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Health Care in Smart Cities: A Survey based on IoT data analytics

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***Abstract*— The global population continues to grow at a steady pace, and more people are moving to cities every single day. Concept of Smart City is not new, but application of data analytic techniques and improving performance of Smart city application needs focus. The first cut idea of Smart city is a city, where ICT(Information and Communication Technology) can be used to solve social problems . We can view the Smart city as an integrated living solution that links many life aspects such as power, transportation, buildings, public security and emergency solutions, city governance, waste and water management and healthcare in a smart and efficient manner to improve the quality of life for the citizens . Smart city applications basically involves pervasive and ubiquitous environment and Internet of Things can make it possible. This environment itself produces 'BIG DATA'. Data analytics in healthcare system mainly carried out in two categories Clinical applications and Non clinical applications.**

In this paper we studied basically Smart city Healthcare applications and data analysis issues related to this. We have developed one prototype smart city application to conceptualize the problem. Outcome of this survey is to summarize methods used for smart healthcare data analysis and issues related to it.

***Index Terms*— Big Data, , Healthcare applications, Internet Of Things, Predictive analysis, Smart City.**

1. INTRODUCTION

The global population continues to grow at a steady pace, and more people are moving to cities every single day. Experts predict that world's urban population will double by 2050 , which means we are adding the equivalent of seven New Delhi Cities to the planet every single year. Urbanization accompanies economic development. Urban areas also contribute a higher share of the GDP.. It is referred to as the 'engines of economic growth' and ensuring that they function as efficient engines is critical to our economic development. This trend of urbanization that is seen in India over the last few decades will continue for some more time. It is for this reason that we need to plan our urban areas well and cannot wait any longer to do so. The relatively low base allows us to plan our urbanization strategy in the right direction by taking advantage of the latest developments in technology.

As introduction of IoT has tremendously improved the techniques and practices in Health industry.. The world is advancing day by day, in the system of healthcare and the advanced technology today, collects data from various sources . It can be clinical, e-health prescription, test reports, records and records of the test images. The main obstacle comes in extracting the data and providing helpful knowledge and information to medical researchers and practitioners. These datas are extracted and used in the scenario of real life giving profit to the common people.

If Big Data Analytics is applied in the field of healthcare than using the historical data,the diseases can be predicted especially the epidemic diseases. The quality of life is improved by adverse reaction of the drug obtained from social media and helps in avoiding preventing decease. There is more opportunities in using the big data analytics as handling it through the traditional system. The traditional process of data collection, storage and processing is very complex [1]. The rate of life expectancy is continuously increasing on our planet. According to the United Nations Population Information Network, the predicted population of the world is going to increase double till 2050. There is a long expectation rate of life and the survival of acute diseases is also increasing and these both things increases challenges in the system of health care as per the requirement using sophisticated technology without adding any value [2-4]. In the systems of health care, the complexities are increasing in the whole world by correlating the medicine into the intensive

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data and these data cannot be handled using the traditional approaches. Using the traditional approaches can no longer fulfill the demands, the results of increasing the risk of unsatisfactory delivery. For managing the larger amount of data smart approaches are being used [5-9]. There is a possibility of collecting all sorts of records of the personal bio medical data over the time as the cost of storing data is decreased and reduced by the advent of smart phones and powerful ubiquitous smart sensors. Storage of these data is leading to the growth of longitudinal data which is known as time series data. This time series data is significant for the predictive analytics which functions as one of the cornerstones of the medicine P4 [10-13].

According to Mark Weiser, his vision is also true for the healthcare industry regarding the ubiquitous computing and smart objects. The law of Moore can also be applied to the biomedical sensors. This law is applicable to more devices above imagination. Their vision was the interaction of people amongst both the cyber space and physical space. The main power of such cyber-physical system is intelligence, i.e. the smartness lying in their adaptive behavior [14-17]. The future is the world of technology and hence the humans are moving forward in loop as the strengths of the computers and humans is different but if they are merged together then they can become extremely powerful. The combination of the cognitive as well as computer science is the combination of two powerful worlds. The advancement in technology is networked sensors, the integrated circuits of low power and wireless communications have made the possibility of low cost design, lightweight miniature, and the physiological sensor nodes which are intelligent and smart [18-20].

