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Proximity Tracing Method to reduce Community Spread of COVID 19

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ABSTRACT: The technology in the world is growing at super high speed and the humans feel they are unbeatable and can control everything; the sudden rise of Corona Virus has put this thought of humans to a halt. This virus has turned from epidemic to pandemic bringing the whole world to its knees. Since no vaccine has developed till date so prevention is the only solution to control this virus. Indian Government has launched a novel app "Aarogya Setu" where it gives the real time information of the number of cases around us even in the range of 500 m and also a provision of self testing. Till now it is based on the input given by the infected user about his visits and people he had in contact with. So only the persons he recommended are physically contacted by the government officials to go to for Corona Testing. To automate the procedure the author proposed a novel mobile app wherein a user who is infected or detected with corona positive can be backward traced so that a cluster of users is identified and the government and the hospitals are timely notified to avoid community spread along with the details about the place where he might have caught the disease. Also an alert SMS is sent to the users individually to take preventive measures. To implement this datasets of instances has been collected and tested for cluster formation. The major challenges were the unavailability of exact data and total dependency is on IMEI number.

Keywords: App Development, Cloud Database, Contact Tracing, COVID 19, Proximity, Use Case.

I. INTRODUCTION

This unknown new virus and disease outbreak began in Wuhan, China, in December 2019. Fever, tiredness, and dry cough are the most common symptoms of COVID-19. Some patients have also complained about aches and pains, nasal congestion, runny nose, sore throat or diarrhea. To stop people from getting in contact with an infected measure, necessary actions are taken like wearing a mask, social distancing and sanitizing hands frequently. Already known Corona viruses have infected many people with different levels of respiratory infections. Many countries have undergone lockdowns because people are getting ill because of Corona Virus. COVID-19 has brought the world to a standstill. The Global Economy is suffering along with the major loss of lives. India has already observed 54 days of lockdown and is now entering into lockdown 4.0.

There is a dire need to end this pandemic before it stops the world economically and emotionally. Not only prevention but its detection is really important to stop its spread in the first place from where it is seeding to avoid community spread. Every person nowadays should be fully responsible as to where he is going, why he is going, who he is meeting and where he is meeting. Movement should only happen if it is necessary; this is going to be a new trend that is a mandate to follow.

Short encounters are sufficient enough to spread contagious disease COVID-19. A brief dealing between a fruit seller and a customer, a bank executive and account holder or between two travelers on a metro can infect each other. We cannot remember all contact information but apps automatically do so. So contact tracing is need of the hour.

Pandemic is worse because of its contagious behavior. So there is a need for a mechanism which can maintain a list of proximity users in real time so that immediate action can be taken to stop community spread.

Vigorous actions are taken by Governments and health authorities, whenever a new case is identified of COVID-19. They ensure that the infected comply with all the local restrictions whether it is related to travel, movement or large gatherings.

All IT experts believe that smart phones could provide a solution to Control the spread of COVID 19. The need for a contact tracing app to keep a spy eye on infected people to save more people was utmost important. The smart phones keep track of the movement in the physical world through Location tracking which uses GPS and cell site information which cannot give exact information of the close contact tracing which are more prone to communicate the disease. For location tracking various positioning strategies can be considered: GPS (Global Positioning System), Bluetooth technology. Bluetooth can be considered indoor as well as outdoor communication medium.

"Proximity tracing, measures Bluetooth signal strength to determine if one of the users becomes infected, others whose proximity has been logged by the app could find out, self-quarantine, and seek testing" [15].

The datasets from UCI depositary has been collected and clusters of users for proximity tracing are identified using k means clustering algorithm. k means clustering algorithm is a recursive algorithm that tries to group the dataset into fixed non overlapping sub clusters where each instance belongs to only one cluster.

II. REVIEW OF LITERATURE

An extensive literature survey has been done to discover the technique and find the research gap. The

new approach has been proposed based on the existing work.

