple connected things and providing them with a high degree of smartness for improved user experience is a key challenge.  The shortcomings of modern IoT systems can be broadly classified into two types:   1. Technology Centric Challenges 2. Human Centric Challenges.   With the help of sample chatbot user conversations given below, we discuss the opportunities for Chatbots and demonstrate ways in which Chatbots can overcome challenges in IoT.    **SAMPLE CHATBOT-USER CONVERSATION:**  Use Case (A) User: “Keep the living room temperature comfortable”  Chatbot: “The weather outside is a cool 17 degrees Celsius.  Setting temperature in the living room to 21.4 degree Celsius.”  Use Case (B) User: “How much is my car charged”  Chatbot: “The Tesla Model S is currently 40% charged. 3 Hours 10 minutes to full charge.”  Use Case (C) User: “Turn the light on in the guest bedroom”  Chatbot: “Which light would you like to have turned ON? The Lamp or Table Light?”  User: “Both”  Use Case (D) User: ‘Help me setup my new device’  Chatbot: “Here is some help to guide you through the setup”  “Which device would you like to setup?  1)Smart Lock  2) Smart Kettle  3) Smart light?”  User: 1 Chatbot: “Ok, Enter your secret passcode for the smart lock”  User: “\*\*\*\*\*” Chatbot: “Done. Smart Lock is now setup.”  Use Case (E) Chatbot: “The monitoring service indicates that the smart lock  has been offline for over 24 hours.”  Chatbot: “Would you like me to report the issue to the Smart Lock Vendor?”  User: “No, I want to talk to a human”  Human-Operator: “I can see the issue you are facing. I will try to resolve it remotely.”  **A. Technology Centric Challenges of IoT**  **1)** **Data Management**:  A key challenge in the realm of IoT, is managing the vast amount of big data being generated, as IoT sensors are becoming easily affordable. Not only is the data generated by the sensors large but also diverse (varying in quality and type) and multimodal (temperature, light, sound, video, etc.) in nature. While data deluge is one challenge, drawing insights from the data and being able to present it in a timely, understandable way is a much larger challenge. The situation can be best illustrated by the well-known Knowledge Hierarchy also called the DIKW (Data, Information, Knowledge, Wisdom) Pyramid in the context of IoT which calls for solutions to tackle the difficult challenges as one moves up in the pyramid. The data gets smaller but becomes more difficult to gain abstractions and perceptions (Knowledge), which is required to derive actionable intelligence (Wisdom). Chatbots are attempting to solve the problems of data and information management by mainly addressing the upper layers of the DIKW pyramid.  **a) Data Context**  Processing and analysing of IoT data can be solved through the many “big data” solutions and cloud platforms which offer storage and computing infrastructure to accomplish the task. These existing IoT cloud solutions handle Data source and transmission challenges. However, a major challenge of existing IoT systems is conveying data about the various interconnected devices (sensors, objects etc.) back to the user in a simple humanly understandable way. This requires context, which is achieved by enabling Chatbots to understand the true intent of the user query and collect and process information from their environments. Moreover, Chatbots have access to a global network of information via the internet and can be easily programmed to retrieve information in real-time which can improve the context. In practical terms, Chatbots simplify the way we consume information from multiple screens and heavy data and graphics to simple conversational interfaces capable of delivering highly contextual and intelligible information within the flow of the chat app itself. Achieving this high-level of abstraction can deliver actionable intelligence (wisdom) with domain and user knowledge to maximize the full potential of IoT. For example, in use case (A), the query was relatively vague. The Chatbot could have used contextual information from Real time outside temperature along with knowledge from historical user preferences to perform a specific action.  **b) Information Retrieval**  IoT dashboards are often saturated with various metrics, data points, charts and tables making it difficult for users to find the required information. Chatbots can effectively solve this problem by responding quickly to direct queries with highly accurate information. By understanding the specific intent of the user, they limit the scope of information for presentation. In terms of the knowledge hierarchy, Chatbots perform lookup and abstraction on IoT data. By automatically providing IoT data as well as user-contextual data to analytics, Chatbots can also derive its own knowledge. For example, in use case (B) the query only asked for Battery Charge related information and nothing else. The Chatbot limited the response accordingly.  **2) Device and Application Management**  A key challenge of IoT has been the fragmentation of technology. Having application interoperability between heterogeneous devices from a single remote (mobile device or operation terminal) is especially uncommon. For Example, consider the situation where a smart light and a Heating Ventilation and Air Conditioning (HVAC) system belong to the same network and environment yet may have different user control terminals which are mutually independent entities, unaware of each other nor able to control or communicate with each other.    Chatbots are built on IM platforms (such as Facebook Messenger and Slack) which support multiple different chatbot applications. A single chatbot application as well can use unique HTTP REST APIs pertaining to different IoT devices. Chatbots can thus act as a single interface for communication between single purpose devices (e.g. Controlling two smart lights), heterogeneous devices (e.g. Controlling a HVAC and a Smart Car) and even different IoT ecosystems (e.g. Controlling Smart home devices and Smart Retail devices) in the case of cloud based IoT. For example, in the Use cases above, the same chatbot is being used to converse with multiple heterogeneous devices. Provided the right permissions are available it can communicate with Public IoT devices  **3) Bridging Data across Platforms and Services**  IoT platforms can be seen as software development environments which handle Device management, Application management, Connection Management, Dashboard and Analytics. Yet owing to platform fragmentation, sharing of data across platforms is still uncommon. One solution is to solve the issue at the application level by using 3rd party services, which through APIs can access data from each platform. The data can be either processed on the various platforms or extracted into another service and used to deliver something of value which can then be presented through a single Chatbot interface.  **4) Search and Discoverability**  A key attribute in IoT is the natural tendency of objects to be dispersed in the environment while being interconnected and identifiable at class-level (i.e. common information across the same class) or serial-level (i.e. unique to an individual object). Based on the permissions of the requester and the availability of the connected objects in the scope of the environment, IoT requires lookup and discovery services to effectively find and control these objects. Such services include availability of sensors and actuators which the Chatbot would be able to retrieve from the entities and convey to the user at the appropriate times.  **5) Monitoring and Reporting**  From IoT wearables such as health monitoring devices to industrial sensors which convey information in real time, monitoring and reporting are key aspects of IoT systems. Chatbots can also be effectively used to perform as monitoring services by integrating with solutions such as Application Performance Management (APM). Accessing data from various IoT systems is a key advantage which is unique to Chatbots in this scenario. Similarly, Chatbot services can utilize its own reporting services and present the abstracted information to the user in an actionable and timely manner.  **B. Human Centric Challenges of IoT**  Chatbots were created with the primary purpose of improving the human-computer user experience. As such, solving the user experience shortcomings of IoT systems can be an important opportunity for chatbots. IoT, with its complex system of applications, sensors, actuators and services presents a daunting challenge of gaining technical knowledge to interact with these various components. Hence exposing settings and configurations to users presents an obvious and unfriendly burden that is far from ideal.   1. **Cognitive Burden**   The changing technology landscape of IoT is both imminent and rapid. Furthermore, as newer features and use cases are introduced, there is an added responsibility to educate the end users which can be burdensome for both the users and the developers of the system. Complicated systems cause difficulties in adoption and diffusion.  As an assistive technology, chatbots can simplify the learning curve by the following ways:  a) Help Features: IoT enabled Chatbots can feature help texts which clarify the user request to ensure that the action performed is same as the one intended.  b) Recommendations: Chatbots can recommend possible actions to the user which can be made more intelligent and context aware depending on user preferences and the dynamics of the environment.  c) Automation: Chatbots are good at automating common cyclic, tasks and can perform certain actions such as monitoring availability of sensors (uptime, downtime etc.) and others through routine API calls, Websockets or Publisher Subscriber methods.  