

Face Temperature as an Indicator in Detection of Deception

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Abstract:- In Modern span, people are victimized by many criminal activities and face different stressful situations. It is the duty of the Crime investigating officer to connect the criminal to the crime scene. Interrogation of the suspects, witnesses and complainants and methods used to elicit information are always challenging tasks for the investigating agency. Success of any investigation depends on how efficiently an investigator, or an officer can identify the real offender at the scene of crime. In any criminal investigation, cross questioning of the suspects and accused plays an important role in extricating the truth from them. Change in the face temperature is termed as a good indicator of the change in emotion of a person which can be taken as one of the important parameters in detection of deception. Thus, face temperature can be taken as an important parameter in solving various crime scenes, which will facilitate faster disposal of the pending cases at Indian court.

I. INTRODUCTION

Deception has long been recognized as a persistent aspect of human behavior. It wasn't until the 20th century when John Larson invented the first functioning polygraph, revolutionizing the field of lie detection. Prior to this technological advancement, determining the veracity of statements relied primarily on sworn oaths or declarations, serving as the basis for determining whether someone was being truthful or deceptive.. Yes, polygraph exists for more than a century ago.As the time passed by, there was an understandingthat on the basis of facial expression a person can be identified as whether he is guilty or innocent as well as along with the behavior. The first know method of Lie detection comes from Ancient China where dry rice is used as commonly used method to obtain a confession of guilt. As per the ancient method, a subject or suspect asked to place rice in their mouth and on the basis of splitting of rice subject is termed as innocent or guilty. The subject is termed as innocent if rice spilled is wet while dry rice means guilty.During investigation, an investigating officer would make a subject to have handful of dry rice in his mouth while he was asked a series of relevant questions. In other words, while questioning, the suspect needs to chew dry rice. The assumption made while identifying whether he was guilty, or innocent was made based on the fact if the spat-out rice was moist or not. If the rice coming out is moist, then it is termed as the suspect was telling the truth for the questions, if not then he is considered as telling lie. This rice examination test is based on psychology that, the stress connected with such doing would cause a slowdown in

saliva flow which would lead to a dry mouth. This belief would mean that when someone is lying, he don't have salvia in his mouth, that's why he spat out dry rice. In other words, if there is no change in salvia flow, it is believed that he is not stressed with stressed with the questioning, and he is telling truth. With the passage of time, new inventions or studies have been came up out. One such method is the machine that was invented for lie detection. The polygraph is a test which is used to measure a person's psysiological factors such as respiration, heart rate, blood pressure, and skin conductance (sweating) during the time when few questions have been asked from subject.

Other emerging technique used in lie detection is change in the face temperature that is certainly taken a good indicator of emotional change which can help as important parameters in detection of deception. The examination of changes in facial temperature can be evaluated by utilizing infrared cameras, enabling the application of remote sensing and eliminating the necessity for attaching any sensors to the subject's body.

Thermal imaging captures the blood flow in the facial region.

When facial temperature increases, it can result in enhanced blood flow around the eyes, facilitating rapid eye movement during preparedness for combat. Additionally, elevated temperature in the forehead area can indicate the activation of the corrugators muscle, which is closely linked to mental stress. The nose, eyes, and forehead regions of the face are reliable indicators of sympathetic nervous system activation, triggering physiological responses in stressful situations. Similarly, when the body reacts to heightened levels of anxiety, such as in a simulated event, temperature values decrease due to vasodilation, shivering, and sweating.

II. DETECTION OF DECEPTION

Deception involves knowingly guiding others to adopt false beliefs. Researchers in the field have primarily investigated deception as a form of interpersonal interaction within specific contexts, where one individual intentionally misleads another. The act of deception detection involves making judgments about whether a particular communication is truthful or not (8). It is an active and evidence-driven process that aims to determine the veracity of information. Deceiving and lying are intentional acts where the deceiver deliberately leads the recipient to believe something false (12). These actions are conscious and purposeful, carried out by the individual engaging in deception. (3).

The act of lying, as well as being on the receiving end of lies, is a frequent phenomenon. However, accurately detecting lies presents a significant challenge for many people. Studies indicate that the average person's ability to detect lies is around 54% [11, 2], with only occasional instances reaching 60% and sometimes even falling below 50% [4]. Various research indicates that threat and challenge appraisals initiate the stress process and are robust predictors of various stress responses.

Deception can be identified both with verbal and non-verbal clues which we got from the subject. The only thing is to analyze such cues. Non-Verbal cues can be in the form of head gesture, eye moments, gaze, facial expressions.

