

A NEURO-FUZZY SYSTEM FOR DECEPTION DETECTION DURING INTERROGATION IN LAW ENFORCEMENT AGENCY

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ABSTRACT: The development of soft-computing approaches in law enforcement agencies has a wide range of application to intelligence analysis in the face of interrogation and evidence gathering during investigation. The capability of these tools to alleviate attempted deception by an informant or suspect is affected by many issues including the type of critical method, the type of hybridization used, and the ability to address issues of source reliability and information credibility. This work at the end will presents a hybrid model using neuro-fuzzy system to aid in the detection of deception during interrogation.

KEYWORDS: Interrogation, Investigation, Deception, Informant, suspect.

1. INTRODUCTION

An aspect of deception (apart from being an intentional act) is that it is defined solely from the perspective of the deceiver and not from the factuality of the statement.

In law enforcement, the detection of deception during interrogation is of utmost importance as it helps in providing proper perspective of the case.

This importance is agreed upon by researchers who have worked on the subject and who realise that deceitful evidence may lead to questioning of the ability of the law enforcement agency. Human ability to detect deception simply by observing the sender's behaviour is far from perfect.

Deception in its entirety includes several types of fabrications or omissions which act as a distortion or omission of the truth [JEC04]. Deception can be defined as the intentional act of communicating a message (known to the sender as false) to a receiver in a believable way. In the act of deception, there is always intent to deceive. The reasons why people, even professional lie catchers, fail to detect lies as highlighted in [Vri08] include: Poor motivation, Difficulties associated with lie detection and Common error made by lie detector.

Another reason known as the ostrich effect [Vri08] is that people attempt not to detect lie because they do not want to learn the truth. Also, people are afraid to detect lies because they would not know what to do if they know the truth.

Evidence can be an object or information used as a proof of guilt or a statement of witnesses to ascertain or establish the truthfulness of a fact while evidence gathering is the collection of these proof or statement of witnesses to resolve the issues surrounding a case. The information needed in an investigation can be obtained from people who have significant knowledge concerning the crime [Nav03]. In such cases, witnesses or victims of such crimes are interviewed, and suspects are interrogated. In some cases, eyewitnesses to a crime when asked to give an account of the incidence may recall the event somewhat differently from each other, and sometimes their statements may even be contradicting. It could thus be that none of the witnesses are lying but that at least one of them misremembers the event.

The scenario is different in the case of a suspect; interrogation is used to gather the information needed regarding the case. In a murder case, the location of the weapon used is known only to the perpetrator and without the right information provided by the suspect, the crime may go unsolved and in another case innocent citizens can be apprehended, prolong investigations and concealment of the actual offender.

Information gathered during interrogation of suspect or eyewitness testimony is of uttermost importance to any investigation therefore the certainty that the information gotten is not deceptive is of paramount benefit [SAD07]. The system proposed will be such that generate rules that will be used to classify the verbal information and non-verbal responses of the suspect into deceptive or truthful statement/evidence. To detect the applicability of the information gathered, the techniques of the system will be applied to discover, identify patterns and make predictions so as to make the law enforcement more efficient.

Lies in law enforcement can be detected in three ways as stated in [Vri00]. The first way is to discover the non-verbal behaviour of the liar. This aspect include the movement of the body (scratching the head), their expressive and responsive expressions, the expressions on their

faces (blinking of the eyes), and their verbal or spoken characteristics (pitch –high or low-of the voice). One’s behaviour which could expose deception, is often influenced by the emotional disturbances that is caused by the act of lying. The other way is to analyze the verbal contents of what was said by the subject. The contents of the speech of the subject can be analysed using the characteristics stated in [Vri00]. These include negative statements, plausible answers, unrelated information, over-generalized statement, self-references, and response length. In this regard, the distinction between deceptive and truthful statements can be readily ascertain as some verbal criteria are more likely to occur in deceitful rather than in truthful statements. The last way is to study the blood pressure, the rate at which the heart beats, sweating palm, and breathing which is considered as the physiological responses of the subject. Forming a hybrid of verbal and non-verbal can go a long way in helping law enforcement officers to effectively detect deception during interrogation. The hybrid system will rely on the principles of neural network and fuzzy logic system in formulating the rules that will classify information as deceptive or truthful statement.

