International Journal on Future Revolution in Computer Science & Communication Engineering
Volume: 4 Issue: 1
ISSN: 2454-4248
314 – 321

IoT based Health Care System for Cholera Infection

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***Abstract*:** The healthcare is a significant issue which is concerned with every human being. The hitch which exists now days is lack of time. Some diseases are reparative, and some are fatal in nature. The proposed paper deals with Cholera which is an infection of the small intestine. Cholera infection could be sewage, and its cure in the form of medicines is available. In our proposed system, the user will enter some parameters to diagnose disease. The parameters entered by the user should be stored in a cloud database. These entered parameters will be analyzed by a doctor to diagnose the level of disease. The information presented by the user will be secured since it is protected through authorization. Unauthorized users will not be able to access information stored in a cloud database.

Keywords: *Healthcare, cholera, cloud computing, EEG(electroencephalography), ECG (electrocardiography), EMG (Electrocardiogram).*

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I. INTRODUCTION

CHOLERA is a fatal disease that causes astringent watery diarrhea, which can lead to dehydration and even death if underdone. It is caused by eating food or drinking water tarnish with a bacterium called Vibrio cholera. However, globally, cholera cases have increased immovably since 2005, and the disease still occurs in many places including Africa, Southeast Asia, and Haiti. CDC responds to cholera convulsion across the world using its Global Water, Sanitation, and Hygiene (WASH) expertise. The disease is most common in places with bad sanitation, crowding, war, and famine. Common locations include parts of Africa, South Asia, and Latin America. It is impressible information which must not spread among the population. A certain set of security mechanisms are required. We can use authorization, authentication and some other secure methods for information transfer. The rationalization behind cholera is lack of awareness, time and facilities available in the healthcare centers. The technology is growing, and with this, it is possible to get the information about the disease on the go. The most common technology involved in health care fundamentals is cloud computing.

Cloud is a technology which provides user to utilize the resources they don't have. The cloud technology is widely used in healthcare environment also. [1] Cloud computing is an emerging technology that is expected to support Internet-scale critical applications which could be essential to the healthcare sector. It's scalability,

resilience, adaptability, connectivity, cost reduction, and high-performance features have high potential to lift the efficiency and quality of healthcare. This technology is used to integrate security and privacy engineering process into the software development lifecycle. In particular, security and privacy challenges are identified in the proposed cloud-based home healthcare system. Moreover, a functional infrastructure plan is provided to demonstrate the integration between the proposed application architecture with the cloud infrastructure. By using several mitigation techniques putting the focus on patient-centric control and policy enforcement via cryptographic technologies, and consequently on digital rights management and attribute-based encryption technologies we make our system secure. [2] The problem under study consists of an improvement in health care system using the cloud. Cloud-based Health Care is the integration of cloud computing and health monitoring. The computing device enables the delivery of accurate medical information anytime anywhere by means of internet. Cloud-based healthcare system consists of a computing device and number of sensors mounted on patient's body. In this paper, we present a Cloud-based Intelligent Healthcare Monitoring System (CIHMS), which can provide medical feedback/assistance to the patient through the cloud (if data are already available) or hospital. The suitable sensor is/are to be used to obtain adequate data related to patient's disease.

Table 1 *Describing benefits of cloud in healthcare environment*

Parameters	Description
Mobility	Data and information regarding disease can be available to a person no matter where they are in the world. She/he can check the information anywhere via smartphones and tablets etc.
Reliability	Most cloud providers are extremely reliable in providing their services, with many maintaining 99.99% uptime. The connection is always on, and as long as we have an Internet connection, we can get our information from practically anywhere. Some applications even work off-line.
Security	Security is a prime issue because our information is so much sense. Cloud computing gives us greater security due to data is stored in the cloud, you can access it anytime, anywhere on the single go.
Reduced Cost	The client will pay only for the resources. She/he is using not for the maintenance and hardware of cloud.
Speed	As the whole information of client present on the cloud so it can be accessed easily without wasting time.

Hence, the primary aims of the proposed system are:

1) To provide user validation and security to the user and also provide an initial diagnosis to all users depending upon the symptoms.
2) The information about the disease will propagate to the user through the means of internet.

 ISSN: 2454-4248
314 – 321

3) To locate infected persons on the Google map using geographic positioning system(GPS).

The proposed system uses the facilities provided by the cloud to store the parameters provided by the user and then transfer those parameters to the prescribed doctor. The doctors will provide feedback directly to the user. In order to use this system user has to validate him or herself. Hence security of information is present. In order to input the parameters, mobile apps can be used. If the person is detected with a positive result, then we can suggest them Doctor as well as nearby Hospitals.

