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An Intelligent Decision-Support System For Telemedicine

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Abstract: In the modern era, wireless devices have entangled and influenced the medical space on a large scale of effectiveness. To monitor an elderly person who need medical attention in the periodic interval is very vapid using existing technologies. To conquer this, we select a unique wearable sensor, so it can be remote monitoring and data gathering of patients on the cloud through the internet of things which adds the advantages of mobility. Thus around the clock medical attention can be given to the patient by rigorous data observation before medical condition to escalate. In this work, all the viable options regarding patient surveillance are considered. SVM is a supervised learning algorithm.In this work,there is a need to manually keep the label of the standard value of parameter data with what the range predicts the correct choice for the train an SVM model as the need for classification. Eventually, it can be used for optimal prediction algorithm. The strategy of this work is done with the help of frontier technology, IoT and machine learning. This research work addresses the challenge in computing to optimize the efficiency of prediction data with the IoT-enabled information architecture-driven approach.

Keywords: Internet of Things, Classifier, Healthcare, SVM, Cloud Computing, Machine Learning, Wearable Sensor

1 Introduction

Medical information system and healthcare service are always the backbones of progress for the national welfare. Emerging Internet of Things (IoT) technologies and mobile health scenarios provide opportunities for a new generation of healthcare systems. Current development meets the challenge of sensing patient's health data with the security guaranteed in mobile and resource-constrained settings as well as in fatality situations. This work coordinates with an IoT-driven architecture that enables security data classifier to healthcare services. Demand for medical services increases rapidly because of worldwide aging and an increase in population. The work analysis in [1], addresses a part of this issue and focuses on the subsequent analysis question: the way to change a delivery of vital info notification to old individuals. This implies a constructive design approach and it progresses the IOT-embedded approach in addition, [2] contains the IoT-enabled realization architecture pattern and system structural design for the effective delivery for critical information notification to elderly individuals. With the improvement of the world's daily life, people show more concentration to their health; nevertheless, the traditional medical methods can't meet the needs of individual health requirement. As the complement and extension of the traditional medical, telemedicine has been respected and accepted. The telemedicine requires the high speed, safe and steady mobile communication network to achieve the aim by which the medical adviser and patients can communicate in real time. The coming IOT era [3,4,5,6] is expected to drive a new phase of the telemedicine, and the hospitalize method of the patients is expected to have a revolutionary change. Although the practice of wearable kit in area of healthcare system is still in preliminary stage, which can play very vital role in healthcare [7]. With the revolutionary growth of the Internet, a new scope for medical fields from the incorporation of cloud computing and internet is to provide needs opportunities for the tracking medical records, hospital and even in social fields also [8,9,10,11]. This work cares about the health information, especially in elderly tracking application fields of the current study situation

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2 Objective

The collaboration of machine learning and computational intelligence techniques transform healthcare to a new height and made it very easy for a medical professional to analyze and track patient conditions. In these days there has been a revolutionary growth in the use of machine learning in both biosensor data and pattern recognition for computer-aided diagnosis. The aim is to bring this research work is to edify data collection and communication from the wearable biosensor, in the area of medicine, by the convergence of technology and the internet in the application of machine learning and computational intelligence to medical diagnosis and prognosis. The aim of this device ”pioneer” in this process has to provide facilitation around the clock for those who require it. The sensors interfaced with the processor are used for monitoring the patient. The various peripherals interfaced with the processor are given in the ”pioneer”. The purpose of this research is as follows: the patients who are restricted to their bed require 24/7 attention and care, these sensors designed as it becomes wearable for them with monitoring their vitals. The sensors will serially communicate the data to Wi-Fi module which will religiously communicate this data to a certain IP address. Owing to IOT distance is not a problem in monitoring patients so the patients who require caretakers to provide continual medication can be assisted through automation. Their movement and orientation can be monitored through the MEMS sensor. Monitoring the patient health records in the periodic interval is tedious using the existing methodology. To conquer this, recent wireless sensor technologies and data mining with cloud computing become most recent advancements. From this wearable biosensor device, patient medical information monitoring and data gathering from the remote station become a very easy task. The medical examiner will get alert of the vital information that would reflect any gradual changes in the condition of the patient, and care can be given immediately. On existing methods, it is a challenge and if it’s not to do, then there may be an adverse impact on the well-being. To assess proposed architecture, it may conduct a formal validation regarding data extracting properties on a cloud. Also, in this study, it evaluates both communication stability and computational costs to highlight interference. The results and analysis show that the prototype provides a considerably optimized level of gain in communication with security while its functional properties are ensured. After this examination, ”pioneer” mimics as a doctor, to save the time of patient to go for medical report periodically. Here we elaborate cost-benefit analysis to provide a proof of concept and hardware implementation, it may demonstrate a prototype of it and discuss the architecture and implementation of the demonstrator.

