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# Health Smart Home with IoT – A State of Art Survey

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***Abstract---*** *Recent survey estimates that almost over a billion people are found to be disabled which is around quarter the amount of the world's population. People with disabilities are particularly vulnerable to inadequacies in health care services and hence health care needs for individuals are unmet. Thus the introduction of a home automation technique for people with disabilities who would prefer to remain in the comfort of one's own home and giving healthcare service is becoming a feasible option. In recent years several projects have been carried out with the aim to ensure better quality of life for disabled patients by applying Internet of things (IoT) in healthcare domain and building an intelligent smart health home. The survey encompasses the complex issues, paucity of diverse techniques proposed for control and monitoring health status systems and a better way to meet the needs of the disabled patients over other techniques.*

***Keywords---*** *Smart Health System, IOT, Art Survey.*

## I. INTRODUCTION

Identifying and implementing efficient ways to improve the well being of disabled people has always been a national issue. Healthcare and health programs for the same reasons are necessary for people with disability than anybody. But the hurdles faced by them to overcome challenges for leading a normal life are enormous. The goals of home health care services are to help inhabitants to improve one's lifestyle, promote the extent of well being and to live with greater independence.

Disabled people need to manage everything by themselves. Health smart home considered as the wave of the future, constitute one of the most promising way to monitor and control the building's functions remotely and also to monitor the changes in health status of the inhabitant in a regular basis. A person in Healthcare dogma in need health status information and relevant knowledge to make informed decisions and to satisfy their information needs to take immediate actions. The Smart health home dogma in being significant today requires the help of multimedia and IoT very much through the development of a Decision making system to get patient health status monitored in a regular basis.

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IoT is an infrastructure of information society that interconnects the physical world and computer systems to collect, integrate and exchange data with the help of sensors, necessary electronics over an existing network infrastructure. The rest of the paper includes the following sections. In the following section various systems developed for health smart home domain using IOT and how are they meeting the challenges are studied and a comparative study is made between different techniques.

## II. APPLICATIONS IN HEALTH SMART HOME

### *A. Smart Home Monitoring*

Etienne Pardo et.al [1] proposed a framework for management and control of anomalies in homes embedded with sensors to detect abnormalities and take necessary measures. The framework represents information regarding anomalies using a semantic method involving ontology and hence can be used in all environments including home to understand the day to day activities of the inhabitants. If there is to be any change in the regular patter n of the day to day activities or in the health condition then the caregivers are informed about the issue to take necessary actions. Proof of concept for show the effectiveness of the framework was provided.

Ali Hussein et.al [2] presented a framework that would help disabled people to live life on their own through an adaptable home embedded with sensors and other devices. Security, health monitoring and automation was taken into consideration. The system has an interface which enhances communication between the inhabitant and the house environment.

Lukas Smire ket.al [3] analyzed the similarities and differences between two systems Eclipse smart Ho me (ESH) project and Universal Re mote Control (URC) that ad dresses the lack of appropriate user interfaces and problem of low interoperability between different smart home systems. The first platform focuses on integration of different devices and back-end technologies. The second platform provides a personalized, pluggable user interface.

Pavle Skocir et.a l [4] focused on activity detection in smart home environment, more specifically entrances to a room and exits from a room. The information can be used in applications that control Heating, ventilation, air conditioning and lighting systems or in Ambient Assisted Living (AAL) applications which monitor the people's well be in g. The approach uses data from two sensors, passive infrared sensor (PIR) which monitors presence and Hall Effect sensor which monitors whether the door is opened or closed. Two approaches for activity detection were proposed, first based on a sliding window and the second based on neural network.

Juan Ye et.al [5] presented a technique that leverages the use of sensors in a statistical manner to detect abnormal events. A novel technique called CLEA N was proposed that combines sensor readings and statistical detection. The technique can successfully detect sensor anomaly and improve activity recognition accuracies.

Andreas Jacobson et.al [6] focused on analysis of risks implemented in a home for automation system. The human factors or the software components of the system yielded high risks. The result indicated the need for a perfect model with security and privacy to be inculcated in the homes. An interface using which stakeholders can both monitor the energy consumptions within the home and control electronic devices in the homes were also introduced.

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### *B. Smart Home Controlling*

Xiaohua Wu et.al [7] focused on management of energy in a home embedded with sensors using energy storages and photovoltaic array. The paper focused on minimizing a consumer's energy charges, random variable models were developed and a control problem to manage the flow of power among various sources of energy in the home was mathematically formulated. The performance of the proposed control strategy was systematically examined.

