A Survey on Big Data Techniques in Medical Field

B. Triveni, P. Bhargavi, S. Jyothi

Abstract*: Big data analytics is rapidly expanding in various fields and it has started to play a crucial role in Medical field. It is providing various tools to store, manage, analyze, and assimilate massive data sets of disparate, structured, and unstructured data produced by current Medical systems. Big data in medical field can build better health profiles and predict outbreaks of epidemics, Clinical decision support for patients with accurate diagnosis and can build novel treatment for diseases .This paper provides Big Data concepts and its characteristics used in Medical field. This paper also reviews the analysis of Big Data Analytics in Medical Field.

Keywords: Medical field, Diagnosis, Clinical decision support, Big Data Concepts, Big Data Analytics.

I. INTRODUCTION

Highlight a section that you want to designate with a certain style, Big data is a collection of techniques and methodologies which needs new forms of integration to uncover large hidden values from large datasets that are diverse, complex, and of a massive scale. Big data can also be defined as large volume of unstructured data which cannot be handled by traditional data management tools [20]. Big data often comes from multiple sources, and arrives in multiple formats. Big data has capability for capturing data ,analyzing data, searching, sharing, transferring, visualizing, querying, updating data and information privacy. Medical field includes the maintenance or improvement of health via the prevention, diagnosis, and treatment of disease, illness, injury, and other physical and mental impairments in human beings. Healthcare is delivered by health professionals (providers or practitioners) in allied health professions, physicians, physician associates, dentistry, midwifery, nursing, medicine, optometry, audiology, pharmacy, psychology etc.Medical field generates huge data about every patient but accessing, managing and interpreting the data are critical to creating actionable insights for better care and efficiency. Big data in medical field can be used for analyzing data in the medical data with the goal of reducing costs and improving patient care. This data includes the unstructured data from physician notes, pathology reports etc. Big Data and healthcare analytics have the power to predict, prevent & cure diseases. Big data is having a tremendous impact on the medical field. Medical domain has a lot of possibilities to provide better cure for disease using different analytical tools.

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II. BIG DATA

Big data is described as large voluminous and complex data of structured, semi structured and unstructured form that traditional data processing applications are inadequate to deal with them [4]. Big data challenges provide effective, innovative tools and technologies for seeking storing, analyzing, searching, sharing, transferring, visualizing, querying, updating data and also provide information privacy. The characteristics of Big Data are:

A. Volume:

Volume refers to the massive amounts of data generated every second. The data size could be Terabytes (TB: Approximately 1012 bytes), Petabytes (PB: Approximately 1015 bytes) and Zettabytes (ZB: Approximately 1021 bytes), or even Yottabytes etc.

B. Variety:

Variety refers to different sources of data like structured, semi-structured and unstructured, structured data from spreadsheets and databases, semi structured data from key-value web clicks and unstructured data form of emails, photos, videos, audio, monitoring devices, PDFs, etc.

C. Velocity:

Velocity refers to the speed of data generated. Big Data velocity refers to the speed at which data flows in from sources like business processes, application logs, networks and social media sites, sensors, mobile devices, etc. The flow of data is huge and continuous.

D. Variability:

Variability refers to inconsistent data also speed at which big data is loaded into database.

E. Veracity:

Veracity refers to the accuracy of big data, because will become useless if it is worthless and misleading, especially in the case of automated machines that use unsupervised machine learning algorithms to make decisionS.

F. Visualization:

One of the challenges of Big Data is to collect and transform the massive data into the form that is easier to analyze and understand. Once the data is processed, it should be converted into a more understandable form that is achieved with the help of graphs and charts.

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G. Value:

The other characteristics of big data are meaningless if we don't derive value from the data.

III. MEDICAL FIELD

Medical Data can be thought of an example of how the seven Vs of data, velocity, variety ,volume ,Variability ,Veracity ,Visualization and Value are an innate aspect of the data it produces[24].The Medical industry has historically generated large amounts of data, driven by record keeping, compliance & regulatory requirements, and patient care. Most of the data is stored in hard copy form, the current trend is towards rapid digitization of these huge amounts of data which are coming in different data forms [1].Data in the medical field can be categorized as follows:

A. Electronic Health Record:

Electronic clinical data is obtained from hospital, clinic or practice. The data collected includes administrative and demographic information, diagnosis, treatment, prescription drugs, laboratory tests, physiologic monitoring data, hospitalization, patient insurance, etc.

B. Administrative Data:

This data is associated with electronic health records; these are primarily hospital discharge data reported to a government agency.

