An Expert System to Reduce Emergency Response Time Using a Machine Learning Technique

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***Abstract*—In any unusual circumstance occurred an individual would look for a quick and accurate response with a minimum response time because the most important thing which is at risk is life in any emergency situation. For the past couple of years many life's have been gone due to less effective emergency response time. So the main purpose of the study would be the development of a mechanically learned data driven emergency response expert system which would be human resource independent and would be dispatching required emergency response within the shortest time. The system itself will mine the required information from the textual format of what the caller will say and then systematically generate the case, case nature and then depending upon the case nature it will inform the concerned department which will putt down the response time, as if computer works much faster and more efficiently than human beings. Results declared have shown a minimized emergency response time graph with an accuracy of 91.17% depicting the effective of algorithm.**

***Keywords*—Expert System, Ret Response Time, Data Driven Mechanism and Emergency**

I. INTRODUCTION

According to WHO research it is shown that whenever an emergency situation occurs the individual relies on a proper, systematic, fast and immediate emergency response. All over the universe emergency response systems are functioning mostly in the domains of FIRE brigade and rescue 1122 emergency situations. Some emergency response systems are also developed in the domains of natural disasters and chemical related organizations.

In the domain police response situations very limited and less work has been scene, emergency situations with respect to police related matters are of a great concerns in today's era. Un ethical and criminal activities are being done 24/7 in every corner of the world. Obviously in such situation an invidual will surely depend upon the

Since Response Time (ReT) is the main concern in the emergency call centers of any department at national or international level. Efficiency directly depends upon the response time and care/protection must be provided at time in which it is supposed to be effective [1]. According to the survey many developed courtiers decrease their ReT by 8.7% over the past year. In a typical Emergency Call Centre (ECC) call handlers take essential fine points about the circumstances and pass it to dispatching division contact response unit [2]. This long-established technique takes time from call taking to dispatching as call takers gathers all information and place it in software and pass it automatically after filling information to the relevant unit. In our execution we are going to make a scenario where extra time is eliminated by removing the manual dispatching system [3].

We are designing a complete expert system where calls will be handled automatically and process accordingly to dispatch the correct resource. So, our purpose is to reduce the response time by automating the systems using machine learning techniques. The system itself will mine the required information from the textual format of what the caller will say and then systematically generate the case, case nature and then depending upon the case nature it will inform the concerned department which will putt down the response time, as if computer works much faster and more efficiently than human beings. Another important feature of the system is, it will learn every input statement of the caller so that if the same kind of input comes next time, then the system does not have to work the way it worked for the first time. It will also drag down the costs since common systems could be used by multiple departments to entertain the multiple types of queries.

The techniques, which are commonly used, are:

- Data mining-voice to text conversion
- Data parsing-information retrieval
- Data segmentation-pattern matching
- Deep learning-data driven.

When the voice will be received by the system it will be firstly converted to text by using some efficient algorithms. After this data would be divided into multiple segments. After this segmentation process the segments would be parsed in the system and their patterns would be made. In the next step these patterns would be matched to define the nature of the case, already stored in the system and once the statements have been recognized then a case would be generated against the patterns and then the case would be forwarded to the concerned department for efficient and timely response.

In our exertion we are going to make a scenario where extra time is eliminated by removing the manual dispatching system. We are having a system where emergency calls are being received and then automatically dispatch to the response unit by investigating the call and extracting useful information like location case nature and person or caller's

contact number [4]. We can make hoax calls, test calls, and consult calls in addition to emergency calls. The information about these calls is not passed to dispatching unit [5]. First, all the calls will be filtered from Hoax or valid calls then using a dedicated algorithm keyword will be extracted from an audio call whose data is converted into text format then according to system's data base call will be dispatched to response unit [6]. By using the system, we can reduce the response time and increases the efficiency of the whole process and through all this process, we can reduce public risk and relation between public and field forces can be more trustworthy [7].

In addition, our paper would be divided into the following sections, the first section would be elaborating the introductory, background, motivation and objectives of this particular study than in the second section we would be elaborating the literature review, research gap and our present result-oriented methodology. In the third and last section of our paper there would be results and discussions, followed by future work and acknowledgment factors. We would be concentrating to develop an emergency response system particularly in police emergency situations and extensively in rescue, traffic and fire emergency situations.