II. RELATED WORKS

Related work is divided into four sections which are cloud computing, security mechanisms, cholera virus and IoT.

2.1 Cloud Computing

Cloud computing referred to the delivery of on-demand computing resources—everything from applications to data centers—over the Internet on a pay-for-use basis.

In 2014, M. D. Assuncao et al. [3] studied that cloud is used to manage a large amount of data. Health care system requires lots of space to maintain the data of patient and cloud is one of the best ways. As cloud has a lot of storage space and it is easy to access data from there by using single click. In 2014, J. Mohammed et al. [4] discussed that building an Android platform based mobile application for the healthcare domain, which uses the idea of the Internet of Things (IoT) and cloud computing we can provide a facility to the peoples. The whole data can be uploaded to the user's private centralized cloud or a specific medical cloud, which keeps a record of all the monitored data and can be retrieved for analysis by the medical personnel. Though the idea of building a medical application using IoT is good and cloud help the user to diagnose his disease. In 2012, S. Guilloteau et al. [5] stated that privacy is increasingly important in the online world. It is widely accepted that cloud computing has the potential to make the information of user privacy. The secure processing of personal data in the cloud is a huge challenge. Adoption of privacy-enhancing technologies to support such activities in the cloud will help in handling personal data at the international level.

2.2 Security Mechanisms

The information of cholera is sensitive in nature so to make it secure our prime duty. We are using authorization and authentication mechanisms so that only the validated user can only access this information.

In 2012, D. Zissis et al. [6] studied that for the security perspective, a number of unchartered risks and challenges have been introduced from this relocation to the clouds, deteriorating much of the effectiveness of traditional protection mechanisms. As a result to evaluate cloud security by identifying unique security requirements and to present a viable solution that eliminates these potential threats is required. We can use specific security characteristics within a cloud environment. The proposed solution calls upon cryptography, specifically Public Key Infrastructure operating in concert with SSO and LDAP, to ensure the authentication, integrity, and confidentiality of involved data and communications. In 2009, C. Wang et al. [7] discussed that cloud computing had been envisioned as the next-generation architecture of IT Enterprise. In contrast to traditional solutions, IT services are under proper physical, logical and personnel controls; Cloud Computing moves the application software and databases to the large data centers, where the management of the data and services may not be fully trustworthy. This unique attribute, however, poses many new security challenges which have not been well inferred. In this article, we focus on cloud data storage security, which has always been an important aspect of quality of service. Unlike most prior works, the new scheme further supports secure and efficient dynamic operations on data blocks, including data update, delete and append. Extensive security and performance analysis shows that the proposed system is highly efficient and resilient against Byzantine failure, malicious data modification attack, and even server colluding attacks.

2.3 CHOLERA Virus

Cholera is a subtle, diarrheal illness caused by infection of the intestine with the bacterium Vibrio Cholera. An estimated 3-5 million cases and over 1 lakh deaths occur each year around the world.

In 1984, J. B. Kaper et al. [8] explained that the pathogens strain of Vibrio cholera was attenuated by deletion of DNA sequences encoding the A1 subunit of the cholera enterotoxin. A restriction endonuclease fragment encoding the A1, but not the A2 or B sequences were deleted in vitro from cloned cholera toxin genes. The mutation was then recombined into the chromosome of V.cholerae Ogawa 395, a pathogenic strain that confers complete immunity to subsequent infection following an initial clinical infection. The resulting strain, which produces the immunogenic but nontoxic B subunit of cholera toxin and is unaltered in other critical antigens, represents a promising candidate for an attenuated live oral cholera vaccine. In 1977, R. R. COLWELL et al. [9] proposed Vibrio cholera was isolated at several locations in the Chesapeake Bay in fall 1976 and spring 1977. Strains induced fluid accumulation in rabbit ileal loops and positive activity in Y-1 adrenal cells. Vibrio cholera, Vibrio arahaemolyticus, and related vibrios show a spatial and temporal distribution characteristic of Vibrio species in an estuary. The Vibrio cholera strains isolated from the Chesapeake Bay represent serotypes other than O-group I—that is, so-called non-agglutinable vibrios—and are not recognized as a serious epidemic threat, although they have caused cholera-like diarrhea sporadically.

2.4 IoT

The Internet of Things provides technology at its best statutory. The IoT is used in health care system to prevent diseases to simulate within the population. This technology will use the internet as a medium to grab vital parameters of the disease under study and then suggest solution according to information present in the cloud. In 2011, V. M. Rohokale et al., [10] stated that the chances of disease separation is largest among the rural areas where healthcare systems are least operational. IoT can provide great gimmick in such areas. The user will not require any physical health care for diagnosis. In 2014, P. C. J. Chung [11] discussed that the wearable devices are considered and described using the

 ISSN: 2454-4248
314 – 321

system. The IoT will use these devices to increase the performance of the system under consideration. The devices which are considered involve BP monitoring, Blood Sugar monitoring, etc. All these devices provide easy capturing of information from users.