Zhao *et al.,* (2018) has explained various privacy leakages of proximity applications though the applications have brought much facilities to people but at the same time how they expose the information about the user to the non committal strangers. Many insightful observations were also made for the safety of the application user [1].

Mathkour (2011) proposed and developed a GPS-based Mobile Service Locator System to find addresses and locate their services of interest using proximity distances between the user and the locations of the desired service [2].

Liu *et al.,* (2013) explored various approaches including GPS and Wi-Fi triangulation. The paper explains how they are insufficient in terms of accuracy and flexibility. According to them, Bluetooth, provides a sure shot alternative for proximity estimation. Through experimental studies, efficiency of Bluetooth is explained based on RSSI values of Bluetooth and light sensor data. Accuracy and power consumption justifies the use of Bluetooth [3].

"Network based and Handset based positioning are the two major categories of Mobile positioning. In Network-based mobile positioning, to position the mobile device, mobile network in conjunction with the network-based position determination equipment (PDE) is used. The SS7 network is used to derive mobile user location" [4].

A clustering method based on K-means Clustering have offered an improved version of K-means algorithm in terms of both cluster precision and stability for the date which is large and randomly distributed [19].

"In Handset mobile positioning the handset itself is the primary means of positioning the user. The mobile device is provided with Network assistance in making position estimate determinations which is based on data measurement and handset based position determination algorithms. The STK allows for communication between the SIM (which may contain additional algorithms for positioning) and a location server application (which may contain additional algorithms to assist in mobile positioning)" [4].

In the 21st century, there was reporting of two previous coronavirus outbreaks SARS-CoV and Middle East respiratory syndrome (MERS)-CoV which too came as nightmare for the world [6].

The most challenging part is the presumed transmission by an asymptomatic carrier and its spreading the COVID-19 infection. The pattern needs to be understood for its best control [7].

Rapidly and accurately screening patients with COVID-19 is of utmost importance but that requires a lot of study and experiments and sometimes comparison with the previous such outbreaks of virus [8].

High mutation rate of COVID-19 has made study about the disease, its treatment, and prevention a compulsory aspect to control COVID-19 outbreak [9].

Ratnabali Pal *et. al,* proposed a shallow Long short-term memory (LSTM) based neural network for predicting the country's risk category by using a Bayesian optimization framework [10].

Disease prediction techniques can be used to predict the risks of a disease in advance so that necessary action can be taken in time [11].

Roberto Buizza in his paper presented a probabilistic disease prediction systems. As per the paper published it is possible to predict the spread with probability by using different methods from weather forecasting [12].

Many techniques have been devised to check closeness of a device for example a relative positioning system is designed with the name Virtual Compass. It is a peer-based relative positioning system. It uses the mobile handheld hardware and software to sense social interactions between Facebook friends [13].

After all patients clinical chart records were reviewed, a collection of laboratory findings along with chest x-rays indicated the cluster of patients who suffered more had some or the other history of past diseases, ranging from diabetes, blood pressure to cardiovascular diseases. It lead to severe respiratory illness and thus leading to many deaths [16].

Covid 19 has shown the exponential growth. "The mean R_0 which ranges from 2.24 (95%CI: 1.96-2.55) to 3.58 (95%CI: 2.89-4.39) associated with 8-fold to 2-fold increase in the reporting rate which may lead to outbreak" [17].

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"In Handset mobile positioning the handset itself is the primary means of positioning the user. The mobile device is provided with Network assistance in making position estimate determinations which is based on data measurement and handset based position determination algorithms.

A software LBS (Location Based Service) used in mobile devices provides the device's geographical location. GPS system of the device is used to locate a person's location.

"The *proximity sensor* which is hardware based determines how close the face of a device is to an object" [5].

Out of the many prediction methods offered by different authors, one of the effective COVID predictions was done by using hybrid Ant fuzzy clustering method [18].

Top end mobile phones these days have a number of specialized sensors including digital compass, gyroscope, GPS, proximity sensor, ambient light sensor, accelerometer, and general purpose sensors like microphone and camera.