II. LITERATURE REVIEW

Days, hours, minutes and seconds which a field force consume to detect the crime, dispatch the respective force needed, makes a difference in the emergency response time. The number of chances that a crime is detected, and its criminal is charged is the main component of examining whether police numbers, police composition or high visibility patrolling are associated with lower crime to minimizing response times. Stronger affects for thefts are found more than violent offenses or any other type of crime. Suspect, witness or victim is important aspects through which response time makes a difference. In many scenarios response time is directly proportional to time dispatched field forces [8].

Fire is caused by human due to decrease in public awareness. Fire stations are located at different places and in case of fire, dispatch time cause loss of lives and damage to properties. Therefore, more fire stations should be built to over fire. We can also use fire alarming system. This system enables to reduce fire and risk to human life [9].

A lot of tragedies and sudden accidents especially fire explosion become evident due to rapidly increasing development of industries in our country. Fighting with harmful chemicals and products require higher training team and skills. How to handle unexpected situation and harmful chemicals become an important issue in unexpected situation. Effective actions have not been taken to control fire and rescue training methodology. Fire and rescue teams are not able to be control emergency because they lack knowledge about harmful chemicals and crash course. Build successful defense of harmful products unexpected accident team fire-fighting and rescue expertise centers. Build a lot of emergency rescue training base with all facilities and skills [10]. It is all about the service of the national ambulance. Around the globe every passing year the count of casualty is 1.2 million that die through road traffic accidents, to reduce this thing improve the service of ambulance. Reduced Response time and level of awareness were needed for the survival techniques and prehospital emergency response. People must be educated how to deal with emergency situations; efforts for a smart emergency response system are formulated and implemented successfully. Prehospital emergency response system will help to secure the life of injured [11].

The Efficiency of clinical dichotomous is 8 minutes. The Response of ALS depends upon the adult patients. However, the study shows that EMS response is not considered or having any kind of importance. The analysis shows that the clinical limitation is considered by its time of response. Challenges used MPDS system to verify who get the rapid response of EMS and who get the benefit of the EMS. All of these activities done by its call time [12].

Firefighting combat trainings are directly linked with minimum response time. Its combat is against the fire and different chemicals that produce rapid fire, lack of trainings are seen which causes the fire to ignite more and cause the risk to human life , efforts are done to create an emergency fire control mechanism or system which the fire fighters can use in there combats with hazardous fires and chemicals it is necessary for a fighter to understand the fire range , density and chemical that has caused the fire timely to reduce response time and effective rescue appliances [13].

This paper describes the smart reply system to assist the driver in replying to the messages of riders. This app uses smart reply system. It uses the machine learning algorithms to retrieve the replies from previous data. It achieved the accuracy of 76% for intent detection. It is helping the driver to reduce the response time with respect to users on whom the response is to be made [14].

Study describes the phenomenal art of reducing and minimizing the emergency response time with the statistical emergency situation analysis around the globe, the study prefers and elaborates the algorithms that can be integrated with the previous acquired data and timely response generated to save the human life and risk of death [15].

III. MANUAL SYSTEM

In Fig. 1, we can clearly see the working of a traditional emergency system in which a call is landed, listened by any individual officer then a case is made which is delivered to a respective dispatching unit, the individual in the dispatching unit passes the case to the respective field force, field force then does the coordination with the caller and then move to the respective location for the required emergency response. This definitely produces a huge delay in the emergency response time. According to different studies it has been shown that average response time is varying in many situations. Previously used mechanisms were Human resource dependent, Slow in response, less accurate, partially automated, Numerous developed systems were Medical emergency situations, Fire and traffic emergency situations, chemicals and power emergency situations Natural disasters emergency situations. Specifically for police related emergency situations very less or few systems are developed so our main purpose is to develop an automated emergency

response system with minimum emergency response time for police related emergency situations.