3 Related work and motivation

The focus of this analysis is on the augmentation of the biosensor wearable kit Pioneer. This work is attached to the architecture and application of a product in response to some real or perceived problem. The newly realized artifact contribution for elderly or physically challenged person or patient is based on research, however, the knowledge gained from the novel artifact design and its suitability becomes a great integration of machine learning and internet of things. Evaluation and applicability of the proposed Pioneer approach are evaluated and accommodated in a demonstrated scenario, where a portable device-based system implementation with user wearable and evaluation. The prototype is rendered as a proof of concept to guide further research and development in this important area of research. The definition of elderly individual as the basis of age 60+ is taken in account in this research work on basis of classification of elderly individual as followed by the UN along with many other institutions and WHO, i.e. 60+ years old [12]. The electronic health record in the database is a key feature of data analysis techniques for making use of data. From Electronic Health Record, the extraction of data is a significant and useful step for creating alarm. For a large amount of data, its pattern recognition and properties extraction have been done in data mining. The health care system and the area of data mining are growing together in terms of the prediction algorithm. Recent healthcare system becomes human-centric with respect to hospital-centric [13]. Statistic study gives the ability to the medical practitioner and planner in predicting risk and positive outcomes [14]. These ways are either simple ways of risk-assessment or a sophisticated machine learning method. [15] and [16] both are based on the relevant history of clinical and medical records. The need of patient or elderly person must be classified as per an analysis of data in the integration of healthcare system for personalized as per requirements. The elder who suffer from a different type of medical condition required rectification or awareness of as per need. So here research takes general need of elderly person for risk management when the critical condition regarding health care system is an escalation. Regarding to the privacy of the patient, the electronic health record cannot be enquired continuously. Thus here the prediction algorithm in machine learning makes it cost-effective, reliable and event-driven approach. In the modern era, the IoT is emerging trend among industry, government, and communities to develop IoT-enabled smart architectures and systems. For instance,it has been come out with an idea of an IoT-enabled architecture for the healthcare systems [17]. IoT enabled devices such as (e.g. tablets, GPS, and various sensors) to offer new ways of emergency information delivery [18]. Further work solves data analytics in a predictive way through a secure network Hadoop for big data [19]. The work states that Internet of things realizes intelligent identification and tracking, monitoring, and management by connecting anything to the Internet [20]. Research has shown that, the initial idea of this paradigm shifts is the ability of many things like the sensor to interact and collaborate mutually to achieve common goals towards pervasive healthcare [21]. The CodeBlue which is most well-known healthcare research projects that have been created at the Harvard sensor network Lab [22,23]. In this approach, a few therapeutic sensors are kept on the patients' body. It has been expected that CodeBlue to be set up in the hospital, critical care, stroke patient rehabilitation, and disaster response. IoT-enabled medical application CodeBlue security issue is taken into account. However, the security part of CodeBlue is as yet pending. The traffic priority and RF-based location tracking has been enable in CodeBlue [24]. The real time application on m-IoT and heterogeneous connectivity for measurement of glucose level has done [25]. Research work has been introduced the integration of vehicular and eHealth test beds [26]. which suggested safety in wearable sensors [27]. The eHealth protocol information carries sensible data and it needs integrity, confidentiality, and availability. The privacy issue has been taken into account for proposing pseudonymization of medical data [28]. The work had been focused on the digital emergence of healthcare [29] and specifically monitoring for clinical environments [30]. It was shown that active employment of Smart e-Health Gateways makes it of pervasive nature for the healthcare monitoring system. Further such mechanism integrate the parallel and the mobile computing techniques to optimize the efficiency [31]. The illustration has been done that how the ”busyness” metric, comprising a sequence of sensor events corresponding to user actions, can be made to monitor the user's habits using a commercial IoT system and data aggregation [32].

