



Public opinion mining using natural language processing technique for improvisation towards smart city

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Abstract

In this digital world integrating smart city concepts, there is a tremendous scope and need for e-governance applications. Now people analyze the opinion of others before purchasing any product, hotel booking, stepping onto restaurants etc. and the respective user share their experience as a feedback towards the service. But there is no e-governance platform to obtain public opinion grievances towards covid19, government new laws, policies etc. With the growing availability and emergence of opinion rich information's, new opportunities and challenges might arise in developing a technology for mining the huge set of public messages, opinions and alert the respective departments to take necessary actions and also nearby ambulances if its related to covid-19. To overcome this pandemic situation a natural language processing based efficient e-governance platform is demandful to detect the corona positive patients and provide transparency on the covid count and also alert the respective health ministry and nearby ambulance based on the user voice inputs. To convert the public voice messages into text, we used Hidden Markov Models (HMMs). To identify respective government department responsible for the respective user voice input, we perform pre-processing, part of speech, unigram, bigram, trigram analysis and fuzzy logic (machine learning technique). After identifying the responsible department, we perform 2 methods, (1) Automatic alert e-mail and message to the government departmental officials and nearby ambulance or covid camp if the user input is related to covid19. (2) Ticketing system for public and government officials monitoring. For experimental results, we used Java based web and mobile application to execute the proposed methodology. Integration of HMM, Fuzzy logic provides promising results.

Keywords Speech processing · Hidden Markov models · Fuzzy logic · Natural language processing · Covid 19

1 Introduction

Human voice based audio signals can be utilized by the doctors in detecting disease at the early stage and provide diagnosis. In existing systems the audio signals from the public are obtained in person manually by the doctors during the

consultant visits. In this pandemic situation smart device based voice analysis can be used for covid detection using trained dataset model (Pramono et al. 2017). In previous researchers, several research has been performed in detecting illness, parkinson's disease, artery disease, stress using public voice analysis (Erdogdu-Sakar et al. 2017; Benba et al. 2019).

For covid-19 detection patient has to manually go to the testing center which causes spread contamination and it's a major cause for the increasing count. Also covid-19 negative patients has the probability to get positive while visiting testing centers. Thus a novel web and mobile based smart application to detect covid-19 from public audio signals and also identifying public opinions, grievances automatically using text mining techniques has a larger scope towards government implementing new laws, policies etc.

Public opinion mining towards government plans, schemes, maintenance of public properties, day to day problems faced by the public would let the government know how the schemes have reached the public and how does the public react towards

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the government plans and schemes. Opinions play an important role in each human behavioral decision making thinking how other individuals, society react. The significant piece of our data collection procedure is to discover what others think. Step by step instructions to break down and condense the perspectives communicated in such enormous opinionated content is another developing field for research. This new domain is termed as opinion mining. Opinion mining is also defined as sentimental analysis examining people's opinions, people's emotions, people's sentiments, people's reaction, people's grievance towards an individual, organization, government bodies, events, social issues, governmental schemes.

The sentimental analysis/opinion mining now a days plays a vital role in business growth using business analytics in which large amount of text need to be analyzed and mined for improvisation.

The motivation of this proposed work is to create a common platform which can connect and bring both public and government servants closer so that day to day problems faced by the public would be regularly updated to the respective government department during this pandemic situation. In the proposed methodology, the public user voice input messages can be provided using a smart web and mobile application. This voice can be analyzed for detecting covid-19 positive patients in an easy manner and also obtain public day to day opinions, problems, suggestions, grievance etc. and create a public ledger which can list all the public problems and covid-19 suspicious patients in each zones and the necessary actions taken by the government officials providing complete transparency.

The public general opinions are analyzed using natural language processing technique and provide an automatic update to the particular government office's and also a copy of the public opinion would be sent to the respective public as well. It explicitly describes how does the public react towards democratic, participatory and transparency models of the government. Thus usage of natural language processing provides automatic category identification for a respective public opinion and sends an e-mail to the respective government department, So that day to day problems faced by the public would be updated to the government department and makes the decision making easier.