II MACHINE LEARNING USED IN HEALTHCARE ANALYTICS

For the evaluation of the interaction between the survival of the patient and the interaction between the physiological parameters several data preprocessing, mining and transformation approaches are used for the determination of knowledge about these interactions The prediction of the survival of the patients is exhibited by decision making algorithms and the rules which helped in making these decisions. These decisions play a significant role in the survival of the new patients which are unseen. All the significant parameters were identified and interpreted using the process of data mining and were reported related to the medical significance. A concept was introduced by the auther [21] in their research, the approach used decreases the cost and effort of the selection of patients for the clinical studies. The significant parameters are discovered and on the basis of the prediction of results patients can be selected [21]. By the help of the artificial neural networks, using the analysis of pattern electroretinography signals the optic nerve disease can be diagnosed. The complete technology used was ANN was forward with multilayer feed along with Levenberg Marquart (LM) back propagation algorithm. There was an efficient and effective interpretation which was made using this PERG method and the classification of the final results amongst the healthy and the diseased could be performed easily [22].

Another algorithm used was a technique of machine learning named Support Vector Machine and Random Forest which were used to classify compare and study of the data sets of the cancer, liver and the heart diseases, with varying the kernel and its parameters. The results obtained from various data sets obtained from breast cancer, liver and the heart diseases. The results were further merged with different kernels for the selection of proper parameter. For the establishment of better learning techniques regarding the prediction of the diseases results obtained were better analyzed. Altering results were observed with the classification of SVM techniques using different functions of kernel [23].

Further two neural techniques were used along with the BPA, RBF, SVM etc were used and compared for better efficiency and accuracy. The BPA being the Back propagation algorithm, RBF being Radial basis Function, SVM being Support Vector Machine which is one non-linear classifier. For the determination of kidney stone diagnosis, WEKA 3.6.5 tool was implemented to determine the best and better technique amongst the three algorithms used. The main aim of their work was to exhibit the best tool for the diagnosis of diseases, reduce its time of treatment and efficiency and accuracy were improved regarding the disease of kidney stone identification. Their results exhibited that the back propagation method was the best and improved version of the conventional classification technique for its use in the medical field [24]. The sector of healthcare has exhibited great evolution via the development of new technologies in the field of computers, and because of this

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technological advancement has given rise for the production of extensive medical data and increase giving opportunities in field of medical research.
There is a combination of medical data in large quantity with obtaining the knowledge from the same. For helping in the extraction of knowledge for the decision making complete technological advancement and innovations being big data analytics, predictive analytics machine learning and learning algorithm. The prediction of future disease and their anticipating cure has now no more a difficult task because of the use of machine learning and predictive analytics in big data. The evolution of big data in the sector of healthcare system is presented and the learning algorithm is applied over the medical data sets. They have further proposed the prediction of the chronic kidney diseases using the decision tree algorithm of C4.5.

III SMART HEALTHCARE ENVIRONMENT AND CHALLENGES

We have surveyed approximately twenty papers to study concept of smart city and characteristics of different usecases in smart city applications. City-Pulse white paper explain round about 101 usecases in smart city environment. Evangelos Psomakelis etl. Discussed about smart city application architecture following figure.
it is very clear physical layer consists of sensors collecting the data and sending tuples on the wireless channel in cloud for further decisions. This 24x7 data collecting sensors are generating petya byte big data and also velocity is very high. In the survey paper related to business intelligence and big data analytics Hsinchun Chen etl. Surveyed basic data analytics techniques. In healthcare generally we focus on Genomics and sequence analysis and visualization , EHR association mining and clustering ,Health social media monitoring and analysis ,Health text analytics , Health ontologies , Patient network analysis Adverse drug side-effect analysis , Privacy-preserving data mining. We have surveyed almost twenty papers, with different applications. Aggregation of data from various sensors is important issue related to IoT based smart healthcare applications. G.Nollo etl. Explained concept of smart citizens for healthy city. They explain the sciotechnical cities for smart health.