4 Proposed systems and its implementation

Architecting and developing IoT-enabled emergency information data passing and notification addressing the special concerns of elderly people. This approach is estimated by the means of a real-time scenario with the performance of the prototype. Recent research is used to signify progressive connectivity in systems and services which have given rise to a new technology, the Internet of Things (IoT). IoT gives people a virtual environment to interact hence realizing, such as smart healthcare as part of a digital society. It has been visualized that in future, currently provided healthcare system will be getting a paradigm shift from hospital-centered to home-centered. A well-known application domain of the IoT is given by e-Health and in particular telemedicine applications that allows to seamlessly monitor patients and support physicians. The availability of the resources (i.e. the data) offered by the medical devices is of crucial importance for proper decision making. Managing medical devices is difficult due to the huge heterogeneity of communication technologies and data formats, the variety of available standards and the mobility of the patients carrying the devices. It can be assumed that medical devices or sensors, in general, are resources that provide knowledge healthcare (i.e. data) about entities and are able to move in space. The data should be accessible by each entity whenever needed. Cloud computing containing its following advantages such as high reliability, virtualization, high efficiency and scalability and manageability, the formation of public cloud in the terms of keeping the database, health problem and respected answer for the elder can promote resource sharing, cost savings, build medical monitoring and supervision system with high efficiency. The architecture of an IoT-based health caring system which can be used as mobile health monitoring and the caring structure are shown in Figure 1. This prototype device ”pioneer” is able to identify odd patterns and, make an intelligent decision about the situation. Pioneer is connected to Wi-Fi, which transmits data to the cloud. The system architecture includes the following main components:

4.1 Medical Sensor Network

The kit pioneer is here embedded in four different types of medical sensor. MEMS are an enabling technology with smart microsensors. This category of the sensor is used mainly for patients suffering from a seizure (fits) in epilepsy. It detects the motion and vibration in x, y, and z-axis simultaneously. Heart bit sensor needs to find out heart rate which is plays a vital health parameter directly showing the robustness of the cardiovascular system. The interface unit, MAX232 is used to integrate sensor and ARM processor. This performs the necessary ADC for the ARM to process the data. The infrared LED transmits IR motion through the fingertip of the patient. The blood pressure sensor (MPX 5500D) is a non-intrusive sensor utilized for estimating human circulatory strain. It utilized measures of systolic, diastolic means blood pressure using the oscillometric strategy. The sensor converts the air that is pumped into it to sensible values using a pressure sensor. The ADC of the processor samples these values to produce discrete signals. Digital-to-analog conversion is performed internally by the processor to provide the necessary output on the display. In units of Pascal, the pressure has been displayed on the LCD and the web page. These all biosensors are attached to ARM LPC 2148 for processing and it makes its all data compatible to pass through Wi-Fi on the cloud where the process of data extraction can take place with the threshold. This threshold chart is given for all vital care which has to be taken for the elder.

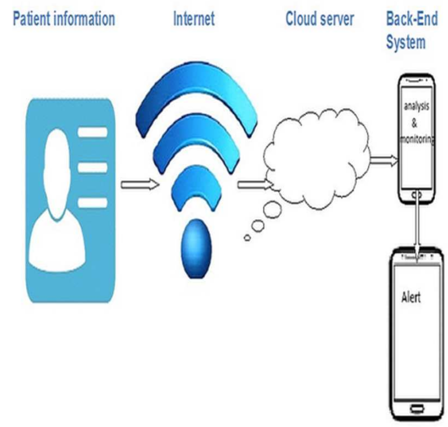

Fig. 1: Generic architecture of the proposed healthcare system

Table 1: Table 1. Threshold chart for an embedded biosensor in pioneer kit for patient

Sl no.	Parameter	Normal
1	Memes(degree)	30-140
2	blood pressure(mm of Hg)	60 - 150
3	Temperature (f Fahrenheit)	95-99
4	Heart rate sensor (Beats per minute)	60-100

4.2 Smart e-Health Gateway

In this IoT-based healthcare application, a gateway between Body-worn sensor and the data passing between the protocols on the internet and activated parameters networks. In the processing responsibility for the handling of the wireless sensor network for a portable health-care, smart e-health gateways can be entangled with a lot of challenges such that security, scalability, and reliability. These challenges have been recognized as effectual advances in the frame of the Internet of Things. Certain IP address and communication protocol make this information accessible to authorized personnel with ease.

4.3 Back-End System

The back-end of the system are made of two major components, a local switch and a cloud computing stage that includes broadcasting, data warehouse, big data analytic servers and finally web clients as a graphical user interface which works as a final visualization and apprehension. The collected data of health and context information can play a very important role as a source of big data for the statistical and medical research. Here wireless fidelity is a wireless networking technology which uses radio waves for connecting network connections and high-speed Internet. The Wi-Fi module used here is ESP 8266. It is a low-cost Wi-Fi chip with full TCP/IP stack and microcontroller capability. This aids in connecting the sensors to the internet with ease. Initially, the Wi-Fi module is configured with MikroC software and is connected to the hardware. The static IP address can be got from commands which are used effectively for data collation. Once ESP 8266 is connected to the internet, the sensors send their values to the IP address which is accessed through a HyperTerminal or a Web page. Around the clock, assistance is achieved effectively with a prototype which enables IOT. In this research study, the system has opted for a low-power Wi-Fi module to do the job. So, by understanding IEEE 802.11 standard and implementing it in the proposed system,all sensors data can be connected to the internet. The wireless 802.11standard has two network architectures, infrastructure network and point-to-point network. WiFi-enabled sensors are associated with an Access Point (AP) through which the nodes are associated with the internet. The module is interfaced to the processor. ARM performs ADC on the sensor data and serially sends it to the Wi-Fi module which is configured by MikroC. The results finally output to the specified IP address. The alert diagnosis can be viewed on HyperTerminal from the control center.