d) Better Quality of Service (QoS): Feedback loops can be easily integrated within chatbots to aggregate most frequent queries and data from the process can be used to improve the future Quality of Service (QoS).  As more use cases are discovered, chatbots can make the adoption and diffusion of IoT systems significantly easier and reduce the cognitive burden required to understand the functionalities of these systems.   1. **User Interface Opportunities**   Graphical User Interfaces (GUI) for IoT are largely functional in nature. While it achieves simplicity by displaying virtual switches, sliders and buttons rather than passing complex commands, it still has some shortcomings which Chat interfaces can solve.   1. Chat interfaces understand natural language which makes interaction with the system as simple as asking queries and receiving answers. There is no need for navigation of menus and finding the right icon/button to perform a task. 2. Chatbots use machine learning techniques to learn about an individual user and can personalize the service to that user. In this way, they can understand the unique way the user converses with while maintaining the natural flow of the conversation 3. They are also highly contextual interfaces and can understand the intent in the scope of the past interactions which is unique to chat based interfaces (also speech). 4. Chat based interfaces concern mostly textual information thereby simple log files can be maintained and consequently analysed to make debugging easier      1. **Configuration Challenges**   Apart from the knowledge required to adapt to the new systems and ease cognitive burden, each IoT device has its own unique setup and configuration in terms of software, network, firmware etc. As the number of different IoT devices increase, it becomes difficult and burdensome at best to navigate the interfaces of various applications and properly configure the system. Often technicians are involved to configure and explain the uses of the system. Using Chatbots, users can be guided and advised on the right configurations for their system by creating step-by-step setup processes using predefined configuration APIs. This also reduces human effort in setting up the system. For example: A new device was configured in use case (D).   1. **Lack of Automated Error Reporting**   The distributed nature of most IoT systems implies that user report databases of IoT errors are spread across multiple organizations, Operating System (OS) vendors, ISPs, and device vendors which makes automated problem reporting a major challenge. Furthermore, users themselves are uncertain which organization to report the particular issue to. Thus, various stakeholders in the system have a limited understanding of the true nature of the problem and avoid sharing information with each other. Chatbots, in this scenario, can access these reported problems and by integrating other services, be able to not only retrieve information from the IoT system but send information to it. In Use Case (E), the chatbot identified the correct stakeholder to send the error.  **5)** **Support Challenges**    Remedying hardware and software issues in modern consumer IoT systems can be an irksome task. The recourse is to call the service provider for technical support or in many cases return the product. Either way it is an unnecessary burden on the user as well as the support vendors in today’s cost structure. Smart Chatbots often have support services built into their functionality. It can even integrate human-in-the-loop systems to handle situations the Chatbot is not trained or authorized to perform, in real-time. In this manner, users need not go beyond the scope of the chatbot application to look for product support. Any software issue or hardware malfunction can be monitored and Over the Air (OTA) software repairs can be performed. Chatbots can also be used to schedule technical repairs making it a convenient and fast solution to customer support [24]. For example, in Use case (E), a human operator was made to intervene.  **SMART HEALTHCARE MONITORING SYSTEM FOR RURAL AREA USING IoT & MEDICAL CHATBOT:**  Real-time healthcare monitoring provides enriched life care for fast aging population in rural areas. This technology was used to reduce cost expensive for rural people and life quality will develop senior citizen living hood .  1.Embedded sensors are used to collect the information to detecting the health changes in a body. Identifying the problem in beginning stage may help to cure. It will be more useful and benefit for people where above 60 years to promoting healthy life.  2. Currently, this technology has been increased for enabling of life style and standardised healthy aging. The major issue in the environment are capture truly sufficient data for analysing purpose. This approach is to monitoring the patient pulse frequently for independent living. Nearly half of the people in rural region may not know about heart disease and hypertension, arthritis. These systems are not analysed by the people and the issue was taken as a challenge to provide service by this study.  