C. Claims Data:

Claims data refers to the billable exchanges (insurance claims) between insured patients and the healthcare delivery system. Claims data falls into four categories: inpatient, outpatient, pharmacy, and enrollment. The sources of claims data can be obtained from the government (e.g., Medicare) and/or commercial health firms.

D. Patient/Disease Registries:

Disease registries are clinical information systems that include a narrow range of key data for certain chronic conditions such as Alzheimer's disease, cancer, diabetes, heart disease, and asthma. Registries often provide critical information for managing patient conditions.

E. Health Surveys:

This data refers to the national surveys of the most common chronic conditions that are generally conducted to provide prevalence estimates.

F. Genomic data:

It refers to genotyping, gene expression and DNA Sequence [2].

G. Web and Social Media Data:

This data is available from Search engines, Internet consumer use and networking sites (Face book, Twitter, LinkedIn, blog, health plan websites and Smartphone, etc.)[2].

H. Mobility Sensor Data or Streamed Data (Data in Motion):

This data is obtained from regular medical monitoring and home monitoring, telehealth, sensor-based Wireless and smart devices [3]

IV. NEED FOR BIGDATA ANALYTICS IN MEDICAL FIELD

Big data is very useful in the Medical Industry. Over the past decade, electronic health records (EHR) have been widely adopted in hospitals and clinics worldwide. Important clinical knowledge and a deeper understanding of patient disease patterns can be studied from such data. It will help to improve patient care and improve efficiency. Big data can be used in the Medical Field for the following benefits:

A. Electronic Health Records (EHR):

Every patient can have their own digital record which includes demographics, medical history, allergies, laboratory test results etc. Records that are shared in a secured way between physicians and healthcare providers as they examine patients can reduce duplicate tests and improve patient care. By secure way to mine patient data can improve the quality of care while reducing costs.

B. Improve Clinical Trials:

Monitoring the effect of medication continuously and based on the analysis dosages of medications can be changed for faster relief. Monitoring patient vital signs to provide proactive care to patients. Making an analysis on the data generated by the patients who already suffered from the same symptoms, helps doctor to provide effective medicines to new patients [5].

C. Predict Diseases Earlier:

Predicting the various viral diseases earlier before spreading based on the live analysis. This data can be identified by analyzing the social logs of the patients suffering from a disease in a particular geo-location [6]. This helps the healthcare providers to advise the victims by taking necessary preventive measures. Using prediction modeling and machine learning, Hadoop can provide information which will be helpful to the doctors.

D. Hospital Administration:

Health Care administration becomes much smoother with the help of big data. It helps to reduce the cost of care measurement, provide the best clinical support, and manage the population of at-risk patients. It also helps medical experts to analyze the data from diverse sources. It helps healthcare providers conclude the deviations among patients and the effects treatments have on their health.

E. Fraud Prevention and Detection:

Big data helps to prevent a wide range of errors on the side of health administrators in the form of wrong dosage, wrong medicines, and other human errors.

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It will also be particularly useful to insurance companies. They can prevent a wide range of fraudulent claims of insurance.

F. Evidence-Based Medicine:

Using evidence-based medicine, the doctor can match symptoms to a larger patient database to get accurate diagnosis which could be faster and more efficient. Big data plays an important role for assimilating information from different sources and normalizing the data.

G. Reducing Hospital Readmissions

Hospital costs are raising partially because of high readmission rates within one month of patient discharge. Big data analytics can be used to identify at-risk patients based on past history, chart information, and patient trends, hospitals can identify at-risk patients and provide the necessary care to reduce readmission rates.

H. Control Data for Public Health Research:

The medical profession is drowning in data..The data related to medical conditions and immunizations are submitted by medical offices and hospitals, but without big data, those data are meaningless. Analytics normalizes raw patient data to fill gaps in public health records that can affect regulations as well as providing better care.

I. Genomic Analytics:

Big Data analytics discovers hidden patterns, unknown correlations, and other intuition through examining large-scale of different data sets. Genomic analytics provides efficient and effective approach to identify clinically actionable genetic variants for individualized diagnosis and therapy [7].

V. ANALYSIS OF MEDICAL FIELD USING BIGDATA TECHNIQUES

With the help of computational analysis, research in the field of Medical Field has gained tremendous benefits over the past few decades. In medical field, large amount of information about patient's medical histories, symptoms, diagnoses and responses to treatments and therapies is collected. Big data analysis has tremendous potential to improve medical field and transform the health of populations. Its potential will depend on solving challenges associated with data privacy, security, ownership, and governance [58].The requirement of healthcare discussed by Srinivasana et al., [8] ,where big data is used to detect the errors, frauds in health insurance and then in the reduction of recurrent losses and giving proper care to patients. Saria et al., [9] focused the issues of healthcare delivery (HD) in big data. This founds helpful for computational engineers to sort out the issues of big data in transforming Health data.