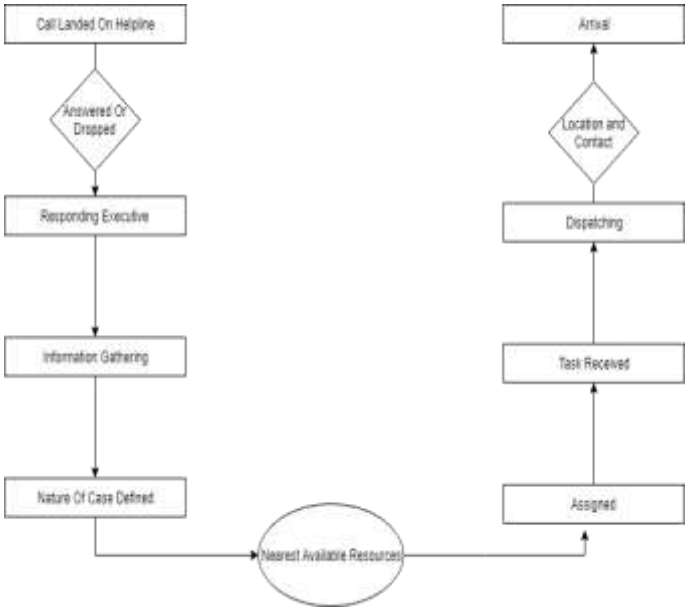


Fig. 1: Traditional Emergency System

IV. METHODOLY EMERGENCY RESPONSE SYSTEM BASED ON DATA DRIVEN LEARNED PATTERNS

Many steps in this manual system are useless and just consumption of time which causes losses in emergency situations. Defining the nature of current case manually and Searching for nearest available resources in critical situation may also cause delay in responding to it. Assigning tasks manually and providing information of caller and location manually are also challenges and time taking process in emergency situations.

Calls will be answered automatically and so no more queues will be in the emergency helplines that assure the instant contact to responding centers. Furthermore, all the information will be figured out on knowledge base systems and no more human misunderstanding or low response which used to be if there is a trainee in the helpline responding the caller. All the nearby resources will be looked automatically, and relevant task will be assigned to concern department with a chunk of some basic information regarding to time, location and contact details, the process may be of less than a minute.

- A data driven mechanically learned system is developed to generate automatic responses to emergency situations with the accurate dispatching of field force.
- Emergency call will be received, it will be converted into text and then the learned patterns from algorithm will extract the keywords on which the decision will be made automatically by the system and a message will be passed to the respective responding field force.
- This will reduce the emergency response time to its minimum limits with the effecting factor of human resources.