The appearance of IoT has been leading in a smart world for last 15 years the appropriation of solution to patients in hospital in specific place is still extremely conventional and obsolete. Patients sit tight for guide while in lines to get their treatment for causality. This is for the most part because of the non-appearance of an effective emergency problems. Moreover, we propose a basic and dependable way to deal with screen a patient.  The technique depends on electric sensors associated with Arduino-Uno and Raspberry Pi in collaboration with a medical chatbot to play out a solution in this pursuit. The usage expensive of such framework is extensively less expensive than other real-time framework for rural areas. This framework was compared and worked for rural region yet it can be summed up for different purposes.  It was dependably an essential need on the rural region to enhance clinic and hospital as far as electronic gadgets. This smart monitoring gives more proficient service to patient. The internet of things brought a innovation and advances in different field. An exceptionally pointing and emerging models for IoT is exhibited and procedure definition  Information gathering innovations that sense changes in physical status of things for then put away and shared this data. IoT utilizing diverse correspondence designs demand/reaction and notice in things with Nano-innovation that will supply and convey and co-operate with a specific and goal to fulfil some primary reason and client application.  Interface regular articles and gadgets to internet with a practical framework distinguishing pieces of proof for example pulse rate sensor. Create proper programming for concealing the heterogeneity. An arrangements of information mining /huge information/semantic-based empowering influences to permit separating data from expansive arrangements of information. Lastly application that connection clients with things. Absolutely the future, internet will made by billions of shrewd things with capacity of being identifiable import what’s more interface amongst themselves and with end clients. Along the pointing of this work and its commitments.  The method of monitoring patient as well as pulse rate and body temperature were present.in this technology we have design and implemented to solve the current problem of causality. There is some interact method which is helpful to avoid risk of mistakes occurs8. The main advantage is that every information of monitoring may save and helps to manage the data remotely. IoT is way to communicate all electronic sensors together in real-time monitoring.  In this methodology we have major functionality like  1. Assistance  2. Monitoring  3. Alerting  The simultaneously monitoring from the home for collecting information about changes of health condition. This assessment embedded with sensor environment and capture real-time activity pattern. They firstly display results which helpful for clinical analyses and the system provides automatic health alerts algorithm to identify the health problems in beginning stage that is very useful for possible treatment.  In this paper monitoring the patient especially in the rural region even the doctor is not available physically. This will be very useful to analysing patient continuously using web browser and doctor will monitor over internet. Moreover, it is cost effective and reduce casualties is a biggest advantage by frequently monitoring the patient were predicted.  **Machine Learning Approaches in Smart Health**  **BY:-** Zeina Rayan, Marco Alfonse, Abdel-Badeeh M. Salem  (Some lines are taken from this paper)  **Understanding:**  This research paper reviews the papers in the area of smart health starting from the year 2011 to 2017 and a structured analysis for different machine learning approaches that are applied in s-Heath.  Their results highlights some of the ML approaches used in many s-health applications such as Glaucoma diagnosis, Alzheimer’s disease, bacterial sepsis diagnosis, the Intensive Care Unit readmissions and cataract detection.  According to them, Artificial Neural Network (ANN), Support Vector Machine (SVM) algorithm and deep learning models especially the Convolutional Neural Network (CNN) are the most commonly used machine learning approaches where they proved to get high evaluation performance in most cases.  They have highlighted the following 5 principles:-  1. The **data acquisition** means collecting data from different sources such as sensor network, Mobile Ad hoc Networks, Vehicular Ad hoc Networks, Social networks, Internet of Things (IoT), 5G devices, Device-to-Device (D2D), Unmanned Aerial Vehicles (UAVs), or may be a combination of a set of them.  2. The **networking and computing technologies** are applied to the data gathered in the data acquisition phase, since this data is a bit complex, we need a server or a computing technology where the data can be processed such as cloud computing, or fog computing.  