Hong Song et al., [10] presented a scalable multi-user framework for multiuser. This framework can be used in hadoop-based big data healthcare applications (HBDHA). As the volume of data is growing by social medias, medical histories, and weblogs, the functions of big data resource (BDR) provide the better understanding of complex systems. It helps in taking decision for national security, healthcare, cyber security and finally for business [11]. Kaur et al., [12] focused on the increasing medical data problem in healthcare and presented a persistent polyglot framework (PPF), which helps in the documentation of different medical data separately. Aizawa et al. [13] proposed a multimedia tool "Food Log", this tool offers the method of recording the daily food consumption in healthcare. The tool also provides significance in latest healthcare monitoring applications (HMA).A machine learning algorithm using big data is suggested by Taylor et al., [14] that conforms the actual real time clinical practice. It allows incorporation of more clinical variables that assist in discovering unexpected predictors. J.Archenaa et al., [15] discussed about that big data analytics using hadoop which plays an effective role in performing meaningful real-time analysis on the huge volume of data. It also predicts the emergency situations before it happens in the medical field.

A smart-evac model developed by author Moulik et al., [16] to take decision in emergency situations like the disaster. It is a cluster based system, where volume, variety, and velocity of healthcare big data are solved. Smart-Evac provides immediate cloud-based basic healthcare facilities and ambulatory medical services for victims after successful evacuation. Zhang et al., [17] proposed proximity privacy model for preserving the privacy of electronic health record and also designed a map reduce algorithm (MRA) to attain maximum scalability computation on real-life patient's data set and was found successful.

Sathiyavathi et al., [18] discussed various solutions to improve health care using big data analytics by finding the origins of diseases, better diagnoses, helping patients to monitor their own conditions. Priyanka et al., [19] discussed big data Analytics advantages and challenges in health care system. Big data algorithms have a capability to help medical field to improve heart diseases and make fast decisions [26]. Big data techniques have great potential to gain insight from clinical data repositories to make decisions [20]. Sudha, et al., [57] proposed a model to predict the number of asthma emergency department(ED) visits based on near-real-time environmental and social media data. This could be helpful for public health surveillance, ED preparedness, and targeted patient interventions.

A framework is proposed by Aditi Bansal et al., [21] that optimizes the store allocation in the slot-base Map Reduce system so that it can properly analyze the health care data to predict the group or gender who has more attacks from disease. Van-Dai Ta et al., [22] proposed generic architecture for big data healthcare analytic by using open sources, including Hadoop, Apache Storm, Kafka and NoSQL Cassandra to be applied for many real-time analytics as well as for prediction and recommendation systems in healthcare. Weider D. Yu et al., [60] proposed a model based on Naive Bayes classification algorithm.

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To classify new cases or patients as they arrive. This model predicts the state of person's health on providing the symptoms as input and analyzes the pattern of disease growth. Knowledge was gained from a bulk of unstructured data sets and implemented into a web system.

Kavitha, V et al., [23] proposed a Fuzzy C-means Clustering Algorithm and ID3 (Iterative Dichotomiser 3) classification algorithm that creates centroid-based clustering and builds a decision tree from a fixed set of examples, that helps to maintain all kind of health data with low costs. Also it provides right intervention to the right patient at the right time. Big data analytical approaches can be employed to recognize inherent patterns, correlations and anomalies by integrating vast amounts of data from different data sets [24]. For better performance, scalability and fault tolerance from massive data can be achieved by hadoop based framework [25].

Over the past few decades, the medical data is also analyzed by various computational techniques like Data Mining Techniques and Soft Computing Techniques. Shiv Shakti Shrivastavaal. et al., [27] discussed a case study using classification based data mining techniques such as Rule based, decision tree, machine learning algorithms like Support Vector Machines, Principle Component Analysis etc., Rough Set Theory and Fuzzy logic on a medical data set. The medical data can be visualized by unsupervised neural networks [54]. Apriori algorithm is used for finding frequent item sets in medical databases and can be used for generating the association rules in medical billing data. [28]. At a particular geographical area at a given time, frequency of diseases can be identified using apriori algorithm. Association rules can be applied to extract patterns that occur frequently within a data set [29].