III. PROPOSED SYSTEM

The proposed system will use Google drive in order to store the parameters of cholera. In order to access the cloud (Google Drive), some sort of app is needed. The app will be used in order to gather the information about the user. The app will require an authenticated user. The collected information has to be processed. Hence we need to perform information granulation. The information granulation will be a three-phase task. In the initial phase, the information will be analyzed using K-means clustering. This technique will identify the persons with same parameters and bind them in a group.

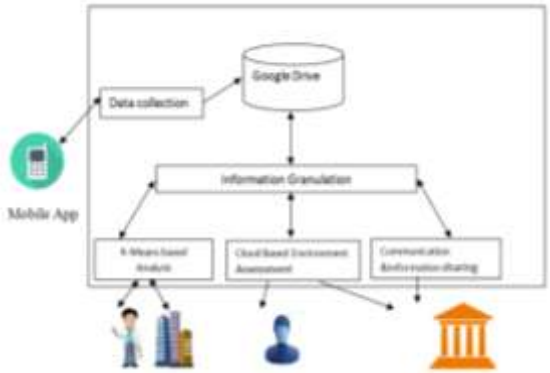


Fig. 1 Cloud System for managing Cholera

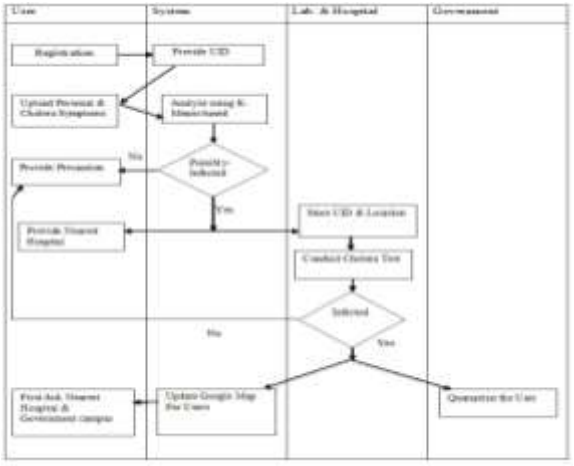


Fig. 2 System Information flow for preventing Cholera Infections

The cloud-based environment will be used to store the information. We will use Google Drive as a cloud to store our data. It is the latest technology which stores huge amount of data in a single storage space, and it is very easy to access this in a single go. Our data is also secure in this space and only validate user can only access the data because the information of cholera is very sensitive in nature. Google provides 15GB free of cost space in Google drive to store our data.

Table 2 Showing the clusters with different parameter values

Nausea=Yes	**Nausea= NO**	**Nausea=No**
Vomiting=Yes	**Low Blood Pressure**	**Low Blood Pressure**
Dehydration=yes	**=NO**	**=Yes**
Low Blood	**Vomiting= Yes**	**Vomiting=No**
Pressure= Yes	**Dehydration=Yes**	**Dehydration=Yes**

3.1 Data collection

Multiple health-related attributes like personal attributes and disease-related attributes are stored as shown in Table 3 and Table 4. Personal attributes remain the same for most of the periods, whereas cholera-related attributes can vary. The values of these parameters are stored in the database. K-means is used to categorize users depending on these attributes.

Table 3 Showing personal attributes of user

Sr. No.	Attributes	Description
1	Name	Name of user
2	Address	Permanent Address of user
3	Telephone Numbers	Mobile/Telephone Number
4	Age	Age in years of user
5	Sex	Male/ Female
6	Occupation	Occupation of user
7	GPS	Geographic location of user or workplace of user
8	Relatives	Names and mobile numbers of user's close relatives
9	SocialSecurity Number	Unique identity of user

Table 4 Showing cholera-related attributes

Sr. No.	Attributes	Output	Description
1	Rapid Heart Rate	Yes/No	Whether a user has rapid heart rate
2	Loss of skin elasticity	Yes/No	Whether a user has a loss of skin elasticity problem
3	Low Blood Pressure	Yes/No	Whether a user has low blood pressure
4	Thirst	Yes/No	Whether a user has thirst
5	Muscle Cramps	Yes/No	Whether a user suffers from muscle cramps
6	Nausea	Yes/No	Whether a user suffers from nausea
7	Dehydration	Yes/No	Whether a user suffers from dehydration
8	Vomiting	Yes/No	Whether a user has to vomit