2. NEURO-FUZZY SYSTEM

Neural network, which try to model the natural functions of the human brain, is an adaptive system that can learn relationships through repeated representation of data. Some of the plus in neural network is that it has learning capacity, generalization capacity and robustness in relation to disturbances.

Fuzzy logic, a superset of the conventional Boolean logic, is used for handling the concept of partial truth (truth value between truth and deception), a situation where the deceiver use an event that has happened previously to deceive. It is currently being used for modelling linguistic and imprecise information [Aki02]. Fuzzy logic is notable for its strength in handling issues relating to areas of limitation of neural network.

Incorporating fuzzy logic into neural networks enables a system to deal with situations in a manner more like human. Neural networks and fuzzy systems can be combined to join their advantages and to eliminate individual weaknesses. The architecture of the neurofuzzy system as adopted from [M+90] is given below:

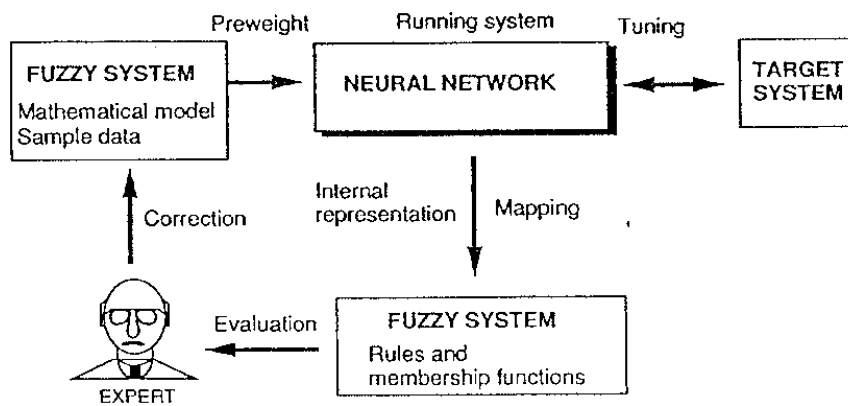


Figure 1. Neurofuzzy system

3. DESIGN

The proposed system is based on a combination of expert rules, fuzzy logic perception, and the prediction capabilities of artificial neural network. It is based on the human deception mechanism [MEC10]: Verbal and Nonverbal. The verbal classes of cues and respective indicators are:

1. Speech Disturbances (number of words, number of verbs, number of sentences)
2. Longer Pauses (average sentence length, average word length, pausality)
3. High Pitched Voice (passive, active)

While the nonverbal classes of cues and their respective indicators are:

1. Eye Blinking (interval between the blink)
2. Facial movement (frequency of occurrence)
3. Leg Movement (rate of speed)

The set patterns of the verbal and nonverbal classes of cues are given below:

$$\text{verbal} \in \{\text{SD, HPV, LP, NW}\} \dots \dots \dots \mathbf{1}$$

where SD is Speech Disturbances, HPV is High Pitched Voice and LP is Longer Pauses.

$$\text{nonverbal} \in \{\text{EB, HS, LM}\} \dots \dots \dots \mathbf{2}$$

where EB is Eye Blinking, HS is Hand Shaking and LM is Leg Movement.

The verbal and nonverbal set will be used to form linguistic rules which will serve as membership functions of the fuzzy set. The membership functions are used to train the neural network.

The indicators are used to form the following membership functions:

$$\text{Var}(x) = \begin{cases} \text{Truth} & \text{if } x \notin \{\text{ver} \wedge \text{nver}\} \\ \text{P.Truth} & \text{if } x \notin \{\text{ver} \vee \text{nver}\} \\ \text{P.Deceptive} & \text{if } x \in \{\text{ver} \vee \text{nver}\} \\ \text{Deceptive} & \text{if } x \in \{\text{ver} \wedge \text{nver}\} \end{cases}$$

where P.Truth is partial truth, P.Deceptive is partial deceptive, ver is verbal and nver is nonverbal.

The variable x takes on the values in the set {Truth, P.Truth, P.Deceptive and Deceptive} if x satisfy the stated conditions.

4. CONCLUSION

In conclusion, forming a hybrid of verbal and non-verbal can go a long way in helping law enforcement officers to effectively detect deception during interrogation. This in turn will help in arresting the occurrence of innocent citizens going to jail and also hasten the process of investigation.

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