A Comparative Analysis of Existing Lie Detection Techniques Over Newly Proposed Approach

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Abstract **Telling lie is very common in our society, especially during interpersonal communication. And people are very curious in finding truth. In the recent years, lie detection is a very interesting and challenging fields for researchers. Although various lie detection techniques are used from years, the main aim of this paper is to compare different existing lie detection techniques and propose a more efficient and reliable method for detection of lie for the sake of the society. The aim of the proposed method is to detect lie by not only in face-to-face interaction but also detecting lie from remote locations. The paper is having various sections which will include description about the domain, literature review, discussion about existing technologies, proposed approach and comparative analysis. This paper also describes, direction about future research work on this topic.**

I. INTRODUCTION

A. Lie Detection

In the recent era of electronic technology, the society faces a challenging task to detect lie. Lie is telling false statement about some facts and provide fake evidence to prove that false statement [1]. Telling lie is very common in our society. This is an open challenge for the researchers to design lie detection technology [2]. Lie detection is very important in various fields like law enforcement, business sector, government agencies etc. [3, 4]. It is a very tough job to identify a liar and truth teller, because a liar has intention to hide the truth and plans everything to hide the fact [5, 6]. So, lie detection is very crucial job for the safety of our society [7].

B. Problems in lie detection

Serious problems are there which may become challenging for lie detection. Some of these are-

- There are various differences in the behavior of the liars. For example, during telling lie, some people speak loudly while some do not, some people laugh loudly while lying, some do not [8, 9]. So it is very hard to distinguish liar because it depends upon the human behavioral pattern.
- There are very small cognitive changes when a person tells lie or truth. That a person has huge control on his/her cognitive emotional changes [10].

- Embedding lies in the truth are very difficult to detect i.e. in this case a suspected person tells lie within some truthful context, which forces lie detector to believe the false statement [10].

C. Objectives of the paper

Due to the above-mentioned difficulties, very few lie detection techniques are available. The proposed approach aims is to give an idea to detect lie using various Artificial Intelligence techniques for the safety of the society. The objectives of the proposed approach is to develop a lie detector with high accuracy, minimum cost, which should be harmless for human body and detect lie not only by face to face interaction but also from remote locations.

D. Literature review

Lie detection is very crucial part in criminal or legal profession. Police officers, judges and lawyers, government agencies faces a problem in determination of the facts. For that some techniques were developed to catch liars [11].

According to Ford (2006), the earliest method to detect lie was used in China in 1000 BC. A suspected person was filled with a handful of dry rice in his/her mouth. When the person spit out, if the rice remains dry, the person considered guilty [11, 12]. It was believed that in fearful and anxiety situation the mouth becomes dry [13].

After several decade in 300-250 BC, Greek physicist and physician Erasistratus, tried to detect lie by measuring

pulse rate which was more scientific than the earlier one [11].

Another method which was very superstitious and harmful for human life, used in the 11ᵗʰ century in various European countries, known as trial by ordeal or the judgment of God [11, 14]. This method was carried out in two ways, hot water test and cold-water test. In hot water test, suspect was instructed to put his/her hand into boiling water for a specific time period and if his/her hand was not burnt or got little blisters then the person was considered as innocent. And in cold water test, the suspected person was put in a bag and thrown in water. If the surface of the water was increased within a short time, the person was declared as liar, because it signifies that water does not accept him/her [15].

In 1870, Franz Joseph Gall gave a new idea of lie detection by recognizing the emotion of a suspected person. The theory was known as Phrenology and Graphology [11]. According to the theory, human emotions and criminal actions was stored in different areas of brain [16]. If the respective portion of the brain got enlarge then that person was considered as suspect or guilty [11].

In 1881, Italian Criminologist, Physician and Anthropologist Ceaser Lombrosso had developed a device to detect lie by measuring the changes in the blood pressure rate [11]. During First World War in 1921, the technology was improved and known as Polygraph and become popular as lie detector [17], which generally measures changes in blood pressure, pulse rate and heart beat rate. After some years, John Larson and Leonard Keele designed a new Polygraph which can measure respiration rate and skin temperature also [18].

In the mid of 1960s, Ekman introduced a new theory, which focuses on face expressions, emotions and gesture [11, 19]. Ekman also developed a device which can identify a liar by using the above mentioned micro expressions theory [11]. After that Patric Kennedy used Artificial Intelligence to detect lie by identifying the small changes in facial expression [20].

In 1980s, some new lie detection techniques were introduced, which uses Electroencephalography (EEG) and Functional Magnetic Resonance Imaging (FMRI) data to extract and analyze the feature of brain [6, 11, 21, 22].

According to Patil, Nayak and Saxena (2013), speech signals are also important for lie detection. During questioning, changes in speech signals are recorded and analyzed to differentiate between truth and lie [23, 24].

Some chemical such as Sodium Pentathol and Scopolamine are injected to the suspected person to extract the truth [25, 26, 27].

II. DISCUSSION OF EXISTING TECHNOLOGIES

The following is the overview of some existing lie detection technologies.

A. Control Questioning Test (CQT) & Guilty Knowledge Test (GKT)

In CQT suspect is asked some questions with some known answers in order to compare the suspect's answers with answers relevant to particular incident [28].

The GKT is a multiple choice format which have one correct answer with additional wrong answers, in order to record the physiological changes when suspect reads the answers [28].

Both techniques are biased against an innocent. There are various techniques to change the result of the test.

B. Polygraph

Most popular technology in the recent day to detect lie is polygraph [2, 7, 22, 26]. It is basically based on the interaction of mind and body [6]. It generally measures physiological changes such as blood pressure, pulse rate, respiration and muscle movement during questioning session [29]. The worst part of this technique is that there are so many innocent people who are getting nervous while interrogation and on the other hand there are some people who are very good in telling lie.