Pooshkar Rajiv et.al [8] focused on image processing based home authentication for more secure and private home. The paper proposed an internet based access system for homes embedded with sensors which sends an email to notify the user about the home access. Visitor's image is captured and Compared by either fingerprint matching or hashing algorithms and the image was stored in the database. The mechanism may be of greater help to disabled people. Rajalingam S. et.al[9] explained the development of Home Energy Management (HEM) algorithm for power supply optimization in order to reduce the electricity cost and also to avoid problems caused by peak demand for a smart home with the help of Time Of Use (ToU) pricing and PV system. The controller is operated based on HEM algorithm and selects the power units accordingly. The proposed system based on the HEM algorithm reduces the electricity cost, peak demand problem and enhan ces the efficiency of energy use.

Stefano Marrone et.al [10] proposed a framework model for a resilient environment and strategies for saving and controlling energy incorporated in buildings. The paper elucidates a pragmatic framework that supports the runtime progression and advancement of the logic of control within the modern homes with sensors. Vibhutesh Kumar Singh et.al [11] Focused on a Zigbee based noble cost effective assisted living system for disabled and elderly by various controlling techniques. The paper designed and developed a fully fledged automation system with affordable price and low energy requirements for the elderly and disabled user. Various controlling methods through GSM/ CDMA ca ll, voice command and internet and cloud instruction mode which may be of help to disabled people were discussed.

### *C. Health Smart Home*

Lili Liu et.al [12] performed a review on homes embedded with sensors and technologies that supported monitoring of health at home for older adults. The study reinforced home health and monitored the functioning and condition of heart of elderly patients. This study yielded greater results with evidences. Kashfia Sailunaz et.al [13] proposed a frame work that has a potential to fulfill the major requirements and to deliver a competent healthcare system for people in rural areas in developing countries based on cloud services. An Identity based encryption method was used to protect and secure the private and confidential information regarding the health of the patient.

Vesle moy Gu ise et.al [14] focused on a collaborative action research approach in training design to facilitate genuine stakeholder input into the development and validation of training based on simulation for health care professionals. Antonio Fernandez Caballero et.al [15] explained architecture for e motion detection and regulation in smart health environments using different sensing and actuation technologies. The patient's emotional state was detected by analyzing the user's physiological signal, facial expression and behavior. The paper describes the three main parts of t he architecture, namely Emotion Detection which works with the data captured from the patient,

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Emotion Regulation and Emotion Feedback Control which performs a feedback control loop to assess the effect of emotion regulation over emotion detection.

Machiko R. To mita et.al [16] explained a model on behavioral methods to promote healthy behaviors in community dwelling older adults.

***D. Health Smart Home with IOT***

Mari Ca rmen Do mingo et.al [17] focused on application of IoT for people with disabilities and describes main benefits. The paper analyzes how people with visual, hearing and physical impairments interact with and benefit fro m the Internet of things (IoT). Three different application scenarios were considered such as shopping scenario, at school and domestic environment and the effectiveness of the system was discussed.

Sharon Varghese et.al [18] analyzed the living environment of sensory and physically disabled people and presents how IOT can help them to overcome these difficulties. Internet embedded assistive devices including Mowat sensor, Binaural Sonic Aid, Nottingham Obstacle Detector (NOD) for visually impaired, Vibe ring and Hand Talk for the deaf, sensor included wheel chairs, wireless injectable micro devices named Bions for the physically impaired people were discussed in detail.Gagan [19] proposed a model to provide security and comfort for the elderly and disabled people including monitoring of humidity and temperature, gas, smoke, motion and fire and controlling different electrical appliances like fan, heater, lights etc. If the sensor value exceeds the threshold value, system alerts the user and actuates required safety procedure. The alert is sent to the user through internet.

Gaurav Tiwari et.al [20] described a wireless system incorporated in an interactive Home which was based on IOT. This system supported management and conservation of energy and also included procuring of data from embedded sensors.

The details are displayed on web page using GPRS and the system also includes sending a SMS and E-ma il ale rt. Dan D. Koo et.al [21] presented an approach of an Internet-of- Things (IoT) system development and implementation to enhance bathroom safety. A Big Data analysis system model was also presented in the paper.

Yeuhong Yin et.al [22] provided an overview o f internet of things in healthcare. The challenges in the development of healthcare systems depending on IOT were discussed in particular. The paper also discusses about sensing technology, identification and authentication, knowledge management and big data management.

JorgeGomezet.al [23] focused on developing architecture for monitoring patient’s health and to recommend routine workouts to be carried out to overcome the chronic diseases by following the method of ontology.