As residents of India, we need to deal with our government schemes, law and polices in our everyday lives. But citizens of India doesn't have time nor a platform to convey their opinions towards the governmental policies, schemes and law. Thus speaking about smart city public opinion mining is an important factor to be considered for improvisation. People expect rapid administration, appropriate treatment, flexible and feasible platform to collect their opinions, addressing their grievances in a short period of time. However the interaction won't be wonderful always as this e-governance based grievance handling platform deals with different class of individual's as the effect of government tasks and arrangements are

unique. As people started thinking of their rights and privileges, the government need to be transparent with the people in its dealings, responsible for its exercises and quicker in its reactions (E-Governance Project Life Cycle 2012; Gupta and Lehal 2009). The rise of Information and Communications Technology (ICT) provided quicker, productive capacity, recovery, data processing and exchange of information's between users, groups, organizations and governments (Gupta and Lehal 2009; Padmapriya 2013). Thus opinion mining with natural language processing integrating data mining and machine learning techniques help in building a bridge to address the gap between the government departments and public. Also public voice based audio signals can be used to detect coughs and other problems faced by the citizens of India. World bank states, "E-Government focus on the utilization by government organizations on information technology (for example, Wide Area Networks, the Internet, and mobile applications)" that can change relations of citizens, organizations, associations with government. As per the World Bank "E-Government alludes to the utilization by government organizations of data advancements, (for example, Wide Area Networks, the Internet, and versatile processing) that can change relations with natives, organizations, and different arms of government. These advances can serve a wide range of advantages: easy covid-19 positive patient detection, early detection and diagnosis to the patients, stop the covid spread by early detection and quarantining the suspicious patients, better governmental schemes, plans, policies to the taxpayer driven organizations, public, improved communication with business and industry, people strengthening through access to data, or effective government management.

The subsequent advantages can be less corruption, expanded straight forwardness, more prominent comfort, income development, or potentially cost decreases. Accordingly, the focus here is on utilization of data advancements in improving citizen government associations, cost-cutting and increase of income and clearness and control the corona spread (Liu 2012; Vinodhini and Chandrasekaran 2012).

2 Related works

Shrivastava et al. (2016) covid-19 got its attention among the world after spreading in wuhan and china. Seeing its impact, WHO said that the pandemic as Covid-19. This virus is not kind of normal virus, causes severe damage to human immune and respiratory systems which leads to illness. This covid-19 pandemic has spread among 203 nations causing several lakhs of deaths and finally leading to economic breakdown.

Faurholt-Jepsen et al. (2016) in this researchers proposed a system to obtain human sound from heart, lungs by

stethoscopes using external microphone. The drawback in this system is doctor, clinician's presence is always needed for audio analysis. Later examination may cause the infection severe and lead to increased mortality rate (Banerjee et al. 2019). In this author, obtain the sounds with the usage of phone microphone from the users during sleeping to analyze and predict sleep apnea disease (Pang and Lee 2008). The audio obtained from the phone microphone can be also used for detection of asthma and wheezing. Several organizations such as Israeli based Beyond Verbal and the Mayo Clinic are creating prototypes in detecting diseases associated with the human audio signals using natural language processing and machine learning techniques.

As we evolve in the smart city era, the main objective of smart city implementation is to increase the public quality of life and attract the public towards the smart city, provide healthier, greener environment to each citizens (Harrison et al. 2010). Smart cities utilize the historical operational data and provide improvisation solutions for smooth operations, example: traffic congestion issue, power utilization, safety measures for public, pollution etc. To obtain the smart city objective, the recent automation and technologies like Internet of Things (IoT), Data analytics, natural language processing etc. have to be integrated with the traditional operation systems. Recent articles states by the year 2025 there would be at least 26 smart city existence (Frost and 2020).

Sentimental analysis plays an important role in the smart city revolution, as public opinion towards the government, private sector schemes need to be considered for providing better quality of life. Sentimental analysis is defined as considering public opinion's, emotions, evaluations, attitude and personal priorities/suggestions towards entities like products, schemes, policies, services, individuals, organizations, ministries, issues, topics, news, events etc. (Liu 2012).