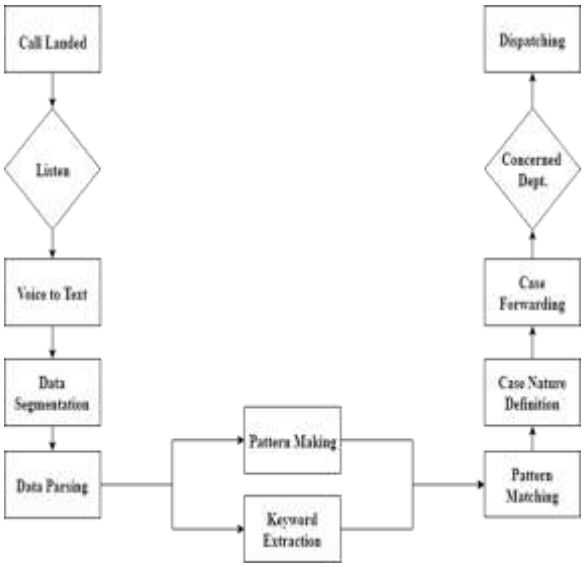


Fig. 2: System Architecture

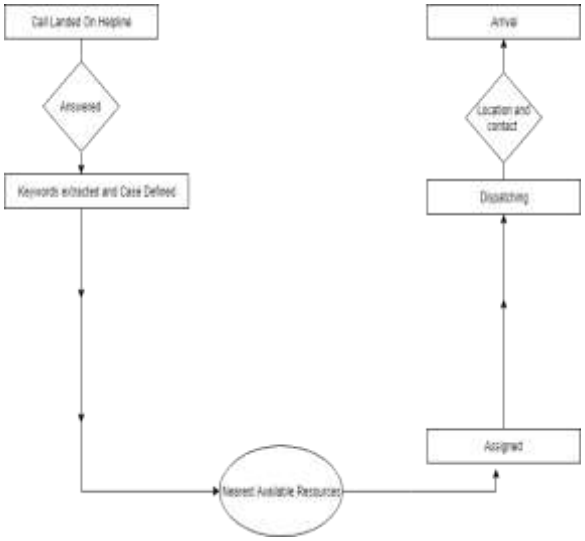


Fig. 3: Fully Automated System

The modern era is mostly dependent on technology work and its usage in our daily life is very vast. We can use technology for different purposes, and we are also achieving its usage goal in our daily life from the start of technology time. The main thing that counts here is decision making that the call receiver listens or reads through some text or any other media giving information that what is actual driven from the scattered data and which thing is valid & informative according to the situation. So that public can rely on the communication centers and forces responding to their problems safely. It is also good for the purpose of building good relation between police forces and public f particular city.

There are different ways to design such sort of platform where we can deploy all the emergency response system using different data driven techniques and by keeping all those in view we explored the main problem that is response time,

public risk, Valid data/information and redirecting workers or call receivers attention to the caller all the time. We can use different strategies for this purpose and can acquire valid and accurate information within some defined time so all the other persons in problem and asking for emergency response can also be entertained timely.

In implementation, system will be developed .NET framework, using Python language, Machine learning techniques, Server-side scripting, Data pattern matching algorithms, data mining algorithms. Technology era making it more flexible to improve the ways to reduce the delay in response time in critical situations.

The system is being proposed for the automatic response. So, that's why the main feature is efficient time management. Because in any situation time is the main thing because every person looking for any kind of remote help will be anyways eager for immediate help. The second feature of the proposed work is the understanding the situation of the seeker because understanding is only possible if there are some prior knowledge existing. Since computers do not have any prior knowledge or experience so the need some test data and a testing model to get predictive information.

It is possible only after a defined process implementation. Some sub features of the second feature are also there like data segmentation in this sub feature the data is divided into some segments.

The second sub feature is data parsing, in this step data is parsed in the system or model where the patterns are matched with the already stored keywords and then the main context is understood and nature of the case is generated.

Further, it is forwarded to the concerned system for more processes. The third main feature of the project is location detection location of the caller will also be detected and also the location where the service is required. The nearest response force center would be notified for help and the location will also be parsed to them. Selection of suitable and precise algorithms is also one of the main features since system itself would decide that which algorithm is to use.

- Efficient time management
- Data segmentation
- Data parsing
- Location detection using keyword
- Record of all data
- Sensors
- Text- to- speech
- System automatically forward the call
- Understanding the situation of seeker

This data flow diagram is showing the working of our algorithm that how it is working and making respective handshakes in order to achieve the required extractions of the commands. Our system is making its own decisions using the algorithm of decision tree and extracting the best answer among the answers using apriori algorithm basically our algorithm is combination of different libraries which are working simultaneously to achieve the respective task and results.

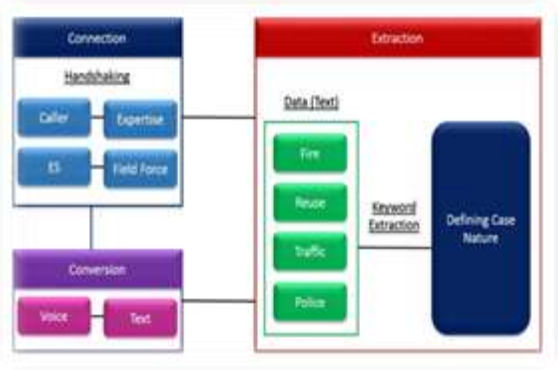


Fig. 4: Data Flow Diagram

Med_ds = ["ambulance", "ambulances", "accident", "murder", "doctor", "patient", "serious", "ill", "sick", "heart", "food poisoning", "food poison", "poison", "firearm injury", "injured", "hurt", "injury", "rescue"]
Med_ds_1 = ["fire", "fire brigade", "smoke", "burning", "burns", "burn"]