Fuzzy association rules and neural network techniques are used to handle medical problems like dealing with noisy, incomplete, heterogeneous data and intensive tasks [30]. Markus Brameier et al., [31] proposed a genetic Algorithm by classification of medical data for assessing diabetic diseases. Classification method based on Bayesian Ying Yang (BYY), three layered model can be used to classify liver disease through automatic discovery of medical trends [55]. Vijayarani, S. et al., [32] proposed that Support vector machine and naive bayes classification algorithms are used to predict liver disease. Feature extraction techniques like automatic feature selection and expert judgment used to diagnose cardio vascular diseases [33].

Classification techniques like naive bayes, decision tree, neural network are used for diagnosis of heart disease [34, 53] Ba-Alwi et al., [35] proposed a comparative analysis by data mining algorithms like naive bayes, naive bayes updatable, FT Tree, K Star, J48, LMT, and NN for diagnosis of hepatitis diseases and the study concludes that the Naive Bayes performance is better than other classification techniques for detection of hepatitis disease. Comparative analysis on medical data discussed by Fatima et al.,[36] using different machine learning algorithms for diagnosis of different diseases like heart disease, diabetes disease, liver disease, dengue disease and hepatitis disease and found support vector machine to be more efficient on detection of various diseases.

The classification algorithms like naive bayes (NB) and J48 are proposed by Manjusha et al., [37] to find different dermatological diseases. For detecting dengue disease the classification algorithms like decision tree (DT), artificial neural network (ANN), and rough set theory (RS) are proposed by Tarmizi, N.D.A et al., [38].

Soft computing methodologies like neural networks-genetic algorithms and fuzzy logic-genetic algorithms are proposed by author Yardimci A et al., [39] to solve the special problems in genetics, physiology, radiology, cardiology, and neurology areas. To detect heart disease Gayathri. P et al., [40] used data mining and soft computing techniques and found neural network based techniques more effective to diagnose heart disease. Dragan Simic et al., [41] discussed different soft computing techniques like fuzzy logic (FL), artificial neural networks (ANNs), and evolutionary computing (EC) for clinical neurology domain. A genetically evolved Bayesian network classifier is used for classifying patients according to the statistical features extracted from their ECG signals [42].

Murad Alaqtash et al., [43] proposed wearable miniature non-invasive sensory system in human locomotion for assessment of gait function using a fuzzy rule-based system. Durairaj.M et al., [44] proposed a comparative analysis of Soft Computing Algorithm like artificial neural networks (ANNs) and C4.5 algorithm to detect diabetes and found ANN to be more efficient on detection of diabetes. Purushottama. T et. al., [45] proposed a diabetic retinopathy screening system for ophthalmologists screening process to detect symptoms of diabetic retinopathy. Expert systems are used for assessing the brain response to marketing stimuli using electroencephalogram (EEG) to analyze human behavior [46].

Fuzzy clusters used for cognitive analysis of multiple sclerosis [MS] related to central nervous system [59]. To diagnosis Hypertension Sujit Das et. al., [47] proposed fuzzy expert system and neuro fuzzy system. Faran Baig et al., [48] proposed a model of Fuzzy logic medical diagnosis control System regarding the normality of a human function in human brain and the diagnosis of hemorrhage and brain tumor. Rule based expert system designed by Rajdeep Borgohain et al., [49] to diagnose cerebral palsy.

Badri Adhikari, et al., [50] designed a neurology diagnosis system, by developing web based expert system to help the diagnosis process of neurology doctors. A neurological disorder diagnosis system based on rule-based expert system (RBES) used by Atul Krishan Sharma et al., [51] to detect neurological disorders. Rajdeep Borgohain et al., [52] proposed a rule based expert system implemented using the java expert system shell for the diagnosis of neuromuscular disorders. Segmentation technique is used by Anitha, R et al., [56]. For brain image analysis to detect diseased area of Alzheimer's diseases.

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VI. CONCLUSION

At present Medical field is generating large amount of information in various forms from different sources these extensive amounts of knowledge and data in medicine need us to develop specialized tools for accessing data analysis, knowledge discovery and effective use of stored knowledge .Big data analytics have the potential to reduce costs of treatment, predict outbreaks of epidemics, avoid preventable diseases and can build the better health profile. In this paper we have made an attempt to review the valuable literary work of different researchers in the field of Medical Data Mining, Medical Soft Computing and Medical Big data Analytics. We have summarized various Computational analysis approaches, algorithms applied in medical field which would be helpful for diagnosing the diseases. However the selection of computational analysis depends mainly on the type of dataset. This study of survey unfolds the importance of research in the field of diagnosing life looming diseases. Accuracy of predicting the disease should be hundred percent otherwise wrong predictions may lead to adverse effect on the patient.

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