Md Muztoba et.al [24] explained robust communication with IOT devices which made use of wearable Brain Machine Interfaces. Two techniques were discussed which includes protocol for confirmation of the command which protects communication between the human brain and the machine against false interpretations during runtime and an algorithm for selection of event that recognizes most genuine and dependable occurrences of events supported by the BMI system.

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## III. BLOCK DIAGRAM FOR SMART HOME WITH IOT

The diagram explains the overall flow of the Health Smart ho me. Raw Data Acquisition is done by using signals fro m Audio/Visual Sensors, Environmental Sensors and Wearable Sensors. The acquired data is sent to the decision making element before which the data is processed, segmented and the dimensionality is reduced. In both the cases of monitoring health status and controlling the home environment, the decision making element decides whether to take immediate appropriate actions or just to store the information in the database. The immediate action to be taken in case of monitoring the health status is to send an alert message to the caregiver and doctors in case of critical situations. In case of controlling the environment immediate actions to be performed include switching ON/OFF the devices controlling the speed etc of the appliances used in daily life. The decision is made inside the decision ma king element by comparing the acquired values from sensors with a well defined threshold value for each case.

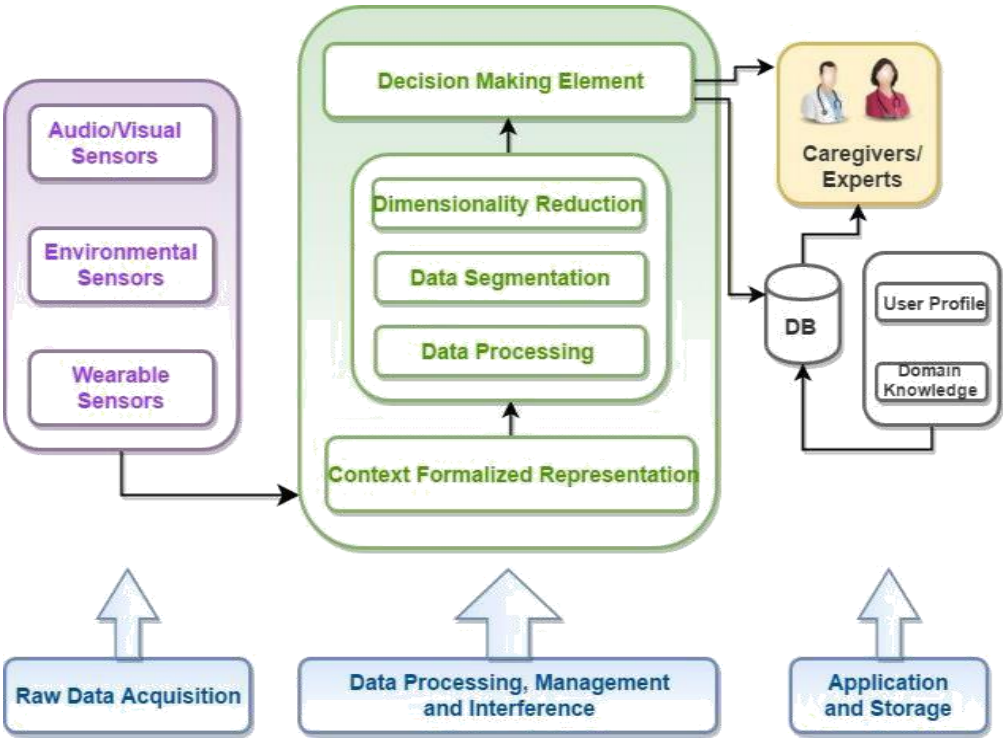


Fig 1.1: Block Diagram for Health Smart Home with IOT

If the acquired value is below the threshold value then no immediate actions are to be taken but the data are to be stored in the database to be presented later on request. On the other case instantaneous actions are taken if the acquired value is greater than the threshold value. The caregivers or experts are informed in case of crucial moments to take immediate custody of the patients and treat them and also are provided with the information about the patient's health condition on a regular basis by looking into the information from the database which includes the patient's profile along with the data regarding their health condition. Since this reduces the need of the disabled patient to travel to a hospital for regular checkup and eases the process of monitoring for both the doctors and the patient, health smart home plays a major role in shaping the lives of the disabled and will be of greater impact to old people with critical health conditions.