3. The **data security and privacy** plays a big role in both s-Health and smart cities where gathering so many information about citizens could possibly violate the citizen privacy.  4. The **data processing** involves pre-processing to remove the noise and clean the data, feature extraction to find the relevant features, and ML technique to process the data and perform the required task such as classification/clustering …etc.  5. The **data dissemination** is responsible for providing the output of the data processing phase to the target parties by means of direct access, push notifications, pub/sub, or opportunistic routing.  They also made a comparative study between different machine learning approaches that are applied in s-Health applications and systems.  **Pros:**  From the data collected by them, we can make an easy analysis of how different ML approaches can help in making smart decisions for the project we are currently working on.  **Cons:**  It is just an overview of different papers published by other authors, no new technical information is described.  Some of the papers which might be important in this subject were not included in their work.  **Virtual Reality in Psychotherapy: Review**  GIUSEPPE RIVA, Ph.D.  **CYBERPSYCHOLOGY & BEHAVIOR**  **Volume 8, Number 3, 2005**  **© Mary Ann Liebert, Inc.**  In the grounds of psychotherapy, VR is most commonly used in treating phobias. The method employed here is called VR exposure therapy. In this a patient is intentionally confronted with a feared stimulus while allowing anxiety to attenuate. Since avoiding a dreaded situation reinforces all phobias, each exposure lessens the anxiety through habituation and extinction. VRE is advantageous over traditional therapeutic settings and is more controlled and cost effective that in vivo exposure. VRE is also used to treat post traumatic stress disorder (PTSD) in war veterans.  It is also helpful in treating eating disorders and obesity. Here VRE is used to modify body image perceptions, the rationale behind this approach is that body image dissatisfaction is considered as a form of cognitive bias  VR has mainly two advantages. Firstly, it can integrate all methods used in body experience disturbances in one single VR experience. Secondly it can be used to induce the patient in a controlled sensory arrangement which will unconsciously modify their bodily awareness.  Immersive VR can also be used in improving the efficacy of psychodynamic approach in treatment of male erectile disorders. Here the VRE is used as controlled dreams, where different situations are given which the patients must overcome. This showed positive improvements in majority of patients over period of 6 months and subsequent follow ups.  Behavioural therapists may use a VE for activating the fear structure in a phobic patient. They can use VR environments to assess situational memories or disrupt habitual patterns. They can also use VR to isolate patients from the external world.  By creating a virtual environment where a patient can feel more secure helps in building up the relationship between the therapist and patient.  **Pros**-   * Helpful in treating phobias * Can develop an environment where the patient may feel secure. * Can help in improvement of patient-therapist relationship   **Cons-**   * Lack of standardisation in VR device and software. The PC based systems, though easy to use lack the advanced capabilities. * Lack of standardised protocols which can be shared among the researchers. * Costs required for setup trials.   **Virtual Reality Training for Health-Care Professionals**  FABRIZIAMANTOVANI, Ph.D.,1,2 GIANLUCACASTELNUOVO, M.S.,1  ANDREA GAGGIOLI, M.S.,1 and GIUSEPPE RIVA, Ph.D.1,2  **CYBERPSYCHOLOGY & BEHAVIOR**  **Volume 6, Number 4, 2003**  **© Mary Ann Liebert, Inc.**  Medicine has gone through large changes over the years. It is considered as the medicinal knowledge doubles every 6-8 years. But even now the training of the health care professionals in still largely based on the old apprenticeship model.  But the recent times saw the rise of innovative learging tools. These include 3D and 2D virtual worlds and computer simulations. Such methods help in the training of heath-care professionals in virtual environment. As many experts claim Virtual Reality (VR) presents a promising area “with highpotential of enhancing and modifying the learning experience: virtual environments (VEs) can provide a rich, interactive, engaging educational context,supporting experiential learning”.  VR helps in creating an environment where one can learn through doing, through first person experience. VEs are used in many fields, from training people in dangerous environments to experiencing contexts which would be impossible or too expensive to reach in real world. The benefits provided by VR like 3D immersion, multiple perspectives and multisensory cues have huge potential benefits to health-care education and training.  