4.4 SVM classifier

The goal of this paper is to recognize biosensor data in real-time in order to monitor and control the requirement of the patient. After analysis this can address the classification problem as a binary pattern recognition applying Support Vector Machines (SVM): Set up the database by experiments wearing the pioneer (wearable experimental kit). For generating an optimal result and characteristic feature needs to use supervised PCA

(Principle Component Analysis), SVM training and finally get the SVM filter. For classification, SVM is one of the best suitable supervised machine learning algorithms. For a certain set of training data, SVM training data prepared a hyperplane, which distinguishes the given data as much as possible by maximizing the distance between two datasets of clusters. However, practically, data separation in given clusters is not frequent because some of the points might fall in a gray area which is not easy to separate linearly. If the data are mapped in higher dimension likewise in kernel function it becomes separable and this way is an optimal solution for separation of required data.

Consider a vector-labelled pair (xi, yi), as a training set of data where$i = 1, ..., l$ where

$$xi \in Rn \tag{1}$$

and

$$yi \in 1, -1 \tag{2}$$

where xi is a vector in an n-dimensional space. If the linearly separable training set is there then many hyperplanes exist

$$f(x) = wi^T xi + b \tag{3}$$

Which exactly categorizes all vectors in the training set i.e.

$$sign(f(x_i)) = y_i \tag{4}$$

The value of hyperplane will be $n-1$ for n-dimensional space. The aim of SVM is to find the required optimal hyperplane which separates the data in training set into two groups,$+1$ or-1 and maximizes the distance (margin) between the hyperplane and the support vectors. From this theory and usefulness, it can be said that SVM can be termed as a solution of the

$$f(x) = \min_{\omega,b,\zeta} \frac{1}{2} W^T W + C\Sigma_{i=1}^{L} \xi_i \tag{5}$$

$$w = \Sigma_{j=1}^{N} \alpha_j y_j x_j \tag{6}$$

Substitute the value of w in equation 1 and, it becomes as

$$||w||^2 = \{\Sigma_{j=1} \alpha_j y_j x_j\}^T \{\Sigma_{k=1} \alpha_k y_k x_k\} = \Sigma_{j=k} \alpha_j \alpha_k y_j y_k (x_j^T x_k) \tag{7}$$

Subject to

$$y_i(w^T \varphi(x_i) + b) \geq 1 - \xi_i, where \xi_i \geq 0, \tag{8}$$

where the training data are mapped to a higher dimensional space by the function φ, and C is a penalty parameter on the training error. Therefore, for any testing vector x, the decision function (predictor), this equation is used for handling data that is not linearly separable.

$$f(x) = \text{sign}(w^T \varphi(x_i) + b) \tag{9}$$

put the value from equation 4 to 3 equation Kernel function and then it is written as

$$K(x_i, x_j) = \varphi(x_i)^T \varphi(x_j) \tag{10}$$

and the most widely used four kernel function are linear :

$$K(x_i, x_j) = x_i^T x_j \tag{11}$$

and, polynomial :

$$K(x_i, x_j) = \{\gamma x_i^T + r\}^d, \gamma > 0 \tag{12}$$

Where γ and r are kernel parameter.

4.5 SVM Simulation Method

In this work, we use the library (LIBSVM), a freely available SVM software library, here we use MATLAB language as software to generate the SVM models. To produce the dataset for training model, here it is selected as a random process to match the number of cases in the training dataset. To match the required format of SVM, the collected data are transformed as follows. Different types of kernel functions, as linear and polynomial are tested and selected for the models on the basis of performance. From the result of this research work patient can easily and very friendly use this health care system which gives them smart decision-making capabilities. Here in this pioneer kit, 4 variable are selected which are normally associated with the risk for the elder: orientation, blood pressure, temperature and heart bit. For each and every data point Xi, the model may prepare a prediction Y displayed as a cross point on the graph. The only difference with the previous graph is that the dots are not connected with each other. In order to measure the accuracy of the proposed model, it has to compute how much error it makes. Further, it can compare each Yi value with the correlated predicted value Y and check how far away these values lay with a simple difference. Here the expression Note is the error if we make a perfect prediction Y not equal to Yi and the error will be zero. If this procedure can continue for each and every data point and add the error then it can get the sum of the errors, and if mean of the error is taken in account result will get the Mean Squared Error (MSE).