3.2 Information Granulation

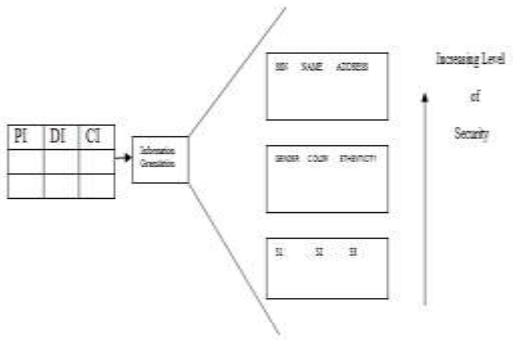
The data collection component receives personal, demographic, and cholera symptom-related information from the user. This information is sensitive in nature so it should be secured from everyone. Disclosure of such information, even unintentionally, to the unauthorized user can cause mass paranoid hysteria among citizens of any country. The proposed system implements authorization mechanism to make data secure. According to recent attacks on information systems, proposed system uses information granulation concept to prevent unauthorized access to data. We will register the user username and password to store the data in the cloud. After validation of data, she/he can only

 ISSN: 2454-4248
314 – 321

access the database. Whenever next time user wants to access the data, she/he has to use valid login ID. By using this mechanism, we will secure our data from others.

The cloud-based environment will be used to store the information. We will use Google Drive as a cloud to store our data. It is the latest technology which stores huge amount of data in a single storage space, and it is very easy to access this in a single go. Our data is also secure in this space and only validate user can only access the data because the information of CHOLERA is very sensitive in nature. Google provides 15GB free of cost space in Google drive to store our data.

The information presented by the user will be stored in the table for initial analysis. The table will be partitioned into three parts. Each part represents distinct sets which will belong to distinct levels of security. In order to provide the security measure the data from the tables are collected in data metrics. The information which is most critical is given level 3 security. The representation of the security will be as follows



PI- Personal Information, DI- Demographic Information, CI- Cholera Information

Fig. 3 Showing Security Levels

3.3 K-Means Analysis

Large amount information may be loaded from the health devices. The information has to be filtered and grouped together by the use of clustering mechanisms. The proposed paper uses K-Means Clustering algorithm in order to group together characteristics which are similar in nature.[12] K-means clustering is preferred in home-based healthcare analysis. The healthcare parameters are gathered and stored within the table from where it is loaded into the cloud. The cloud service which we are using is google drive. From where it is analyzed, and persons with similar attributes are grouped into same clusters. [13]Learning mechanism is required in order to use k-means effectively. The learning techniques are partitioned into supervised and unsupervised learning. The proposed technique will use supervised learning since guidance is present. [14]Community-based health care planning and regulation necessitates grouping facilities and areal units into regions of similar health care use. Limited research has explored the methodologies used in creating these regions. We offer a new methodology that clusters facilities based on similarities inpatient utilization patterns and geographic location. Our case study focused on Hospital Groups in Amritsar, the allocation units used for predicting future inpatient hospital bed demand in the state's Bed Need Methodology. The scientific, practical, and political concerns that were considered throughout the formulation and development of the methodology are detailed. The clustering methodology employs a 2-step K-means + Ward's clustering algorithm to group hospitals. The final number of clusters is selected using a heuristic that integrates both a statistical-based measure of cluster fit and characteristics of the resulting Hospital Groups. Using recent hospital utilization data, the clustering methodology identified 33 Hospital Groups in Amritsar Region. Despite being developed within the politically charged climate of Certificate of Need regulation, we have provided an objective, replicable, and sustainable methodology to create Hospital Groups. Because the methodology is built upon theoretically sound principles of clustering analysis and health care service utilization, it is highly transferable across applications and suitable for grouping facilities or areal units. The located infected and uninfected persons on the basis of K-means clustering is shown as follows