Since learning through VE requires actual interaction it helps in active participation. The students can grasp the information faster and easily as it requires them moving around in their own self-directed activities  VR can be used as an alternate way of presentation of materials and visualization.  This is very important in areas which requires information visualization like manipulating and rearranging using graphic symbols  VR helps in learning about certain areas which are impossible or too expensive in real life, like space exploration or travelling inside human body. This also helps in close-up observation of objects. VE is also useful for teaching with objects or instruments which may be too risky in real life.  Shared VR can help in collaborative learning. It helps in skill development through shared experiences of a group in a common environment.  Virtual learning is very useful to adapt to the learner’s characteristic and requirement. It helps students to learn in their own pace at any time they want and not by a fixed class schedule.  Since every VR session can be easily monitored, it provides a great way for evaluation.  In recent times, several VR platforms are created for learning in various domains. Identifying the various fields were implying VR provides a cutting edge and adapting the VR devices to their needs is a great challenge for both the educators and developers. Currently, VR training apps for health-care differ a lot in both their technological or multimedia sophistication and to the types of skills trained, for example, from surgical applications to interactive simulations of the human body and brain.  At the moment there are task specific individual medical trainers, who are also referred to as partial trainers. They tend to train limited set of skills within a simulation that is realistic and anatomically correct. What is common to all the partial trainers is their focus on specific task and anatomical region. Many developers come up their own programs which focuses on action in emergency situation when provided with limited supplies. Apt action in crucial time will make the difference and save a lot of lives. This will help the trainee to adapt to the stress-filled emergency situations like natural calamities or battle front experiences.  VR has successful in presenting person to person interactions for training in psychiatry and social sciences. This shows that VR can not only be used in acquiring technical skills but also soft skills which can be useful in doctor-patient interaction and psychology.  References:   * + 1. Kim, J. Y., Lee, H. J., Son, J. Y., & Park, J. H. (2015, August). Smart home web of objects-based IoT  1. management model and methods for home data mining. 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Scientific american, 284(5), pp.28-37   Further References:  **1)**  RFID Technology Combined with IoT Application in Medical Nursing System  Chao-Hsi Huang Department of Computer Science and Information Engineering National Ilan University Ilan, Taiwan chhuang@niu.edu.tw  Kung-Wei Cheng Department of Computer Science and Information Engineering National Ilan University Ilan, Taiwan [r0143001@ms.niu.edu.tw](mailto:r0143001@ms.niu.edu.tw)  Bulletin of Networking, Computing, Systems, and Software – www.bncss.org, ISSN 2186–5140 Volume 3, Number 1, pages 20–24, January 2014  **2)**  Imperial Journal of Interdisciplinary Research (IJIR) Vol-2, Issue-2 , 2016 ISSN : 2454-1362 , http://www.onlinejournal.in  Imperial Journal of Interdisciplinary Research (IJIR) Page 368  ECG - Remote Patient Monitoring Using Cloud Computing  Pallavi Chavan , Prerna More, Neha Thorat, Shraddha Yewale & Pallavi Dhade  **3)**  Design and Implementation of Health care system based on IOT  A. Sathish Department of Electronics and Communication Engineering Nalla Narasimha Reddy School of Engineering, Hyderabad, Telangana, India  M.Naresh Department of Electronics and Communication Engineering Nalla Narasimha Reddy School of Engineering, Hyderabad, Telangana, India  Impact Factor- 4.101, ISSN 2455-1457  **4)**  Secured Smart Healthcare Monitoring System Based on IOT  Duddela Dileep Kumar1 & Pratti Venkateswarlu2 1MTech (ES), Loyala Institute of Science and Technology, Satenapalli, AP, India. 2Assistant Professor, Dept of ECE, Loyala Institute of Science and Technology, Satenapalli, AP, India.  Vol-2, Issue-10, 2016 ISSN: 2454-1362, http://www.onlinejournal.in  **5)**  Journal of Network Communications and Emerging Technologies (JNCET) www.jncet.org  Volume 6, Issue 1, January (2016) ISSN: 2395-5317 ©EverScience Publications 21  A Proposal for Mobile E-Care Health Service System Using IOT for Indian Scenario  Rashmi Singh Group Manger-Presales, TechMahindra NSEZ Noida. |