Current research states sentimental analysis not only examine text, it examines audio, video, location etc. Thus sentimental analysis is seen as a natural language processing process handling text mining at different levels like document, sentence, phrase level (Kim and Hovy 2004; Agarwal et al. 2009).

Haddi et al. (2013) in India, recent days both the central and state governments spends huge money for advertising their schemes to reach the citizens of India. Thus through this advertisements, the government can convey their objective, benefits of the schemes to the people. This research article focus on public opinion mining technique to identify the best and feasible advertisement mode for the government schemes to reach each and every citizens of the country. They have briefed data mining techniques like association rule mining and correlation rules for analyzing the public opinions.

Marrese-Taylor et al. (2013) and Senthil-Kumar and Malarvizhi (2020) sentimental analysis is a process which analyze and identify the given sentence of an individual is positive or negative or neutral towards an individual, event, organization etc., Sentimental analysis integrating natural language processing is the current research area where many previous researchers have focused on commercial products like e-commerce websites, movie reviews and twitter data analysis. This research paper considered the public opinions towards government schemes and predict whether the scheme would be a success or failure. In this paper, the input is been obtained from my-gov.in website and perform the sentimental analysis technique to state whether the scheme would be success or failure.

Prabhakar et al. (2016) this research article briefs about sentimental analysis technique been applied for e-commerce platforms to understand the user opinion towards the products and services. If the reviews are mined and showed, it would be easy for the other users to see and make a decision easily and quickly. So thus the researchers designed a system which analyses the user reviews and perform sentimental analysis technique on that. Finally result summarization is been performed in a graphical format for easy visualization.

Patil and Lahudkar (2019) opinion mining, sentimental analysis are the current research area which has huge scope. As we see there are many e-commerce websites now a days provide an option for the users to provide their feedback towards the products, services, web platform etc. Thus these comments would be helpful for the other users in decision making and organizations to know the area of improvisation. This paper explains the types of algorithms available for performing sentimental analysis and its scope, challenges.

This research article explains the sentimental analysis on movie online. In this paper, preprocessing of the text is explained very deeply. The method been proposed is Chi squared method to delete irrelevant advantage. In these 2 datasets are been analyzed and efficient accuracy is being obtained in text pre-processing (Patil and Lahudkar 2019).

In this paper, a detailed study of opinion mining for tourism is been proposed. This would be so beneficial for many industries. The proposed system uses to solve problems in lake distract tourism industries (Mahajan et al. 2016).

From the literature survey, we proposed a novel and effective e-governance system during this pandemic situation and after the pandemic situation bridging the gap between the public and governmental sectors. Our smart web and mobile application can collect the public voice input in which the signals are processed for cough detection and the signals are converted to text to check the type of user inputs. If the user voice input is related to personal opinions and suggestions for the government, our system process the input for natural language processing. The outcome alerts the respective government officials and get listed to the public ledger by

creating a ticket id. Thus the government is been updated with the citizen opinion towards the government issues and actions will make them to perform necessary actions to increase the quality of human life.

3 Proposed architecture

Figure 1.

4 Proposed methodology

Stoppage of covid-19 spread, detection of covid-19 at early stage and diagnose, public opinions/grievance handling are very essential in maintaining ecofriendly environment. It is very important now a days because as there are no common web and mobile platforms to obtain public voice input to detect covid-19 and public opinion analysis towards government schemes, policies and problems faced by the common public.

In existing system, detecting covid patients is difficult. Hence simplified and effective solution to detect corona is

needed and an efficient e-governance platform is needed during and after this pandemic for increasing quality of human life's. In the proposed method, we have designed a smart web and mobile application which can accept user voice input and detect covid-19 and public opinion, suggestions and grievances towards the governing party.

Our proposed methodology can be separated into two phases. From the public voice input covid-19 detection is performed using signal processing technique and public opinion detection towards specific government ministry, individuals, law, policies, news etc. using natural language processing.

4.1 Covid-19 detection

Our smart application collects the public voice input and performs signal processing technique. In this technique the feature values are extracted and compared with a classifier to predict cough, sleep apnea and stress. If the respective citizen is found positive, automatically alert message, e-mail would be sent to the health ministry with the user profile and also nearby ambulance would be alerted by a text message. In this covid-19 positive patients pathological coughs feature values are been extracted and trained. The public voice input signals are matched to detect covid-19. Further the public voice input is pushed for natural language processing for better e-governance and identifying the improvisation area.