Pol_ds = ["robbery", "attack", "murder", "police", "terror", "terrorist", "terrorists", "domestic violence", "dead body","firring", "kidnapped", "kidnapping", "harassment", "suicide" ,"firework", "robbed", "robber", "robbers", "rape", "rapped", "sexual assault", "illegal", "killing", "kill", "killed"]
Pol_ds_1 = ["thief", "theft", "street fight", "street fighting", "snatch", "snatched", "snatching"]
War_ds = ["jam", "jammed", "traffic jam", "traffic jammed", "road fighting"]
War_ds_1 = ["parking", "wrong parking"]

The working of algorithm can be seen from the above-mentioned algorithm commands, similarly, to validate our research we have also developed a real time which is showing accurate results as it has been trained. The developed system is developed in python and d-jango frameworks for a better result orientation.

The data set upon which the training of the algorithm was done has been taken from a very sensitive area and restricted area of Pakistan emergency services. But training upon which our system has produced maximum accurate results is achieved from respective datasets given to the algorithm.

V. RESULTS AND DISCUSSIONS

- Trained model on CUSTOMIZED ALGORITHM.
- Trained model has generated results as per state of art methods in emergency response system reduced emergency response time by 50% by dispatching the case in 60 secs to the nearest field force.

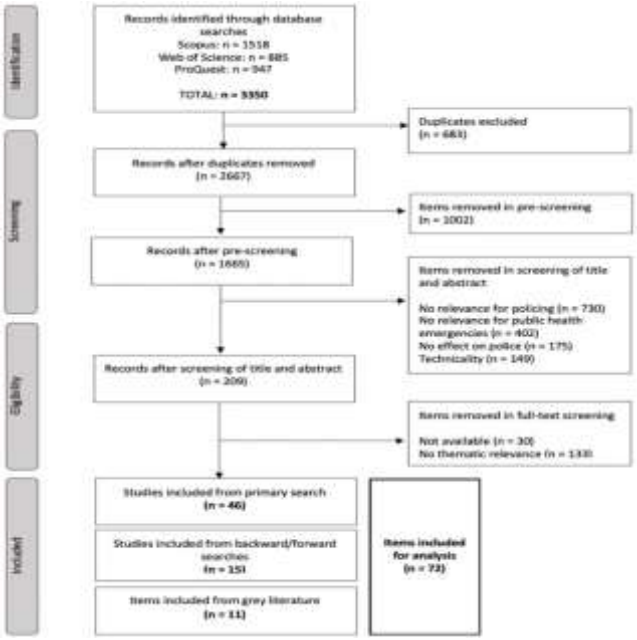
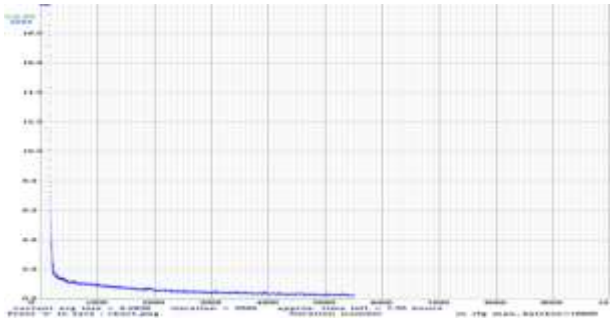
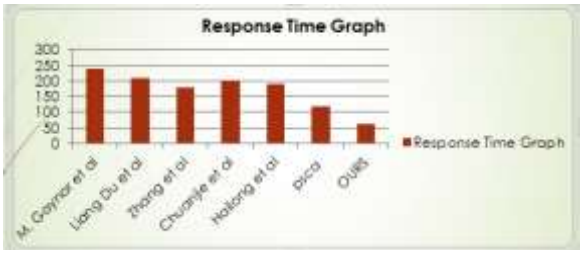