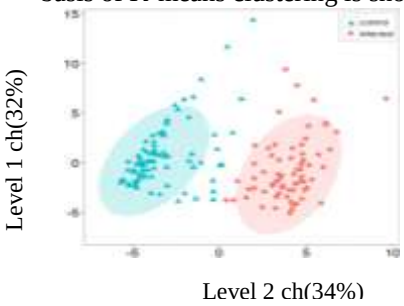


Fig. 4 Showing clusters of infected and uninfected region

3.4 GPS based risk assessment for users

Risk assessment is significant for monitoring and management of cholera. The main objective of risk assessment is to identify risk-prone areas, the population at risk and control the epidemic to vanish this disease. Cholera is a vigorous epidemic sp it's up to date information should be securely available to the healthcare agencies. We have to also know about the region-wise information of this epidemic it can be also beneficial for us. To identify different risk areas location-based risk assessment is required. If the proper information of this epidemic should be available online, then people living in risk-prone areas can be alerted within time, and some infection control suggestions can be suggested to them. [15] Recently, mobile applications which provide health services at any time and anywhere are on demand due to the growth of mobile wireless technologies. For the health service, an inspection service middleware is needed for monitoring health condition such as observing and analyzing EEG (electroencephalography),ECG (electrocardiography) and EMG (Electrocardiogram) waveforms from wearable ECG devices under the coverage of a wireless sensor network (WSN). For the inspection service middleware, we propose a new notion of a prediction model based on risk ratio Expectation Maximization (EM) by monitoring real-time bio-signals. The prediction model can detect abnormal health condition by the monitoring system. In this paper, we

 ISSN: 2454-4248
314 – 321

explain the detail algorithms and results for these steps based on EM. There are the five modules as follows: (1) The measurement of bio-signals such as body temperature, EEG, ECG and EMG, (2) Object assessment from measurement wavelength, (3) Situation assessment from GPS in smart device, (4) Maximized health condition using risk ratio EM, (5) Knowledge update and decision making for healthy life. [16] Considering the sensitivity and the time-consuming issues, a weak GPS signal parallel processing algorithm based on Duo-Core is proposed in the framework of a software GPS receiver. This method was developed for the acquisition of weak signals without a priori information. Based on Duo-Core processor, a parallel processing improvement is designed and implemented. This algorithm average assigns signals over the two cores, and parallel processes them simultaneously. After that, a threshold determination is given. At last a set of IF real data is collected in a dense urban area of Amritsar Region. The method has been examined by two tests using the real sampled data. The results demonstrate that the available signals have been successfully enhanced from 4 satellites to 8 satellites; the sensitivity and processing speed of the GPS receiver has been improved, and the scheme in this software receiver can be used to acquire the GPS signal under weak signal situations.

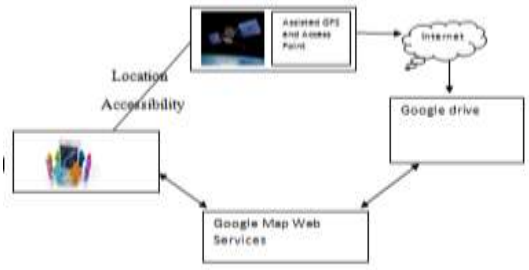


Fig. 5 Healthcare service model

The algorithm to perform the GPS based risk assessment will include the following

Algorithm 1: Mapping Risk through GPS

a) Locate the infected user through validation
b) Store the attributes within the appropriate table according to the security
c) For every registered user
   C1) if infected increase the density
   C2) Increase color in GPS diagram
d) Update table of infected user

The algorithm to test the user against the medical records indicated by threshold values and detect infected persons and quarantine the person is as follows

Algorithm 2: Quarantine the infected user matching records against medical record

a) Check the record.
b) Compare the Heart rate and skin elasticity test against a threshold.
c) If threshold exceeded, declare person infected
d) Quarantine the user from the society.
e) Perform step d for all the family members.
f) If not infected then declare user safe.

The above-written algorithm serves as effective techniques for risk assessment and determining the location of the infected users.

3.5 Communication and Information Sharing

The information regarding the patient, medical reports, prescribed medicines will be stored in the cloud. It can be accessed securely by hospitals, government agencies, concerned doctors under some security mechanism. By using the cloud, information can be easily provided, and first aid will be provided to the patient within time. The latest information regarding this epidemic can easily provide to the peoples living in different regions. The time required to provide better services to the patient will be reduced so he/she can get better results at early stages of this epidemic. The information can be easily shared among different users using social media like Facebook, Twitter, Whatsapp, etc. [17] Nowadays smartphones are equipped with various sensors and powerful processing modules, and are accessible to flexible communication networks, thus enabling complex applications such as context awareness, activity recognition, healthcare monitoring and so forth. These applications typically require contextual information to optimize the effectiveness, e.g., indoor/outdoor identification. This paper utilizes the mobile application for Cholera detection which is based on a generic smartphone platform, utilizing the information extracted from the internal clock, GPS module, and light intensity sensor. The approach has been tested in multiple locations in order to evaluate performance. This includes residences, office space, roads, restaurants, markets and so forth. This method can output detection results with good accuracy in both day and night and all weather conditions. The approach can operate on different smartphone profiles from low-end to high-end. An optimized method also presents for some advanced smartphones with GPS satellite signal noise ratio output, which has been shown more effective in real-time response and detection accuracy.