$$MSE = \frac{1}{n} \Sigma_{i=1}^{N} (y_i y_i)^2 \tag{13}$$

It is a regular way to measure the error in machine learning from Root Mean Squared Error (RMSE) so it can be used in place of it. To compute the RMSE and make it square root and get that.

$$RMSE = \sqrt{MSE} \tag{14}$$

5 Results and Discussions

Here in this kit pioneer we have five general vital life support system health parameter are used for data mining and predicting. The parameter has been selected on basis of medical condition generally escalating at old age. The five parameters are systolic, diastolic, heart rate, body temperature, and orientation. All the dataset run with the different classifier and corresponding true positive (TP), true negative (TN), sensitivity, specificity, and test efficiency calculated from the equation 15 to 19. In different data mining methods, SVM is one of the best classifiers, especially in the condition defined as where the parameter (feature) is high but the sample size is small. Machine learning techniques have been developed to make automated computers analysis to recognize the pattern and it connects it with smart decision-making system. In a larger perspective, the machine learning technique is classified into two types. First the supervised learning technique and second the unsupervised learning method. In supervised learning normally a predefined algorithm is provided; despite in unsupervised learning normally used for clustering further in this method, no predefined algorithm takes place.

Sensitivity:

Sensitivity of a test is the percentage of all patients with disease present who have a positive test.

$$Sensitivity(\%) = \frac{TP}{(TP+FN)} \times 100 \qquad (15)$$

Specificity:

Specificity of a test is the percentage of all patients without disease who have a negative test.

$$Specificity(\%) = \frac{TN}{(TN+FP)} \times 100 \qquad (16)$$

Predictive value:

The predictive value of a test is a measure (%) of the times that the value (positive or negative) is the true value, i.e. the percentage of all positive tests that are true positives is the Positive Predictive Value.

$$PositivePredictiveValue(\%) = \frac{TP}{(TP+FP)} \times 100 \qquad (17)$$

$$NegativePredictiveValue(\%) = \frac{TN}{(TN+FN)} \times 100 \qquad (18)$$

Test Efficiency:

The efficiency of a test is the percentage of the times that the test gives the correct answer compared to the total number of tests.

$$Efficiency(\%) = \frac{(TP+TN)}{(TP+FN+FP+TN)} \times 100 \qquad (19)$$

All the sensors value are fixed in the support vector machine with the help of table where the range is given for normal condition which is tabulated in table 1. Here the value taken is very interesting that the table condition is just not only Google data or data taken from WHO or medical council of US/UK/India, some data taken from the real-time as well. The IoT-enabled Pioneer kit delivery approach seems to be effective delivery and presentation of the critical information to the elder. This shows that it needs one complete architecture design for critical information of the elder (e.g.Pioneer architecture pattern is shown in figure 4) and how the data passed in form of the message is presented to the users of the device (e.g. Pioneer device architecture). We would like to point that the relevance of the existing emergency information warning systems may vary according to the incident, and no complete system can be used in all emergency contexts. All the classifier applied and their confusion matrix plotted, and ROC collected through MATLAB.

Based on the research results, in this work, authentication, accounting, and authorization for IoT - based healthcare system made up from distributed smart e-health gateways. This decreases the overhead forced by the therapeutic sensors without trading off the security. Therefore, the proposed architecture is considered a very promising solution to provide flexible and reliable security for this healthcare systems. The sensor data stored on the cloud from a periodic interval of time is differentiated via SVM classifier where the threshold is already provided based on standard health informative data taken from WHO and medical council of USA/UK/India. The design research allows a third party or medical practitioner to draw an idea from data collected.SVM has been broadly practicing in a different segment of recognition, bioinformatics, and medicine. This study makes smart decision making through SVM. It uses algorithm and techniques which perform different tasks and activities to provide effective learning. Further study can represent complex patterns and how to exclude bogus patterns.