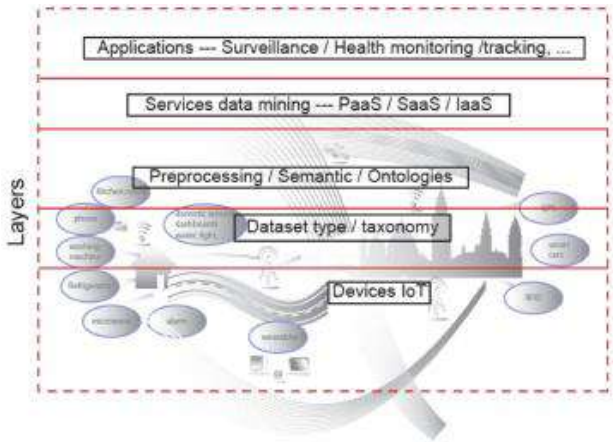

Fig 1. Layers in Smart city Applications Curtsy : David Gil

Ashwini Belle etl,discussed about medical image processing and in turn Volume attribute of the big data. She also discussed many classifying techniques to identify diseases. But real time stream analytics is behind curtain till time. Abdelsalam Helal etl. In the journal of Dibetics discussed about behaviour analysis and architectural framework for diabetic care. Hamzeh Khazaei,etl, in his paper discussed new approach Analytics as service for healthcare applications in his technical paper . Cloud architecture is proposed in the same paper. In 2016 , : Jasleen Kaur Bains,in her paper discuss Big data analytics challenges in smart healthcare system. She discussed following challenges : 1) Unstructured data and provenance of data 2) Missing or incomplete data 3) Quality of data 4) Data aggregation from different database systems. Context aware health parameter with smart cities first discussed in 2014 by Ioannis Vlachos, Mauro Conti. In this article authors introduce the new concept of s-health, review its most related research fields, discuss the main challenges for its implementation and development, and highlight the possible implementation opportunities that s-health might imply in the near future, which we believe are almost boundless. Real-time Monitoring of Clinical Processes using Complex Event Processing and Transition Systems article first available with event processing concept for smart healthcare application.
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From all above literature following points are highlighted:

- Extensive use of IoT is there in Smart city application.
- Sensors at the data collection layer need to aggregate and assign the context as per the applications requirement .
- Complex events are generated and we have to process the complex events. Context aware real time applications are more in smart system scenarios.

For the establishment of smart health care services there are major possibilities provided by cloud computing as an integral part of future care concepts [25] challenged by our society which is getting older. These smart home care environments are basically proposed as a solution for taking the care of elderly and disabled person. Using these sensors and new interaction techniques personalized and context adapted medical support can be provided and integrated in these environments. These support includes activities taking place every-day, personal health conditions are monitored, increasing the safety of patients and getting access to systems of social, medical and emergency.

A variety of services are provided by the applications of smart healthcare and they have the caliber to bring different benefits together. There are various technological problems and challenges which are being faced being mobility, invisibility like glasses, watches and the communications also [26-30]. There are two significant issues as a key for intelligence being adaptive and context awareness.

IV EXPERIMENTATION AND METHODOLOGIES FOR SMART CITY HEALTHCARE CASE

Problem definition :

Smart healthcare center is a mobile application which uses IoT to check patient's physical condition. Patient can be Outdoor Pateint or Indoor Patient. It also helps to perform hospital management task seamlessly. Patients have their EHR stored in cloud and new records(Sensor reading and aggregated values) got added with the existed record along with context. Analysis of this complex events will take place on geographical base, and alerts for epidemics will be generated.

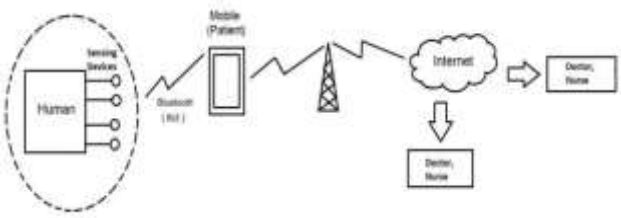

Fig 2 Prototype smart healthcare system Architectural View

External interface requirements :

User interface :

Following are the GUI of our android application. The different components of the GUI include

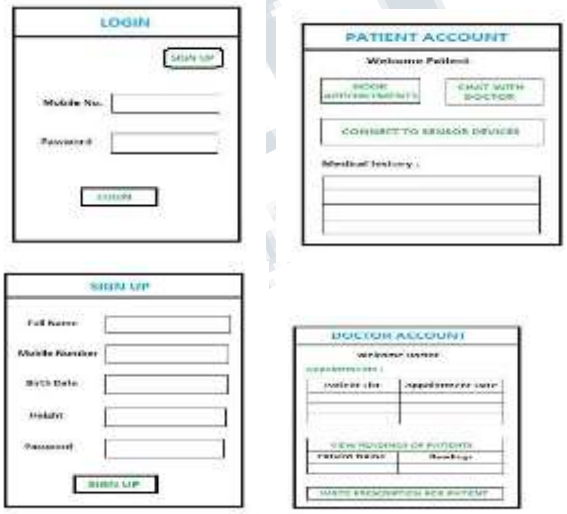

Fig3. System User Interface

Hardware interfaces :

IoT device for measuring body parameters like weight, fat, bone mass, muscle mass, visceral fat, water content, pulse rate, oxygen level, etc.