The sole purpose of a sensory device to a mobile phone is to record and track dynamic information. Environmental impacts and to understand patterns of human movement, traffic, and air pollution can easily be computed through sensors.

In the social community of mobile the information is disseminated among the close groups and it is not shared publicly to others. The data privacy and confidentiality is at risk because the person location data and time every data is saved on the cloud which impose a data security threat. So these kinds of applications must be invoked in case of pandemic situations in the country.

Bluetooth is arguably the least Intrusive, is the most appropriate and inexpensive technology in term of location identification, in this instance, proximity to other phones using the app rather than actual location e.g. GPS or cell tower data. As an interaction tracking tool using Bluetooth, data can be 'localized' and shared.

Bluetooth technology has the potential to de-anonymize a vast number of the population and share sensitive personal data.

As per Cleo Anastassopoulou *et al.,* in his latest paper dated 31st March, 2020 gave a detailed version of analysis, modeling and forecasting of the COVID-19 outbreak and gave a Susceptible-Infectious-Recovered-Dead (SIDR) model [20].

III. PROPOSED SYSTEM

The major research gap area were discussed in a meeting which was hosted in collaboration with GloPID-R (the Global Research Collaboration for Infectious Disease Preparedness). Many major research funders and more than 300 researchers and scientists from a large variety of disciplines offered and discussed all aspects of the outbreak and suggested different ways to control it. Many mobile applications, suggestive physical means and regular improvement of existing new devices and systems is done to have improvised ways to control COVID 19.

The corona virus crisis is location independent and has taken the lives of many and it has to be controlled in a massive manner. With technology advancement with the generation of proximity apps may avoid the privacy settings of location tracking.

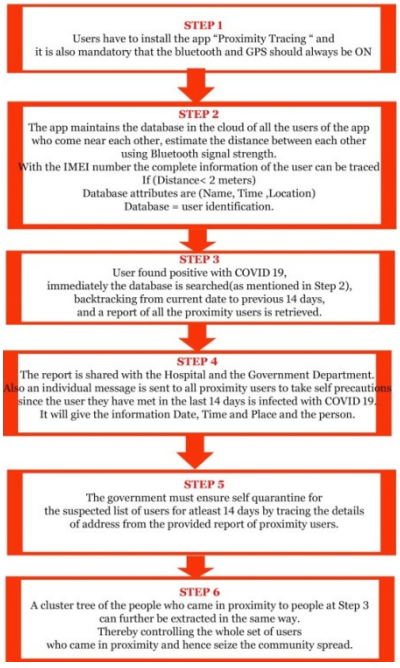

Fig. 1. Flowchart of Proximity App.

But this app has a limitation of backward propagation of contact tracing i.e. it does not give the details about the people who have come in contact with the corona positive user in the last 14 days.

In India to combat this pandemic Arogya Setu app is launched, which tracks the location, number of cases and identifies the risk zones . It helps us by giving the real time information to take necessary measures which helps us to control the pandemic. A proposed app is devised by the researcher wherein the key steps are illustrated with the help of a system flowchart as shown in Fig. 1.

Fig. 2 below illustrates the use case diagram for our proposed system. It is the elementary form of software requirement from the user point of view. It specifies the expected behavior of the system. The first block contains the users which include the username, phone no. and the methods as add User (addition of new user), Update user (which include the updation of contact details), delete User(removal of user name from the list).

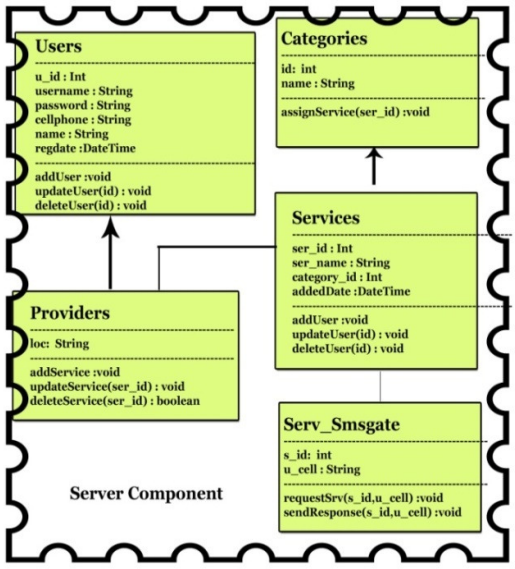

Fig. 2. Use Case Diagram of Proximity App.