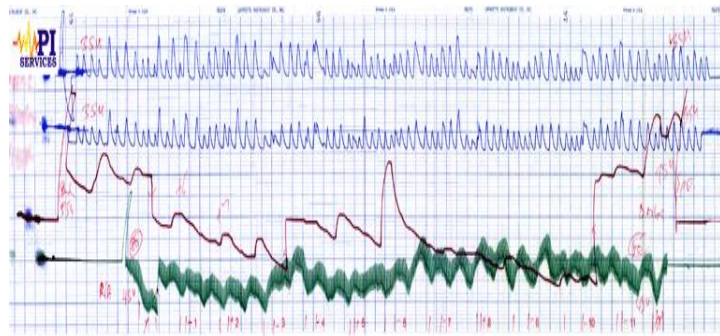


Fig. 1: Demonstration of Polygraph Test

The Polygraph Test is commonly known as a “lie detector test. The equipment which is used for the purpose of truth verification/lie-detection is called "polygraph". The word polygraph means many writings simultaneously. As the name indicates the equipment can simultaneously record more than one physiological response and the changes therein (10). The polygraph is an instrument that detects various subtle and involuntary changes in physiological functions such as heart rate, skin resistance, and blood pressure. These changes differ from the normal state and are triggered when a person is lying. The individual undergoing the test is connected to instruments like cardio-cuffs or sensitive electrodes, which measure variables such as blood pressure, pulse, and skin resistance while questions are posed to them. Each response is assigned a numerical value, enabling the examiner to determine whether the person is telling the truth, deceiving, or uncertain. For conducting polygraph test, we need to have the consent of subject. The utilization of polygraph tests for investigations and personnel screening is widely known and implemented by various reputable agencies such as the CIA, FBI, National

III. METHODS IN DETECTION OF DECEPTION

Criminal investigation utilizes multiple techniques to uncover instances of lying and deception among suspects and accused individuals. Modern approaches, including polygraph examinations, narco-analysis, and brain mapping tests, provide non-invasive methods for detecting deception, ensuring the subjects' physical and mental well-being is not compromised. We will have a brief about them.

The most and widely used technique is Polygraph technique.



Security Agency, C.B.I., US Secret Service, and the US Department of Defense.

The term "Narco-Analysis" originates from the Greek word "narko," which refers to anesthesia or torpor. It is a diagnostic and psychotherapeutic technique that involves the administration of psychotropic drugs, particularly barbiturates. During this test, the subject is brought into a semi-conscious state where their imagination is subdued. In this altered state, it becomes challenging to fabricate responses, and the subject's answers are limited to information they are already aware of. These answers are considered to be spontaneous, as a semi-conscious person lacks the ability to manipulate their responses. Qualified experts administer Sodium Amytal to the subject, and the dosage is determined based on factors such as the person's gender, age, health, and physical condition.

The technique which is used in lie detection to find out the presence of knowledge of crime is brain mapping technique or Brain Electrical Oscillation Signature profiling System .



Fig. 2: Illustration of Brain mapping Technique (BEOS)

The Brain Mapping program focuses on evaluating the recollection of Experiential Knowledge or autobiographical information rather than measuring general knowledge (10). It involves attaching sensors to the suspect's head and having them sit in front of a computer screen. Images or sounds are then presented to the suspect. By monitoring the electrical activity in the brain, the sensors detect specific waves that are generated only when the suspect has a connection with the stimulus (image or sound).

IV. RECOGNITION TECHNIQUES FOR THERMAL IMAGING

There are twodistinct types of face recognition techniques: -

- A. *Uni- Nodal Technique*
- B. *Multi – Nodal Technique*

• Multi Modal Infrared Face Recognition:

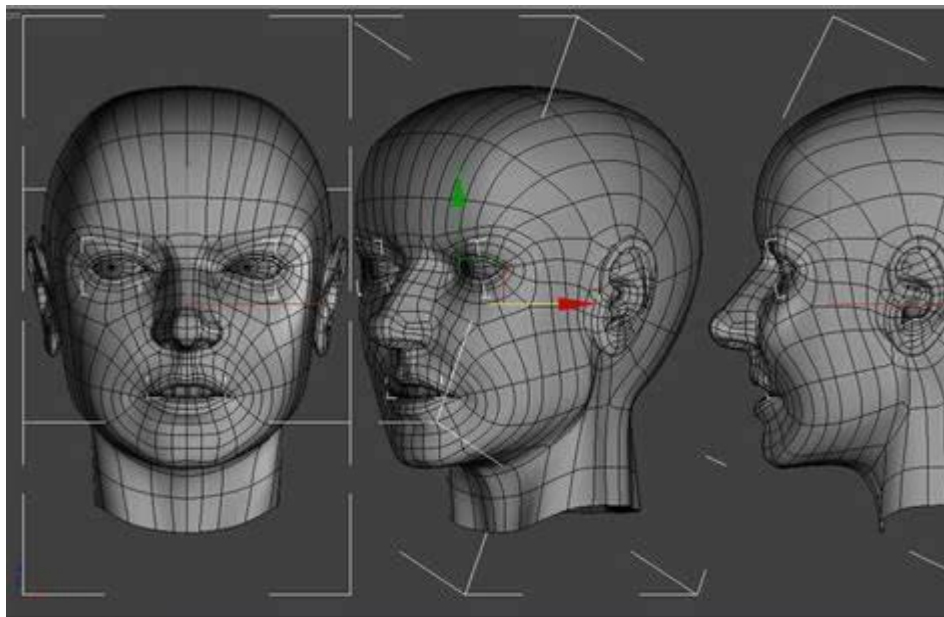


Fig. 3: Portrayal of Visual +IR+3D

Although this technique has not yet achieved widespread acceptance, multiple studies indicate that the hybrid approach combining Visual+IR+3D recognition offers higher accuracy and recognition rates. Furthermore, it appears that noise and facial expressions have lesser effects during recognition when utilizing this method.