The second phase of our proposed system propose a smart web and mobile application through which the public can provide their opinions, grievance, comments etc. in their local language. The smart devices are kept in all public access areas for obtaining the public opinions. In this proposed work, we consider four categories for experimental results namely health ministry, corporation, police and highway departments. The NLP and opinion mining techniques automatically categorize the respective department for which each public opinion corresponds, using web services an automatic e-mail and message alert would be send to the respective email address and primary contact of the departments. The e-mail, message would consists of the public opinion along with essential details like location, street etc. Thus the government departments would be updated with public day to day problems, issues, good opinions by the public, so that it's easy for the government officials to take necessary actions. To make the necessary remedies to be done, we also propose an public ledger based automatic ticketing system in which the public opinions i.e. text is submitted in the exact corresponding departmental web page and an new ticket ID is been generated for it. Using this system, the public, higher governmental officials, ministers, governing bodies can track the steps taken by the respective government individuals. Once the necessary remedies are been taken, the governmental

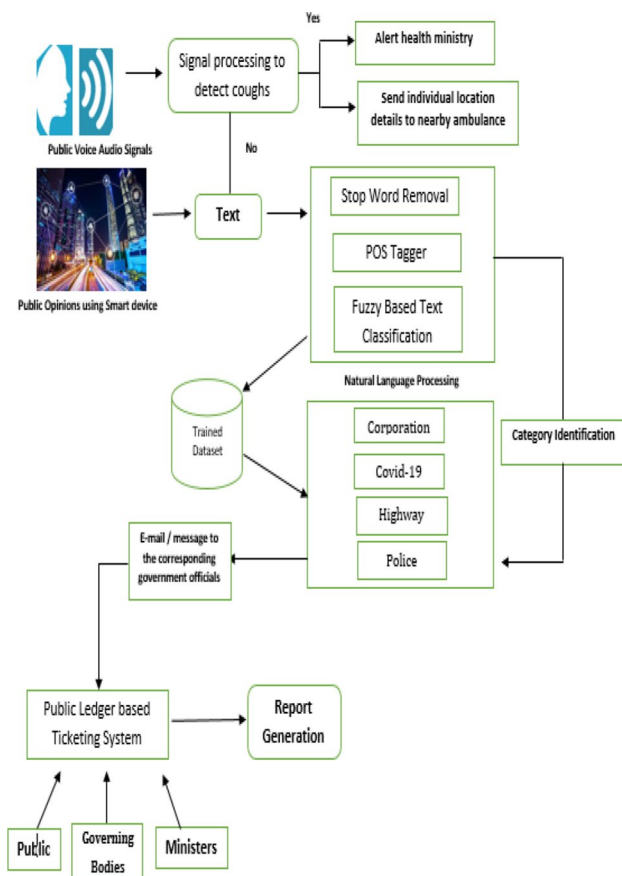


Fig. 1 Proposed architecture

individuals can reply to the corresponding ticket ID and close the ticket. Finally report is been generated on a monthly basis invoking total issues been raised, number of issues been closed, number of issues been kept opened etc., So that overall government respective departmental performance can be evaluated. Also this would state the frequent issue faced by the public on day to day basis. Thus we are trying to add some features to face their problems easily to the public via region or area wise. These data also intimate which respective areas or regions or streets need more attention thus conserving government resources and also provide a close connection with easy communication for the public with the government officials, who are been elected. The methodologies involved in public opinion mining are briefed below.

4.2 Speech to text conversion

Once the public leave their voice opinion in the smart application, using Hidden Markov models (HMMs) the speech would be converted into text (Mahajan et al. 2016). In our proposed methodology, we used java based speech identification module, in which we used small vocabulary, word identification and corresponding digit identification processes. As the user opinion is a random process, the objective of HMMs is to identify the parameters of stochastic process. HMMs process speech patterns with promising accuracy. HMMs follows both forward and backward procedure for processing the words (Bhatt et al. 2015; Vijayakumar and Arun 2017).