IV. EXPERIMENTAL SETUP AND PERFORMANCE ANALYSIS

The dataset of Cholera for analysis is difficult to get over the internet. A large amount of study has been corresponding to such study. The analysis process corresponds to following steps

1) Dataset Generation
2) Performance Analysis
3) Risk Assessment
4) Google Map Based Risk Assessment

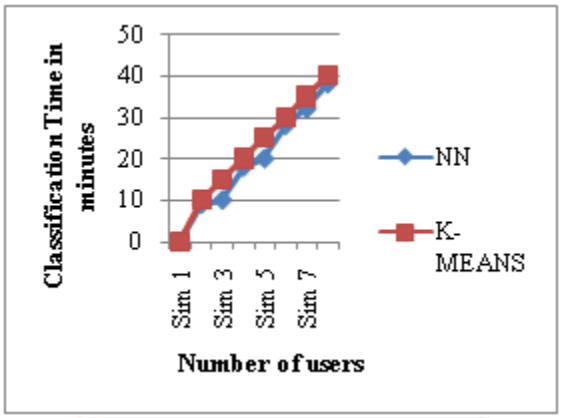
4.1 Dataset Generation

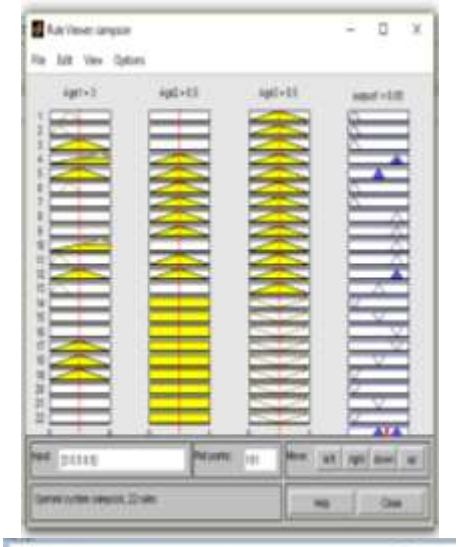
The dataset will involve the collection of records which involve the attributes of persons who may be infected with cholera. The fuzzy rules can be used in order to detect an infected person. The rules can be written as follows:

 ISSN: 2454-4248
314 – 321

Table 5 Fuzzy rules

SKIN RASH	FEVER	JP	LOA	PBE	HDCH	TLC	RESULT
NO	NO	NO	NO	NO	NO	NO	**NO**
NO	NO	NO	NO	NO	YES	NO	**NO**
YES	YES	YES	YES	NO	YES	NO	**YES**
NO	YES	NO	YES	YES	YES	YES	**YES**
YES	YES	YES	NO	YES	YES	YES	**YES**
YES	NO	NO	YES	YES	YES	YES	**YES**
YES	NO	NO	NO	NO	NO	YES	**NO**





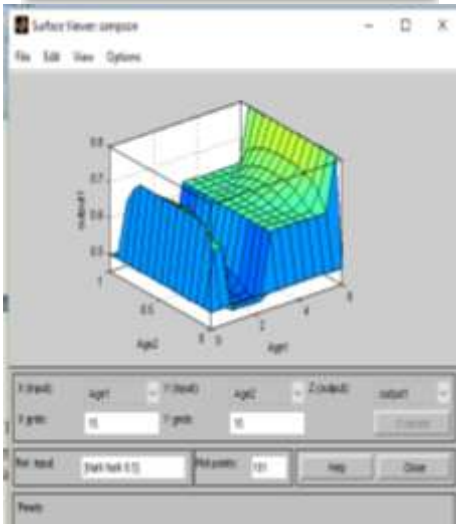


Fig. 6 Showing implementation rules of cholera
Fig.7 Showing level of cholera

All the above-stated rules can be implemented within the MATLAB fuzzy system. The result generated can indicate that whether a person is infected with the disease or not. The implementation charts are described as follow:

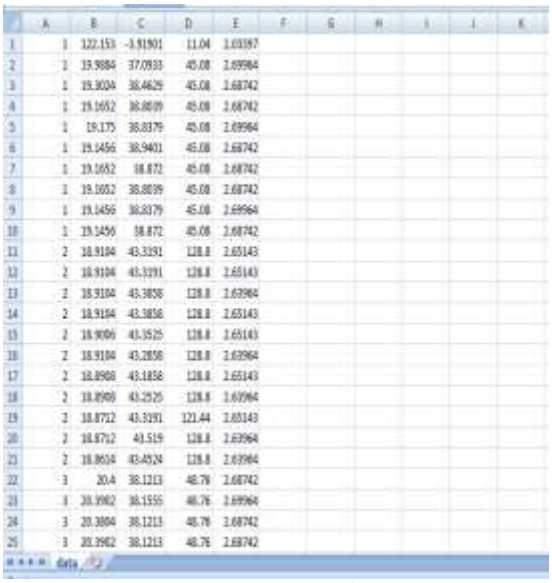


Fig. 8 *Showing Dataset of cholera*

4.2 Performance analysis

The whole information regarding the disease is stored in the cloud using Google drive. To deploy the information of the user on the cloud K-means cluster is used. It can be accessed by doctors, users, healthcare departments, and the governmental agencies. Different classification algorithms such a k-nearest neighbor and nearest neighbor are also implemented to compare them with the proposed k-means so that its use can be experimentally verified. One of the necessary tasks of the proposed system is the classification of users into infected and possibly infected, so it requires a high-performance level.

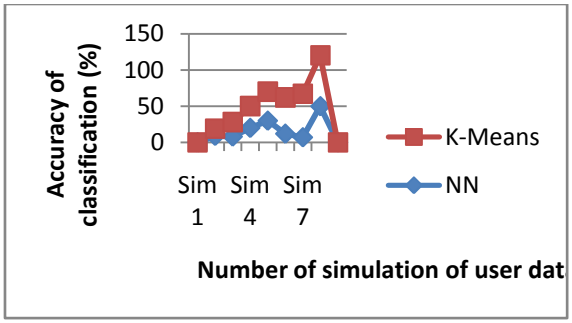


Fig.9Accuracy of classification

 ISSN: 2454-4248
314 – 321

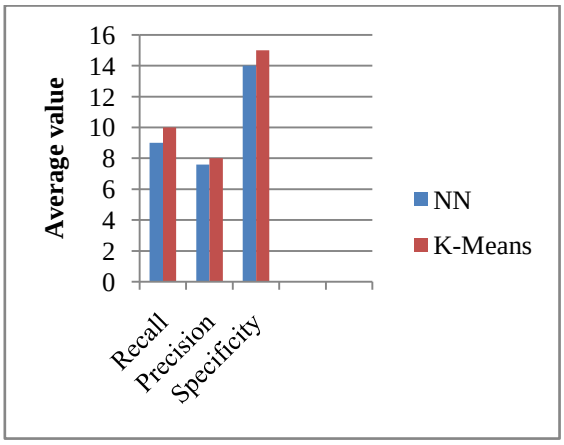


Fig.10 Specificity of clustering methods.

The chart above decisively indicates that k-means yield better result as compared to the nearest neighbor algorithm. The performance in terms of the K-Means is better hence work is justified. The representation of the Cholera is also monitored through GPS. The performance analysis in terms of GPS is as shown below

Fig.11 GPS locator

The above figures indicate the area of the Amritsar region which is detected as infected. The color will indicate the density of infection.

4.3 Risk assessment

Special cases are generated over Amritsar Region, to study the geographic-based risk assessment. Data of twenty thousand users were enrolled for Amritsar region block. GPS location of the possibly infected user is shown on the Google map Without using any re-routing algorithm, the routing of a user forms Amritsar airport to Spring Dale School. The blue line indicates the proposed route by Google services. In this case, the user passes through the red zone area for the Cholera-infected user. However, the user has been re-routed to the safer side of the block, when appropriate re-routing is used.

4.4 Discussion of results

The proposed system is mosaic and constituents of multiple components which make its preparatory evaluation even more mosaic. Thus, the preparatory evaluation had systematically carried on and is broadly divided into four parts. No availability of data for cholera forced us to create a synthetic data that are generated for users. All the preparatory generated statistical measures justified the use of the proposed k-Means. Data table fragmentation process divided into three separate data matrices is also preparatory verified. The table provides the snapshot of the data table and three data matrices which indicated the successful conversion. The whole classification process is tested for the users on Google Drive cloud using multiple classification algorithms. The proposed k-Means performed better in all cases than its fellow competitors. However, NN is also close to k-Means in classification accuracy, but its classification time is much larger than the proposed K-Means.

V. CONCLUSION

Infectious transmitted diseases using common mediums are one of the major concerns of any nation's government and healthcare departments. With the advancements in information technologies, it is possible to control many infections in the most effective and efficient way. In this paper, a system is proposed for predicting and preventing a waterborne disease known as cholera using cloud computing and GPS. K-Means is utilized to classify users, and cloud computing is used for effective information analysis and sharing. The key point of the paper is the use of geographic positioning system to represent each cholera possibly infected users on Google maps. A proposed system implemented on Google Drive cloud provides 80% accuracy in classification. It will help the citizens to avoid regional exposure and the government authorities to manage the problem more effectively. Future study will include the use of the internet of things (IoT)-based smart devices for more accuracy and effectiveness in controlling the infectious epidemic.