Android mobile with minimum android version 2.2(Froyo) is required for using the app but 4.4(Kitkat) for connecting to sors device using Bluetooth Low Energy and Internet as a medium of data transfer.

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Software Interfaces :
NoSQL Database on cloud using Firebase.
Android Studio for app development.
Communications Interfaces :
The product will make use of Bluetooth Low Energy and Internet connection.
Mathematical Model :

System S = { I, O, F, Sc , Fr }

I : Input = { Pdi , Sdi }

Pdi : Patient details = { Patient-Id, Name, Mobile No, Height, Weight, Birthdate }

Sdi : Sensor Data = { Weight, Fat, Water content, BMI, pulse rate, oxygen level }

where i is 1,2,3……,n n is number of patients

O : Output = { Bill Generation, Doctor Appointment, Prescription }

The following functions are for each individual patient.
Patient_Authentication(patient_id, password),
Bluetooth_Connection(sensor_id,mobile_id),
Data_Acquisition(sensor_data),
Insert_into_Database(),Alert_System(),
Bill_Generation(patient_id), Chat(patient id, doctor id)

Smart health center system uses the abilities of Internet of Things by associating the smart de-vices with human beings to provide them the best health care. The system will be monitoring the conditions of a person using various sensors such as oxygen level monitoring sensor, glucose monitoring sensor, blood pressure sensor, weighing scale, etc. These monitoring systems employ sensors to collect physiological information which is analyzed and stored on the Cloud. If the patient needs urgent attention based upon the readings from the sensors, the system automatically alerts the nurse and doctor so that the patient can receive immediate services such as ambulance (in the case of outdoor patient) and help from doctors as soon as possible.
Interpretation and Performance evaluation parameters in Smart Health system The above mentioned system gives us idea how our basic smart healthcare system will be in smart cities .This system can be extended to get spatial epidemic prediction using smart city infrastructure. Smart city infrastructure consist of integration of environmental sensors plus huge citizen information plus all social sites RSS feed like twits and facebook status. Complex event processing and use of that in prediction can easily improve the over all performance of the system. Complex Event Processing (CEP) is an event processing concept that takes asynchronous, real-time, high-volume data event streams and provides a mechanism for application developers to specify correlations, aggregations and other forms of event pattern matching. The approach taken by CEP turns the traditional, database-led approach of application development upside-down. Rather than an application repeatedly compiling a query, submitting it to a database and waiting for a result, applications using CEP submit a query once. This is compiled by the engine and as data events arrive they are passed through this query. When conditions are met, the resulting data is published to the subscribing application. CEP provides a publish/subscribe view of event streams that supports complex analysis of the data stream and negates the need for an application to repeatedly poll a database.
Prediction accuracy is major performance determining parameter. data stream management systems (DSMS) are used to process continuous feeds of data in a method analogous to a database. For example, whereas relational databases often use Structured Query Language (SQL) to query and manipulate static data, stream management systems use a modified form of SQL— such as Continuous Query Language (CQL), StreamSQL, or Event Processing Language (EPL)— to work more efficiently with streaming data.

V CONCLUSION AND FUTURE WORK

In this paper we discussed the healthcare in smart cities. It is fusion of three main technologies mainly Internet of things , Social pervasive environment and Big data analytics. Mainly in IoT data analytics stream analytics and Context management are most important parameters. Mainly Machine algorithms focuses on conventional large data sets, But veracity and velocity makes IoT analysis different from this.
Hence next domain we focus on complex event processing. Researchers implemented stream processing technology on the STRIDE platform to address the

challenge of real time notification of patients presenting in the Emergency Department (ED) , They used Esper stream processing engine and Hl-7 algorithm.
In Smart healthcare system(Prototype developed) which we are using to demonstrate our concept proof. With reference to this system integration of sensor data is very much important. We have easily available medical sensors coming along with smart phone or we have Bluetooth enabled smart wearable devices . we are building a algorithm to aggregate the data with complex event processing engine. Then assign a context to this aggregated data and building up patients profile which can be easily edited in Electronic Health care Record. This application then integrated with standard Smart city application frame work for epidemic outbreak and performance improvement is done on correct predictions.

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