Forward procedure:

Initialization

$$\alpha_1(i) = \pi_i b_i(o_1), \quad 1 \leq i \leq N$$

Induction

$$\alpha_{t+1}(j) = \left[\sum_{i=1}^N \alpha_t(i) a_{ij} \right] b_j(o_{t+1}), \quad 1 \leq t \leq T-1, 1 \leq j \leq N$$

Termination

$$P(O|\lambda) = \sum_{i=1}^N \alpha_T(i)$$

Backward procedure:

Initialization

$$\beta_T(i) = 1 \quad 1 \leq i \leq N$$

Induction

$$\beta_t(i) = \sum_{j=1}^N a_{ij} b_j(o_{t+1}) \beta_{t+1}(j), \quad T-1 \leq t \leq 1, 1 \leq i \leq N$$

The converted text is processed by implementing natural language processing along with opinion mining techniques.

4.3 Natural language processing and opinion mining

In NLP (Pradhan et al. 2016), first process would be stop word removal, in which dictionary based process is used to eliminate the stop words from the converted text of public opinions. A defined stop word removal list might contain 75 stop words which would be eliminated from the obtained input text for further processing.

The second process would be POS tagging for each words to identify the corresponding government department for which the respective public opinion is corresponding. Once the parts of speech tagging is been done, we also analyze unigram, bigram and trigram analysis (Benba et al. 2019).

Example: This road is not so good for driving.

Unigram: This, road, is, not, so, good, for, driving.

Bigram: This road, road is, is not, not so, so good, good for, for driving.

Trigram: This road is, road is not, is not good, not good for, good for driving.

The third process is using fuzzy logic based text classification, in which the extracted text data are matched with the trained models to identify the corresponding governmental department for each public opinions. The trained model can be trained on case to case basis if the system identifies new words, new departments. On identification of the department, an email alert containing the public opinion i.e. text would be sent to the respective departmental email address.

4.4 E-mail, message alert to the government departments

Our smart application authorize to send the public opinions to the respective government sector through e-mail, message. The e-mail, message would consist of the public opinion i.e. text, region. Thus by generating e-mail based system, the public opinions can be viewed on day to day basis regularly. Also it's easy for the government sector to provide multiple authorized access and recover the old opinions as well.

4.4.1 Public ledger based ticketing system

In our system, automatic ticketing system is been integrated for transparency and anyone can able to view the remedies been addressed. Our system automatically submits the public opinion i.e. text to the exact department webpage by raising a new ticket ID along with the date and timestamp. Thus this webpages can be accessed by public, higher governmental officials, ministers, governing bodies providing complete transparency in the responsibility. Once a respective ticket