References

[1] M. Deng, M. Petkovic, M. Nalin, and I. Baroni, "A Home Healthcare System in the Cloud--Addressing Security and Privacy Challenges," in *2011 IEEE 4th International Conference on Cloud Computing*, 2011, pp. 549–556.

[2] K. A. Parane, N. C. Patil, S. R. Poojara, and T. S. Kamble, "Cloud-based Intelligent Healthcare Monitoring System," in *2014 International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT)*, 2014, pp. 697–701.

[3] M. D. Assunção, R. N. Calheiros, S. Bianchi, M. A. S. Netto, and R. Buyya, "Big data computing and clouds: Trends and future directions," *J. Parallel Distrib. Comput.*, vol. 79, pp. 3–15, 2014.

[4] J. Mohammed, C.-H. Lung, A. Ocneanu, A. Thakral, C. Jones, and A. Adler, "Internet of Things: Remote Patient Monitoring Using Web Services and Cloud Computing," in *2014 IEEE International Conference on Internet of Things(iThings), and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom)*, 2014, pp. 256–263.

[5] S. Guilloteau, F. T. Orange, France, and V. Maureen, "Privacy in Cloud Computing," *Media Informatics*, no. March, p. 26, 2012.

[6] D. Zissis and D. Lekkas, "Addressing cloud computing security issues," *Futur. Gener. Comput. Syst.*, vol. 28, no. 3, pp. 583–592, 2012.

 ISSN: 2454-4248
314 – 321

[7] C. Wang, Q. Wang, K. Ren, and W. J. Lou, "Ensuring Data Storage Security in Cloud Computing," *Iwqos 2009 Ieee 17th Int. Work. Qual. Serv.*, pp. 37–45\n302, 2009.

[8] J. B. Kaper, H. Lockman, M. M. Baldini, and M. M. Levine, "A Recombinant Live Oral Cholera Vaccine," *Bio/Technology*, vol. 2, no. 4, pp. 345–349, Apr. 1984.

[9] R. R. COLWELL, J. KAPER, and S. W. JOSEPH, "Vibrio cholera, Vibrio parahaemolyticus, and Other Vibrios: Occurrence and Distribution in the Chesapeake Bay," *Science (80-.).*, vol. 198, no. 4315, pp. 394–396, Oct. 1977.

[10] V. M. Rohokale, N. R. Prasad, and R. Prasad, "A cooperative Internet of Things (IoT) for rural healthcare monitoring and control," in *2011 2nd International Conference on Wireless Communication, Vehicular Technology, Information Theory and Aerospace & Electronic Systems Technology (Wireless VITAE)*, 2011, pp. 1–6.

[11] P.-C. J. Chung, "Impacts of IoT and Wearable Devices on Healthcare," in *Proceedings of the 12th International Conference on Advances in Mobile Computing and Multimedia - MoMM '14*, 2014, pp. 2–2.

[12] J. J. Armstrong, M. Zhu, J. P. Hirdes, and P. Stolee, "K-means cluster analysis of rehabilitation service users in the Home Health Care System of Ontario: examining the heterogeneity of a complex geriatric population.," *Arch. Phys. Med. Rehabil.*, vol. 93, no. 12, pp. 2198–205, Dec. 2012.

[13] S. Goswami and L. K. P. Bhaiya, "Brain Tumour Detection Using Unsupervised Learning Based Neural Network," in *2013 International Conference on Communication Systems and Network Technologies*, 2013, pp. 573–577.

[14] P. L. Delamater, A. M. Shortridge, and J. P. Messina, "Regional health care planning: a methodology to cluster facilities using community utilization patterns.," *BMC Health Serv. Res.*, vol. 13, no. 1, p. 333, Jan. 2013.

[15] Y. Jung and Y. Yoon, "Prediction model for mental and physical health condition using risk ratio EM," in *2015 International Conference on Information Networking (ICOIN)*, 2015, pp. 439–443.

[16] Yongrong Sun, Jianfeng Miao, Wu Chen, and Jianye Liu, "The weak GPS signal parallel processing algorithm in dual-core based GPS software receiver," in *2008 2nd International Symposium on Systems and Control in Aerospace and Astronautics*, 2008, pp. 1–6.

[17] W. Xu, R. Chen, T. Chu, L. Kuang, Y. Yang, X. Li, J. Liu, and Y. Chen, "A context detection approach using GPS module and emerging sensors in smartphone platform," in *2014 Ubiquitous Positioning Indoor Navigation and Location Based Service (UPINLBS)*, 2014, pp. 156–163.