6 Perspective

Mainly The access to information on the remote place is implemented in this work. The Internet of things has been proved that it becomes a very handy tool especially once it encloses an area of healthcare. The sensor outputs are transmitted to the specified IP address as intended. IoT is the way of future in the area of smart decision-making system. The objective set out to be achieved is to provide assistance around the clock, which has become a reality due to IoT and wireless sensors. These sensors help to abolish the need for physical assistance. Future improvement in sensor technology will solve this problem, enabling a fully automated system that can mimic a medical examiner's presence and care. The core of the Pioneer is based on IoT and it enables a device

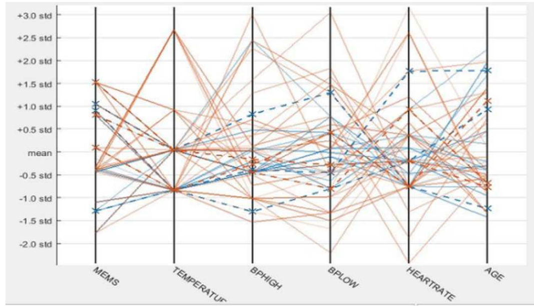

Fig. 2: Data collected by kit

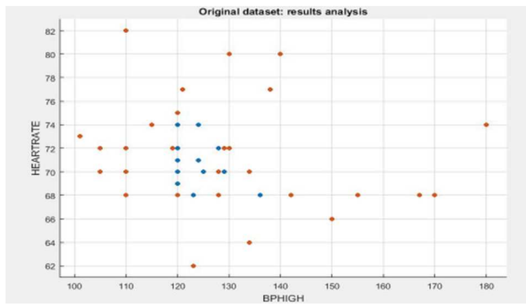

Fig. 3: Clustering of two different attributes

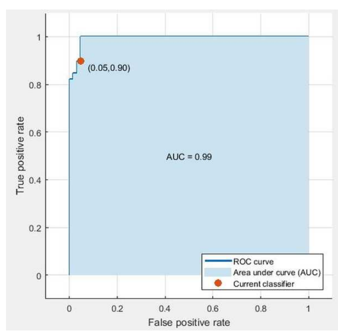

Fig. 4: KNN-weighted ROC

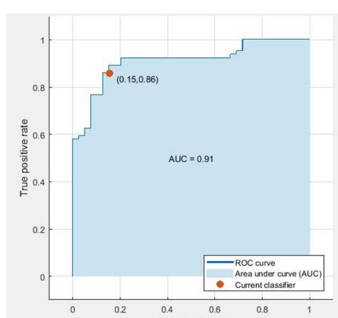

Fig. 5: Quadratic discriminate ROC

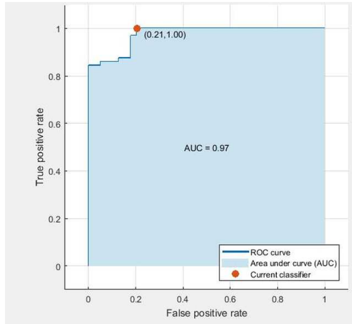

Fig. 6: SVM fine gaussian ROC

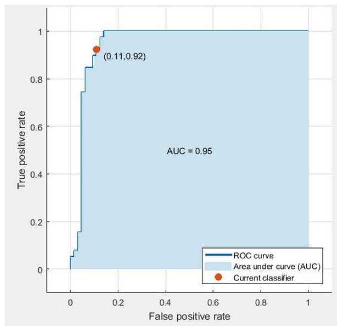

Fig. 7: SVM quadratic ROC

Table 2: The result of ROC in the experimental set-up

Resultant	**Classifier**			
	KNN weighted	Quadratic discriminant	SVM quadratic	SVM fine gaussian
TP	61	55	57	64
TN	32	33	36	35
FP	4	6	3	4
Accuracy	93.2	85.4	90.3	96.0
Sensitivity	95.3	85.9	89.06	100
Specificity	89.7	84.6	92.0	89.7

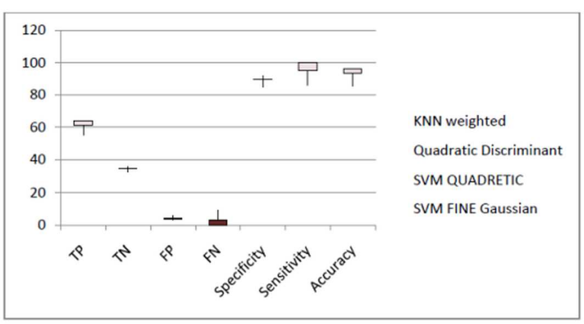

Fig. 8: The plot of all algorithm with test data

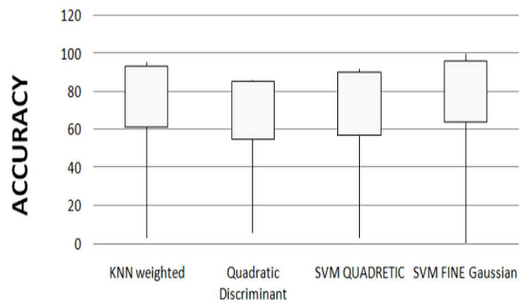

Fig. 9: The plot of accuracy along with all algorithms

which is embedded with an end to end information and system architecture, which delivers the critical information of the elder with integrity and reliability. The design prototype is a fully functioning health monitoring device that not only displays the user's vital parameters on a locally placed LCD screen but also stores the parameters in a server-based database and relays it over the Internet to a remote healthcare specialist. The design is simple and reliable and the underlying idea has been to preserve its size and its portable nature so that user movement is not restricted at the time of measurement.