Fig. 5: System Diagram



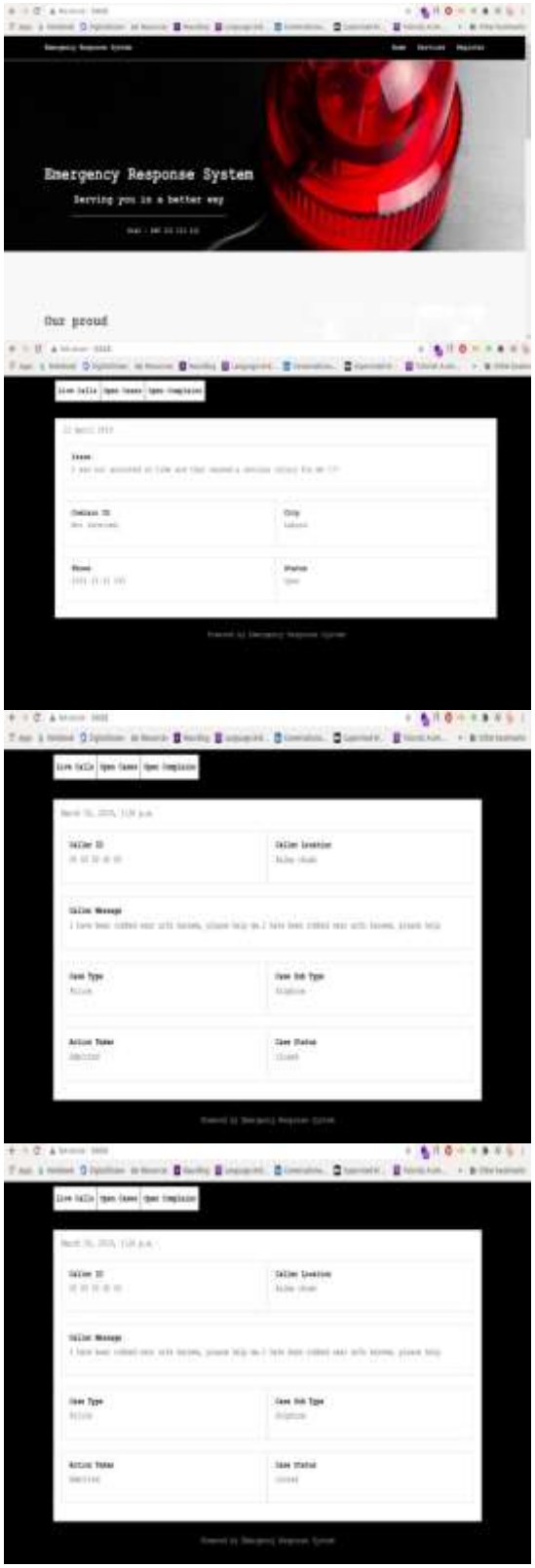
Graph No 1: Iterations and Loss

When the training of the algorithm was done as u can see from the graph when the numbers of repetitions were increased, and the size of data set was increased the loss ratio is decreased clearly shown in the graph. This is showing the accuracy of our algorithm. Mostly the systems which were developed were real time and had no accuracy measuring factors.



Graph No 2: Response Time

The graph is clearly showing a human decrease in the response as compared to previously implemented systems. the response time graph has shown a decrease of 50% in numbers. Our systems main idea was to decrease the emergency response, as per shown implemented algorithm the system has produce best and accurate results as per state of the technological invention.



These figures are basically elaborating our work with a real time system implementation. The results have clearly shown that when a call arrives it is automatically converted into a

text format. The reason to convert it into text is basically a check to separate fake and bogus calls from the real calls. The data set upon which the system is trained is having 405112 calls descriptions. We have trained our system particularly for police related emergency situations in which life seems to be at great risk.

Extensively our system is also trained to sort out calls and dispatch immediate response in the scenarios where there is traffic related help is required. Our system is also trained to manipulate and dispatch positively the cases where there is rescue required.

Our system is simple and less human resource dependent as right after it is getting the description of the case the system is trained on an algorithm which making decisions on its own learned patterns, which are defining the case nature upon which the respective response is dependent and without passing the case to any dispatching unit the case is directly sent to the respective field force. This methodology was a new methodology implemented here in this field of study.

VI. CONFUSION MATRIX

A confusion matrix is designed from the four conclusions formed as a result of binary classification.

➨ *Four Outcomes of Classification*

A binary classifier forecasts all data occurrences of an assessment dataset as either negative or positive. This organization (or prediction) products four results – true positive, true negative, false positive and false negative

1. Correct positive prediction: True positive (TP)
2. Incorrect positive prediction: False positive (FP)
3. Correct negative prediction: True negative (TN)
4. Incorrect negative prediction: False negative (FN)

A confusion matrix of binary classification is a two-by-two tables formed by including of the number of the four results of a binary classifier which are usually denoted as TP, FP, TN, and FN instead of "the number of true positives", and so on.