V. PROCEDURE OF SETTING UP OF INFRARED CAMERA / THERMAL IMAGING TO ANALYSE

In infrared imaging, alterations in facial temperature are visually represented by changes in color within the respective areas. The imaging process utilizes a wide range of colors, ranging from blue to dark red. It is important to note that changes in temperature within the periorbital and forehead regions are associated with levels of stress.

- **Uni-nodal Technique:** This is most common used technique used in face recognition. Under Uni -nodal technique data is being captured under 2 D modal and then is being analysed in two types. Firstly, there are statistical techniques, also known as appearance-based methods, that can be employed for various purposes such as facial recognition. These techniques include Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and Independent Component Analysis (ICA) (6). PCA is applied to each histogram of a thermal image to extract facial features, which are subsequently utilized for recognition (9). Features like the left eye, right eye, and others can be individually represented using PCA, allowing for expressions such as happiness or anger to be conveyed (7). On the other hand, the LDA technique is utilized specifically for recognizing near-infrared (IR) images. Secondly recognition under single nodal is done on the basis of **Feature Based Methods:** As the name suggest it focuses on comparison of individual facial parts such as nose, eyes that can act as technique for detecting of deception.

While individuals can be trained to control their facial expressions, regulating emotional fluctuations proves to be considerably more challenging, particularly when attempting to deceive. The examination of temperature changes in multiple rectangular areas (referred to as windows) across the face yields results. Abrupt stress triggers heightened blood flow around the eyes, while prolonged stress leads to increased blood flow in the forehead region (5). Thus, investigating officer must define these windows that are rectangular fields in the face of the subject very clearly as it helps to identify the stress level. Infrared cameras need to track those area continuously in successive frames of the films.

For selection Area, we need to take three criteria simultaneously.

- The object being used should exhibit distinct color contrasts.
- The object should be positioned in an area where the greatest temperature changes occur, typically near a major blood vessel.
- The object being observed should maintain a consistent shape and remain stationary in relation to the windows.

By conducting comparative analysis and individual examination of the parameters that undergo changes in the facial region during truth-telling and lying scenarios, valuable insights can be gained regarding the body's

response to different stimuli. Researchers focus on identifying specific areas of the face and studying the alterations in blood flow around those regions. In Figure 2, the eye corners and nose region of a thermal image are tracked, often referred to as the region of interest (ROI). In a particular study [1], the ROIs were defined as 17x17 pixels each for the two eye corners. Numerous frames were captured during question-and-answer sessions, enabling the tracking and representation of both ROIs in subspaces, with average values subsequently calculated.

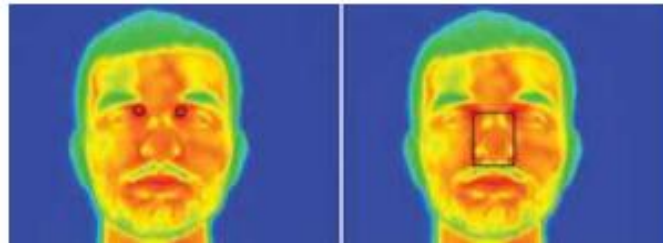


Fig. 4: Tracking Eye Corners & Nose

➤ USES OF Thermal Imaging Cameras

- Maintenance of electrical wiring.
- Inspection of 3-phase equipment.
- Utilized by first responders such as firefighters to enhance visibility through smoke, locate individuals, and identify areas of intense heat in fires.
- Employed by security and law enforcement agencies for purposes of surveillance management, suspect apprehension, crime scene investigation, and search and rescue operations.
- Animal Health.
- Mechanical Installations.
- Gas Detection.

VI. CONCLUSION

After studying various research paper and studies, conclude that this technique is a good technique which helps in early detection of deception. Also, this technique is less time consuming as comparable to other traditional techniques. Though, it hadn't gained much of popularity in India but is considered as one of successful technique in detection of deception mostly in developed countries like USA. These facial recognition techniques are now being used at various platforms like in airport etc.

VII. SUGGESTION

Polygraph is still considered as one of the successful tool in lie detection platform. In other words, it is widely used method to analyse electrodermal, pulse and relative fluctuations in blood pressure and breathing functions but even minor movement of subject would make the process tedious and hence the report become insignificant. The use of a multi-modal 3D imaging approach enhances precision in extracting thermal signatures. Therefore, it becomes necessary to develop an algorithm that can work in conjunction with a polygraph to enable the camera to

consistently track a specific facial area. Thus, study of facial temperature along with polygraphs test of the subject leads to more accurate result in analyzing their behavior whether they are telling truth or lie. Also, if both methods are implemented in crime field it would help in setting out the case in more accurate and faster pace.

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