In this research study, even the sample size selected is fair enough for a demonstration, but for a different person. if it's taken in heterogeneous ways then the system stability is shown correctly in real time. The primary limitation of this study is its small sample size, which made it very difficult for any of the endpoints to achieve statistical significance. The secondary limitation is that here it's unable to find the medicine consumed by the patient. For future research and prediction, a huge number of data can be collected using this system. This colossal amount of data, including medical history of many patients' parameters and corresponding results can be explored using signal processing techniques and data mining in the exploration of consistent patterns in the disease. This could be a point of paramount significance for the medical research. Additionally, they can also predict the nature of the disease and take some preventive measures in advance. For instance, if a patient's health parameters are changing in the same pattern as those of a previous patient in the database, the consequences can also be estimated. If the same patterns are repeatedly confirmed, it would be easier for the medical personnel to find a remedy. The design can be further extended in the future to enable certain other biometric parameter measurements like blood pressure, ECG, oxygen level in blood, etc. and to include self improving advanced data analytics so that the user can be alerted of an anomaly beforehand by taking into account the variations in a person's daily vital parameter readings. This, in turn, can enable more efficient healthcare provision to the young and old alike by the means of preventive medical care.

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References

[1] A. Duffy and F. O'Donnell, A design research approach, In Proceedings of the AID'98Workshop on Research Methods in AI in Design, Lisbon, Portugal, pp.20-27 (1998).
[2] Wang Shouhong, Modeling information architecture for the organization, Information & Management, Volume 32, Issue 6, Pages 303-315 (1997).
[3] Mao Yuxin, Bhuse Vijay, Zhou Zhongmei, Pichappan Pit, Abdel-Aty Mahmoud and Hayafuji Yoshinori, Applied Mathematics and Algorithms for Cloud Computing and IoT. Mathematical Problems in Engineering, Article ID 946860,2 pages (2014).
[4] Y. Wang, and X. Wang, The novel analysis model of cloud computing based on RFID internet of things, Journal of Chemical and Pharmaceutical Research, vol. 6, no. 6, pp. 661-668 (2014).
[5] D. Talia, Towards Internet Intelligent Services Based on Cloud Computing and Multi-Agents, Advances onto the Internet of Things. Springer International Publishing, pp. 271-283 (2014).
[6] F. Bonomi, Fog Computing: A Platform for Internet of Things and Analytics, Big Data and Internet of Things: A Roadmap for Smart Environments. Springer International Publishing, pp. 169-186 (2014).
[7] Ajami Sima and Teimouri Fotooheh, Features and application of wearable biosensors in medical care. Journal of research in medical sciences, Vol. 20(12), 1208-1215 (2015).
[8] John Soldatos, Nikos Kefalakis, Martin Serrano and Manfred Hauswirth, Design principles for utility driven services and cloud-based computing modeling for the Internet of Things, International Journal of Web and Grid Services, vol. 10, no. 2, pp. 139-167 (2014).