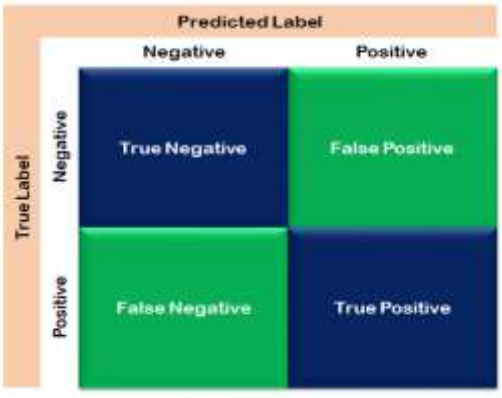


Fig. 6: Confusion Matrix

1. Recall
2. Precision
3. F1-score
4. Accuracy

1. Accuracy

Accuracy = TP + TN / TP + FP + FN + TN

Proposed Model = 582 + 622 / 582 + 11 + 26 + 622 = 1190/ 1352 = 0.9701

2. Recall

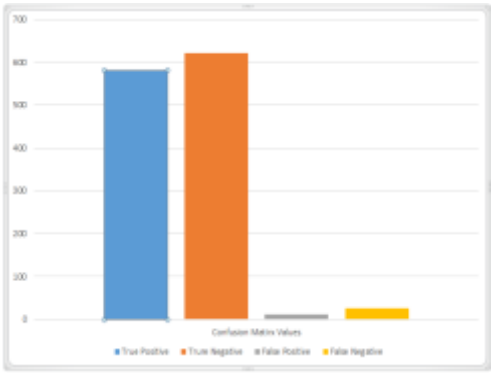
RECALL = TP / TP + FN Proposed Model = 582 / 582 + 26 = 582 / 608 =0.9572

3. Precision

Precision = TP / TP + FP Proposed Model = 582 / 582 + 11 = 582 / 593 =0.9814

➨ *Performance Evaluation Matrices*

In this section, we compare the models in terms of accuracy, precision, F1 measure and recall. Our results are promising because data is gathered by focusing on the challenges faced by the previous models. Such as different case natures definition. We used a dataset that contains 405112 calls descriptions. We have trained model on our dataset to make a neutral comparison as shown in graph below.



Graph No 3 Performance Matrix

4. F1-score

F1-score = 2 ∗ (Recall ∗ Precision) / (Recall + Precision) Proposed Model = 2 ∗(0.9572 ∗ 0.9814) / (0.9572 + 0.9814) = 1.8787 / 1.9386 = 0.9691

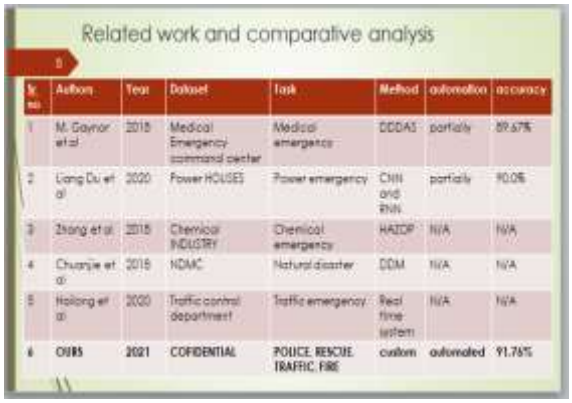
➨ *Results of Proposed Model*

As it is evident from the proposed work, false-positive increased a little bit but overall performance is improved. The generated dataset and trained model are tested on the test dataset. Some outputs are shown in Figures below:

	Positive	Negative
Positive	TP (582)	FN (26)
Negative	FP (11)	TN (622)

VII. CONCLUSIONS AND FUTURE WORK

➨ The study has shown that the automated system has decreased response time by 50% than an ordinary human resource dependent dispatch system.



- With the help of this study in future concerns we can work on the followings

1. Emergency response system directly on voice data.
2. Crime detection and prediction for deployment of specific field forces in the high crime area.

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