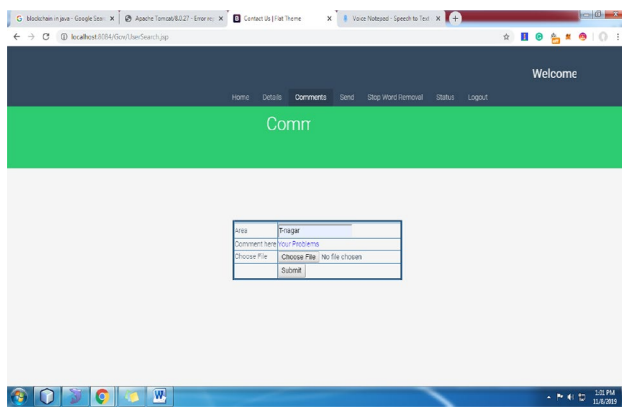


Fig. 2 Citizen Grievance input page

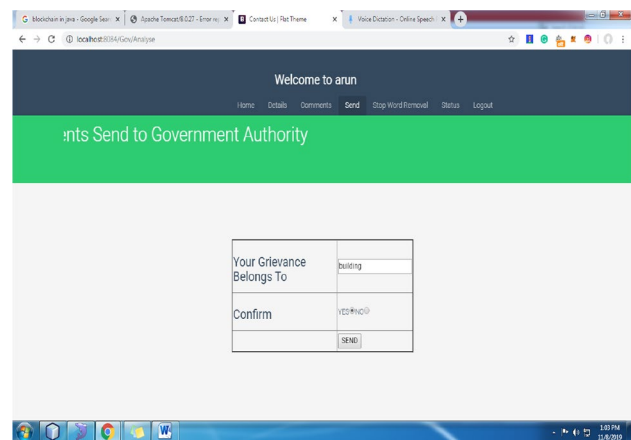


Fig. 4 Automatic category identification using NLP

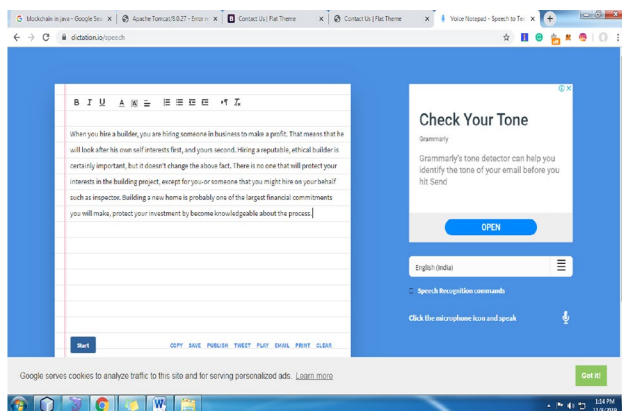


Fig. 3 User speech to text conversion using HMM



Fig. 5 Ticketing system

ID is been addressed, the government individual can reply to the opinion and close the ticket at their end. Thus providing complete transparency gaining public confidentiality and trust.

4.5 Report generation

Finally report is been generated on a monthly basis invoking total issues been raised, number of issues been closed, number of issues been kept opened etc., So that overall government respective departmental performance can be evaluated. This would provide the frequent issue faced by the public in each regions and also departmental individual performance can be evaluated.

5 Experimental analysis

Figures 2, 3, 4, 5, 6 and 7.

Word Frequencies for government departments:



Fig. 6 Respective government official's response

Fig. 7 Report generation

Word frequency analysis from sample data collection

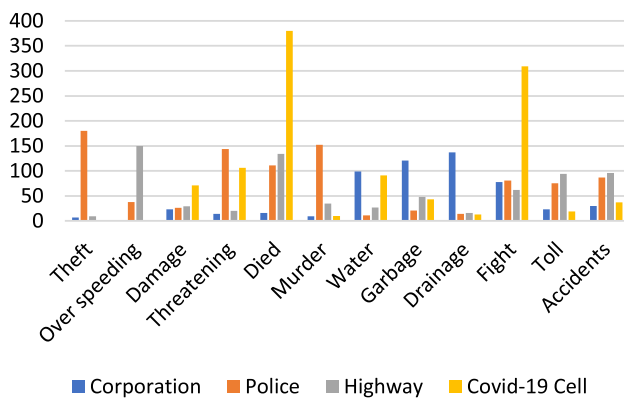


Fig. 8 Graphical representation of word frequency from user sample

For experimental results, we have got 550 sample voice inputs from my academic institution staffs and students with respective of police, highway, covid-19 and corporation through our web and mobile application (Fig. 8).

By looking at Table 1, it was apparent that Words like “damage” “fight” “threatening” and “died” are belonging to all four groups, words like “accidents” “toll” are belonging to three major groups. However words like “Theft” (180 vs 9 vs 7 vs 0), “murder” (152 vs 35 vs 10 vs 9), “water” (99 vs 91 vs 27 vs 11), “garbage” (121 vs 21 vs 48 vs 43), “drainage” (137 vs 14 vs 16 vs 13) can be used for differentiating the user comments to covid-19, corporation, police and highway departments. Based on these set of word frequencies we cluster the given user comments and keep training the new word frequencies on case to case basis (Tables 2, 3, 4; Figs. 9, 10).