[9] F. Xie and C. Z. Liang, Research of Internet of Things Based on Cloud Computing, Applied Mechanics, and Materials, vol. 443, pp. 589-593 (2014).
[10] S. Fang, An Integrated System for Regional Environmental Monitoring and Management Based on Internet of Things, IEEE Trans. Industrial Informatics, vol. 10, no. 2, pp. 1596-1605 (2014).
[11] H. Ding, Traffic Flow Data Collection and Signal Control System Based on Internet of Things and Cloud Computing, Advanced Materials Research, Vols. 846-847, pp. 1608-1611 (2014).
[12] WHO(www.who.int/healthinfo/survey/ageingdefnolder/en)
[13] S. Foldy, National public health informatics, United States. In: Public Health Informatics and Information Systems. Springer, p. 573-601 (2014).
[14] Lindsey R. Haas,Paul Y. Takahashi,Nilay D. Shah,Robert J. Stroebel,Matthew E. Bernard, Dawn M. Finnie, and James M. Naessens, Risk-stratification methods for identifying patients for care coordination. The American journal of managed care. 19(9): pp. 725-732 (2013).
[15] Kevin Plis, Razvan Bunescu, Cindy Marling, Jay Shubrook, and Frank Schwartz, A Machine Learning Approach to Predicting Blood Glucose Levels for Diabetes Management. In Proceedings of AAAI Workshop on Modern Artificial Intelligence for Health Analytics. AAAI Press, Palo Alto, CA, USA, 35 - 39 (2014).
[16] L K Woolery and J Grzymala-Busse, Machine learning for an expert system to predict preterm birth risk. Journal of the American Medical Informatics Association.1(6):439-446 (1994).
[17] Luca Catarinucci,Danilo de Donno,Luca Mainetti,Luca Palano,Luigi Patrono,Maria Laura Stefanizzi and Luciano Tarricone, An IoT-aware architecture for smart health care systems, IEEE Internet of Things Journal vol. 2 no -6, page no. 515-526 (2015).
[18] N.R. Adam, B. Shafiq and R.Staffin, Spatial computing and social media in the context of disaster management. IEEE Intelligent Systems, Volume: 27, Issue 6, page no 90-96 (2012).
[19] P. Sampath, S Tamilselvi, M. Saravana Kumar, S. Lavanya and T. Eswari, Diabetic data analysis in healthcare using Hadoop architecture over big data. International Journal of Biomedical Engineering and Technology, Vol. 23, No. 2/3/4, pp.137- 147 (2017).
[20] Q. Zhou, and J. Zhang, Research Prospect of Internet of Things Geography, in 19th International Conference on Geoinformatics, pp.1-5 (2011).
[21] L.Atzori, A. Iera and G. Morabito, The Internet of Things: a survey, Computer Networks, Vol. 54, No. 15, pp. 2787-2805 (2010).
[22] H. Alemdar, and C. Ersoy, Wireless sensor networks for healthcare: a survey. Computer Networks, Vol. 54, No. 15, pp.2688-2710 (2010).
[23] David Malan, Fulford-Jones Thaddeus, Welsh Matt and Moulton Steve, CodeBlue: An ad hoc sensor network infrastructure for emergency medical care. Paper presented at the International Workshop on Wearable and Implantable Body Sensor Networks, London, UK (2004).
[24] K. Lorincz,D.J. Malan,T.R.F. Fulford-Jones,A. Nawoj, A. Clavel, V. Shnayder, G. Mainland, M. Welsh and S. Moulton, Sensor networks for emergency response: challenges and opportunities. IEEE Pervasive Computing, vol. 3, no. 4, pp. 16-23 (2004).
[25] R. S. H. Istepanian,S. Hu,N. Y. Philip and A. Sungoor, The Potential of the Internet of m-health Things m-IoT for Non-Invasive Glucose level Sensing, 33rd Annual International Conference of the IEEE EMBS Boston, Massachusetts USA. pp. 5264 - 5266 (2011).
[26] S. Imadali, A. Karanasiou, A. Petrescu, I. Sifniadis, V. Vque and P. Angelidis, eHealth service support in IPv6 vehicular networks, IEEE 8th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob), Barcelona, pp. 579-585 (2012).
[27] Al-Busaid, Asiya M and Khriji Lazhar, Wearable wireless medical sensors toward standards, safety and intelligence: a review. International Journal of Biomedical Engineering and Technology, Vol. 14, No. 2, pp.119 - 147 (2014).
[28] D. Slamanig and C. Stingl, 'Privacy Aspects of eHealth', Third International Conference on Availability, Reliability, and Security, Barcelona, pp. 1226-1233 (2008).
[29] Al-Shammari Eiman Tamah, Sensor networks, and systems for pervasive healthcare. International Journal of Biomedical Engineering and Technology, Vol. 14, No. 2, pp.91-104 (2014).
[30] Rahmani Amir-Mohammad, Thanigaivelan Nanda Kumar, Tuan Nguyen Gia, Jose Granados, Negash Behailu, Liljeberg Pasi and Hannu Tenhunen ,Smart e-Health Gateway: Bringing intelligence to Internet-of-Things based ubiquitous healthcare systems, 12th Annual IEEE Consumer Communications and Networking Conference (CCNC), Las Vegas, NV, pp. 826-834 (2015).
[31] Li Ping, Design and implementation of medical cloud database service system based on parallel and mobile computing, International Journal of Biomedical Engineering and Technology, Vol.23, No.2/3/4, pp.213 - 231 (2017).
[32] L. Fiorini, P. Caleb-Solly, A. Tanaka, F. Cavallo, P. Dario and C. Melhuish,The efficacy of busyness as a measure for behaviour pattern analysis using unlabelled sensor data, a case study, IET International Conference on Technologies for Active and Assisted Living (technical), London, pp. 1-6 (2015).

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