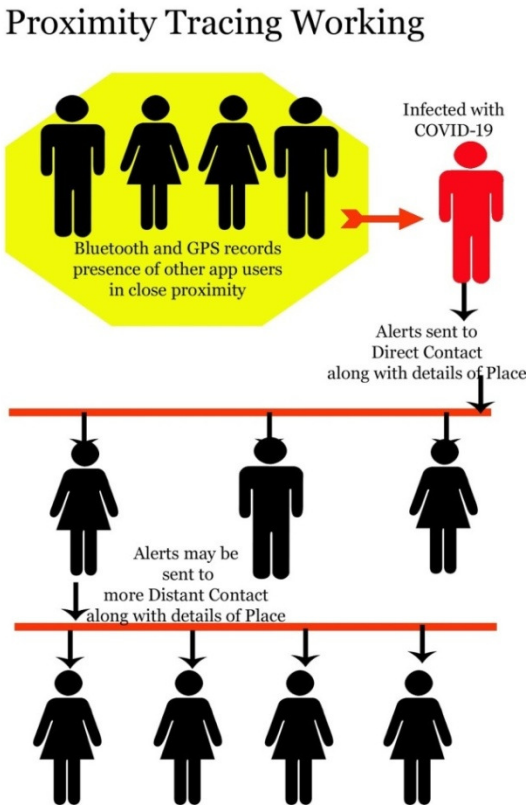

Fig. 3. Working of Proximity Tracing.

Second block consists of the Providers which include the provider list and the functions for deletion, update and deletion of service from the provider list.
Services block includes log of the user connected with the other user with the identifier along with the time and location.
The Serv_Smsgate comprises the SMS component sent to the clustered users in case the user is found positive with the COVID 19.
The categories block maintains the list of users and their associated category as infected or non infected.
The proximity tracing app working is illustrated in Fig. 3. The database of all the proximity users is maintained in the database for the maximum duration of 28 days. If the person is found corona positive immediately the list of proximity users is sent to the government and hospitals for remedial measures and also the individual SMS is sent to all the proximity users with the detail of the location date and time where they met the infected patient.

IV. METHODS AND DISCUSSION

When two individuals come close to each other with the help of GPS and Bluetooth, It calculates the distance if it is less than six feet for a considerable amount of time the apps exchange information and store the database in the cloud and is notified of their own infection risk. With the help of Bluetooth, GPS and cloud a cluster of users is maintained wherein it can signify the risk of community spread.

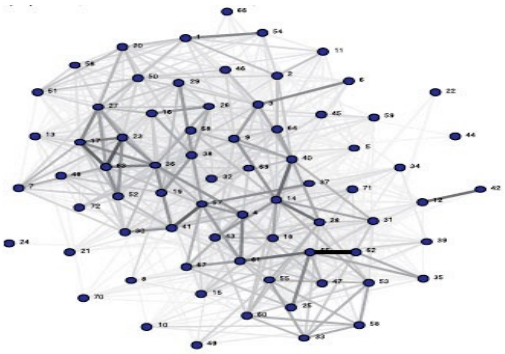

Fig. 4. Cluster Network using Proximity Tracing.