C. Eye tracking

An alternative of polygraph was developed by John Kricher, Doug Hacker, Anne Cook, Dan Waltz and David Raskin, called eye-tracking technology [30]. This method generally tracks pupil movement, response time and reading time. It has lower cost in comparison with a polygraph.

D. Voice stress analysis (VSA)

In this method pitch, frequency and intensity of suspected person are recorded, analyzed and compared with the variations in the voice signals [23, 24, 31]. If a person tells lie, vocal cords produce a distorted sound wave, which is different from the person who is telling the truth.

E. Electroencephalography (EEG)

EEG measures the activity of the brain. The fact is that the brain processes known and unknown information differently [32]. It is much more expensive and requires more time and preparation with respect to a polygraph.

F. Functional Magnetic Resonance Imaging (FMRI)

FMRI is a technique which is used for various purposes in showing the use of oxygen circulation in the brain and identifying the specific portion of the brain which uses

more oxygen, so that it can detect that portion of the brain which uses more oxygen to perform a specific task [6, 21, 33, 34]. So it can be used to map the symmetric procedure of the brain in producing any action or decision at the time of interrogation.

G. Facial Action Coding System (FACS)

Face is the mirror of human nature. 'Facial Action Coding System' (FACS) is the most popular lie detection technology which codes facial movement. It is less expensive than other used lie detection technologies [6, 22, 35].

H. Narco test

Another popular method is narco test. In which some chemicals such as sodium pentothal or scopolamine are injected to suspect's body to extract the truth on the fact when the suspect is in semi-conscious situation [6, 26, 27]. It may be harmful for human body, due to the wrong dose of the chemicals.

III. PROPOSED APPROACH

In the proposed technique, an approach is taken to develop a new lie detector using various Artificial Intelligence techniques, which can detect lie efficiently and accurately, by extracting and analyzing different psychological and physiological changes of human body.

Some analysis will be carried out on the existing technologies in order to find their lack of performance. The various phases which will be followed to complete the proposed approach are explained below.

A. Collection of raw data

In this phase, various psychological changes like eye movement, facial expression etc. and physiological changes such as blood pressure rate, pulse rate, respiration rate etc. and some text-based answer will be the raw inputs for proposed techniques.

B. Selection of Artificial Intelligence techniques

In this phase, one of the Artificial Intelligence model will be designed using some existing Artificial Intelligence techniques such as Rule Based Expert System, Artificial Neural Network (ANN), Fuzzy Inference System etc.

C. Preprocessing of input data

The collected raw input data should be preprocessed in order to get some efficient input data, for example- it may be converted into binary matrices or the collected data may contain some unwanted elements, then such elements should be removed.

D. Feature extraction

In this phase, feature will be extracted out from the inputted data and forwarded to the next phase for classification.

E. Classification

Classification of the input will be done in this phase. Various clusters are generated to find the truth.

F. Output

Finally, the output will be generated.

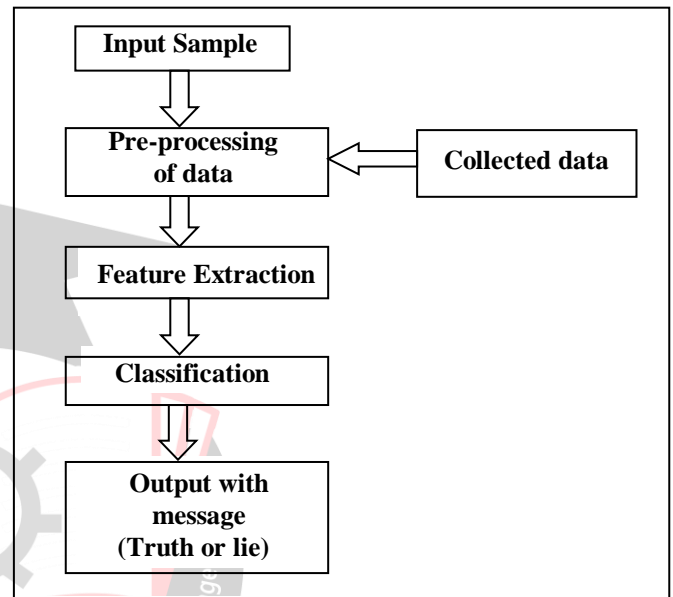The block diagram of the proposed model is depicted below:

Fig 1. Block Diagram of The Proposed Method

IV. COMPARATIVE ANALYSIS

Table1. Comparison of different lie detection techniques with proposed method

Sl no	Existing methods name	Researched gap	How proposed method fulfill the gap
1	CQT and GKT	Suspect may know the answers in advance	Questions will be dynamic
2	Polygraph	Create nervousness and results may be change for some innocent person	No such situation will be occurred
3	Eye tracking	Only track pupil movement	Other parameters are also included
4	VSA	Result may be changed for nervous person	Other parameters are also included
5	EEG & FMRI	Costly	Cost effective
6	FACS	Only changes in facial expression will be recorded	Other parameters are also included
7	Narco test	May be harmful for human body	Harmless for human body

Review analysis of various pre-existing models in comparison with proposed model is done and the comparison is depicted above in Table1.

V. CONCLUSION

There are various shortcomings of the pre-existing techniques like advance knowledge of answers, nervousness, ineffective cost, harmful for human body etc. In this proposed topic, an approach towards the development of an intelligent expert system which plays an important role in lie detection by storing and analyzing different psychological and physiological changes of human body without creating any problem in human body. The input patterns are classified with the help of different Artificial Intelligence techniques. This system would able to accomplish the objectives mentioned above.

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