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## IV. COMPARATIVE STUDY BETWEEN DIFFERENT TECHNIQUES

Table 1: A Table for comparison between techniques

| Inference | Disadvantages | Advantages | Technique Used | Title of the Paper |
|---|---|---|---|---|
| Both Monitoring and control is done effectively. | High Consumption, complex and costly. | Smart ho me is completely connected through a backbone network to exchange information and for better decision making | Neural Networks (Feed-Forward and Recurrent). Insteon technology is also used which is a combination of power line communication (PLC) and a wire less network (Zigbee). | Neural Networks based Smart Home Design to help Disabled People |
| More realistic data were obtained and of effective use to disabled people | Dependent on internet. | Low cost, low power consuming hardware and user friendly control and also flexibility to update and build custom interface | Internet of things (IoT) and integrating cellular communication and Zigbee protocol based wireless devices with internet. | A Home system for disabled people and elderly |

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| | | | | |
|---|---|---|---|---|
| Application in school, shopping complex, domestic environment showing the efficiency of the system and how it could be of greater benefit for the people with visual, hearing and physical impairments. | Complex | Increase independent and | IoT | An overview of the Internet of Things |
| Application of IoT and its use for different disabled people is seen | Cost effective | Both wired and wireless technologies | RFID, IoT with devices including Mowat devices namedBions for physically impaired | Improvement of the life style of disabled and differently abled people by using internet of things. |
| Remote control from internet can | Internet connection reliable | Electrical connected through home network to control by PC | IoT | IoT based system for person with physical disability |
| home from anywhere and anytime using internet compatible devices. | | | | |

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Machine Learning classifiers were applied and the following results were obtained:

Table 4.1: Machine Learning Classifiers and Accuracy

| **ML Classifier** | **Observed Accuracy (% percentage)** |
|---|---|
| Decision Tree | 77. 04 |
| Naive Bayes | 80.32 |
| knn | 85.24 |
| SVM | 81.96 |
| Kernel SVM | 86.88 |

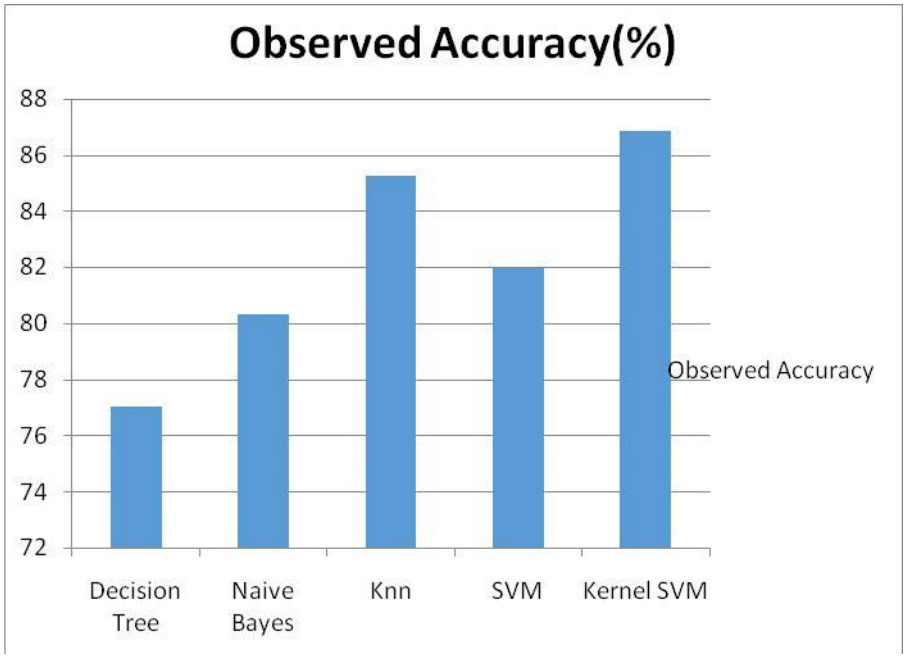


Figure 4.1: Graph depicting the accuracy of Classifiers

### *4.1 Inference*

The above chart depicts about accuracies with respect to various classifiers when used to predict the needs of disabled person with respect to his situation and suggests him some health advices. The chart clearly shows that the classification performance of Kernel SVM was pretty good as compared to Decision-Tree, Naive-Bayes, KNN and SVM followed by KNN as the second best. This paper uses KNN and SVM classifiers and then it combines to get a better output. According to [20], In the future we can combine some classifiers and then predict.

## V. CONCLUSION AND FUTURE WORK

Sensors thereby play a major role in monitoring the health status of the disabled person and to help monitor and control the environment in efficient way to lead an independent life. Major challenges faced are inadequate

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information and the information not reaching in time. Information from sensors is widespread. Aggregation of the information is necessary for decision ma king in both Healthcare domain and in Smart environment. The IoT and Cloud Computing applications contribute huge development towards Smart Environment in Healthcare domain but it doesn't satisfy to meet the current challenges. The future work is to propose an architecture that fulfills all the operations combining decision making element and monitoring and controlling functions.

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