The above figure shows the physical proximity network as we have discussed in the novel app that the app maintains the database of proximity users and maintains a cluster of association like person A meets B and B meets C i.e A may have likelihood of catching infection. So a cluster of proximity networks is maintained which can warn a close knit cluster to avoid community spread.
The researcher collected data 65,536 instances from UCI repository having attributes User ID, UUID, Action and Timestamp and used the k means clustering approach. Following clusters are identified on the basis of varied behavior factors (Bluetooth connectivity, date and time and state of connectivity).
Fig. 5 shows cluster 1, where x axis represents the timestamp and y axis represents a particular location. The lines represent different users at that particular location forming a cluster. When the devices fall within the proximity range, the device details are recorded by every device coming in range for further use related to COVID 19.

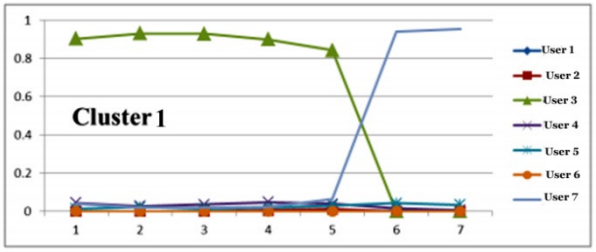

Fig. 5. Cluster based on location.

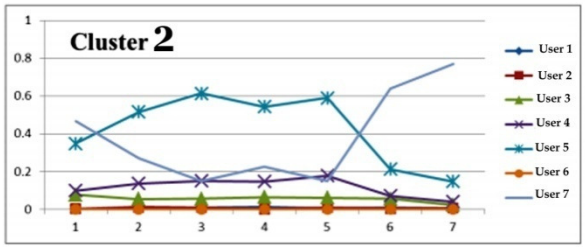

Fig. 6. Information exchange in Cluster using proximity.

As depicted in Fig. 6, Cluster 2, 5 and 7 came in close proximity at location 1. Assuming if User 5 is infected, he had already come in proximity with user 7. User 7 came in proximity User 4 in location 3. At location 4, user 4 came in proximity with User 3, 2 and 1.
Based on these data, it becomes clear that all the people who came in proximity with User 5 directly or indirectly through user 7, all data is recorded and hence are later informed to quarantine themselves as they do came in proximity with COVID 19 infected person.

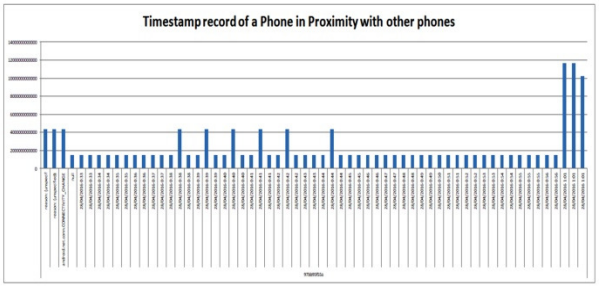

Fig. 7. Devices in proximity history.

As shown in Fig. 7, the graph represents at what day and time and for how long the two devices were in proximity with each other. The details about the device, the current location at which they came into proximity may help to locate the hotspot in a certain area.

V. CONCLUSION

Contact tracing is identifying the infected person and to create a boundary between the infected person to keep him in isolation and to supervise the cluster of people so that it does not spread to other communities of users. COVID 19 is declared pandemic because of its contagious nature but with the technological advancement spatial temporal analysis can be maintained in a timeline. The user identification can be traced with the help of device id. The identification of community spread can be done through smart phones

since the ratio of owning a phone is 1:1. The data mining tools and big data analytics can identify the cluster of locations where the disease is more prevalent and must ensure that every person must install the proposed app. With the advent of IOT these smart phones contain millions of historical and transactional data which can be tracked and analyzed for future prevention of diseases. With the help of real time information the communicable pattern of the disease can be controlled.

V. FUTURE SCOPE

The future scope of this app is when we are moving and interacting with any person and if there is a risk of proximity violation it generates a beep so as to maintain social distancing. When a user is traversing in a rush prone area it must generate a respective alert. App must be installed with inbuilt thermal camera so that a person who is not well or who is prone to infection the mobile may generate an alarm to maintain a safe distance. This app can be extended to wearable technology for children or elderly people who do not own a mobile phone.

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