Table 1 Word frequency analysis from sample data collection

Word	Corporation	Police	Highway	Covid-19 cell
Theft	7	180	9	0
Over speeding	1	38	150	0
Damage	23	26	29	71
Threatening	14	144	20	106
Died	16	111	134	380
Murder	9	152	35	10
Water	99	11	27	91
Garbage	121	21	48	43
Drainage	137	14	16	13
Fight	78	81	62	309
Toll	23	75	94	19
Accidents	30	87	96	37

Table 2 Sample opinions for improvisation towards government departments

No. of tickets raised/month	Corporation	Police	Highway	Covid-19
1/11/2019	6	2	1	0
15/11/2019	8	3	1	0
30/11/2019	14	5	3	0
10/12/2019	21	9	4	0

Table 3 Issues been addressed in public ledger

No. of tickets closed	Corporation	Police	Highway	Covid-19
15/11/2019	2	0	0	0
30/11/2019	3	1	0	0
10/12/2019	5	2	1	0
20/12/2019	5	1	0	0

Table 4 Comparison of training models for identifying the issue categorization

Evaluation	Classifier	Accuracy
Training	Fuzzy logic	0.929
Training	Naïve Bayes	0.920
Training	Random forest	0.908

6 Conclusion

This proposed project is concentrated on analyzing public voice input analysis to detect covid-19 and public opinions. Our proposed system detects covid-19 in an easy and secure manner from public voice input using signal processing

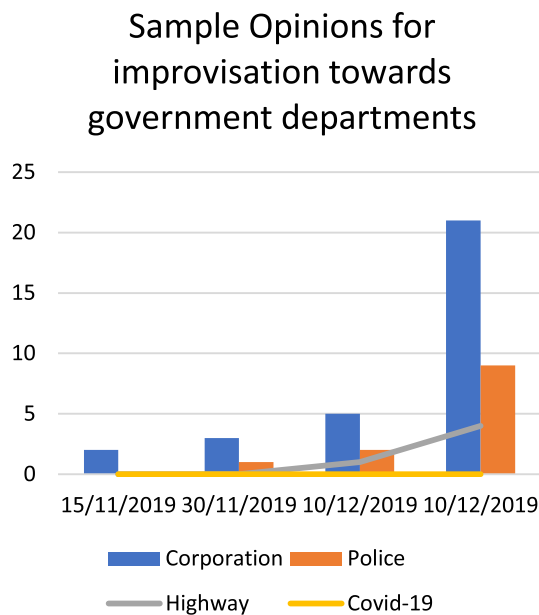


Fig. 9 Sample opinions based tickets raised in public ledger

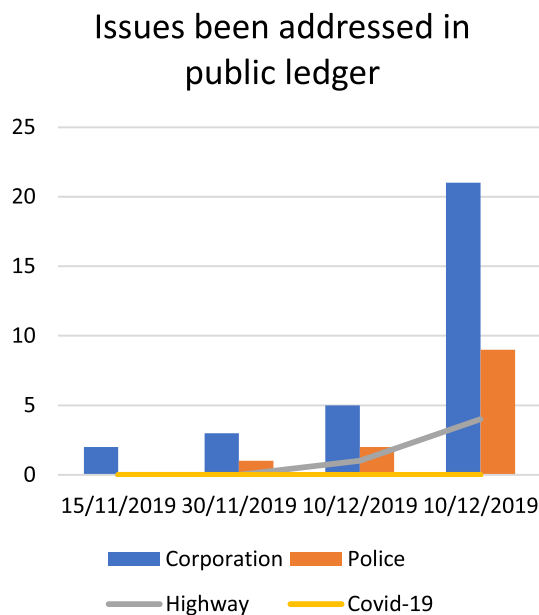


Fig. 10 Issues been addressed

technique and if required alert the health ministry and nearby ambulance. Further the user voice input is analyzed for opinion for the government officials regarding the issues faced by the public every day. Through this web and mobile platforms, the public can convey their issues directly to the respective government officials and track the remedy status. Thus integrating speech to text, NLP, opinion mining, ticketing system processes provides a good picture for the

government officials that which respective areas or regions or streets need more attention thus conserving government resources. Thus proposed system, act as an efficient e-governance platform in early detection of covid during this pandemic and opinion mining to showcase the improvisational areas in the governmental sectors after this pandemic. As a future scope, the proposed system can be enhanced to detect many disease from user voice input signals and launch this e-governance application integrating all the governmental sectors benefiting quality of human life and connect the government individuals closely with the public.

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