



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Portable Cognitive Lie Detector with Decision Making

Dr.Pramod Sharma¹, Harshit Gupta², Piyush Kumar Singh³, Puneet Kumar Sharma⁴,
Shivangi Upadhyay⁵

Faculty, P.G. Dept. of ECE, R.B.S. Engineering Technical Campus, Bichpuri, Agra, India¹

B.Tech. Students, P.G. Dept. of ECE, R.B.S. Engineering Technical Campus, Bichpuri, Agra, India^{2,3,4,5}

ABSTRACT: A recent study found that lying takes longer than telling the truth, and thus, the time to answer a question may be used as a method of lie detection. This paper aims to detect the human's unsatisfactory behavior to examine to detect the lie. Different cognitive parameters like eye blink rate and analysis of the person's speech frequency to detect the deception along with heart rate using ECG machine were taken and examine to design a lie detection system. Along with the mentioned parameters this work implements a machine learning model which will help to classify the liars into one group and not liars into separate groups.

KEYWORDS : Detection, Decision, Eye Blink, Heart Rate, Speech

I. INTRODUCTION

There was a time when people used to lie to simply avoid the consequences of one's actions. But in Today's fast paced world, lies have become a tool to escape from the critical situation, taking the easy way out. Lying hides a person's true image to others. Lies are fine in fiction but not in the contemporary world. Once a lie has been told, there can be two alternative consequences: it may be discovered or remain undiscovered. A recent study found that lying takes longer than telling the truth, and thus the time to answer a question may be used as a method of lie detection. To detect the human's unsatisfactory behavior is what we aim to examine. The idea here is to develop "Cognitive Sensing Based Lie Detection" which includes parameters like eye blink rate and analysis of the person's speech frequency to detect the deception along with heart rate using ECG machine. The objective of this work is to implement a machine learning model which will help to classify the liars into one group and not liars into separate group. However, the results of this analysis cannot be trusted to be completely correct as the person might be clever enough to trick the system by hiding their emotions.

II. LITERATURE SURVEY

P. Ekman and M. O'Sullivan [10] In this paper ability to detect lying was evaluated among 509 people including law-enforcement personnel, such as members of the U.S. Secret Service, Central Intelligence Agency, Federal Bureau of Investigation, National Security Agency, Drug Enforcement Agency, California police and judges, as well as psychiatrists, college students, and working adults. A videotape showed 10 people who were either lying or telling the truth in describing their feelings. Only the Secret Service performed better than chance, and they were significantly more accurate than all of the other groups. When occupational group was disregarded, it was found that those who were accurate apparently used different behavioral clues and had different skills than those who were inaccurate.

G.R. Miller and J.B. Stiff [9] A Deceptive Belief Inventory scale is developed and validated using 10 first-order factors to represent 3 second-order constructs (deception confidence, duping delight, and guiltless deception). A new theoretical model describing how deception confidence, duping delight and guiltless deception may influence a person's intent to deceive others is also tested. Traditional deceptive communication research has focused on situation-specific factors surrounding deception. This study focuses on understanding and assessing a person's propensity to deceive others. The findings of this study can be used to better understand the factors that may influence a person's reported propensity to deceive and ultimately be used to improve security procedures designed to protect critical information systems.



Sharon Leal, Aldert Vrij [8] Author tested the hypothesis derived from eye blink literature that when liars experience cognitive demand, their lies would be associated with a decrease in eye blinks, directly followed by an increase in eye blinks when the demand has ceased after the lie is told. A total of 13 liars and 13 truth tellers lied or told the truth in a target period; liars and truth tellers both told the truth in two baseline periods. Their eye blinks during the target and baseline periods and directly after the target period (target offset period) were recorded. The predicted pattern (compared to the baseline periods, a decrease in eye blinks during the target period and an increase in eye blinks during the target offset period) was found in liars and was strikingly different from the pattern obtained in truth tellers. They showed an increase in eye blinks during the target period compared to the baseline periods, whereas their pattern of eye blinks in the target offset period did not differ from baseline periods. The implications for lie detection are discussed.

III. PROPOSED SYSTEM

Fig. 1 shows the system proposed in this paper. The suspect have to sit in front of the laptop where the facial expressions of the suspect will get captured using the laptop’s web-camera and the answers given by the suspect with respect to the questions asked by the investigator that are in the form of input voice will be recorded using laptop’s headphone/microphone which will be further extracted using MFCC(Mel Frequency Cepstral Coefficients) for feature extraction and the suspect has to wear the ECG machine which will help the system to analyse the heart rate. These are the parameters which are necessary for the system and will help the system to detect the deception. The ECG machine requires the 3 leads to be connected as shown in fig.2. So the pulse signals from the human body will pass through the amplifier which does the filtration of excess noise and will go through the Arduino to the system in the form of frequency.

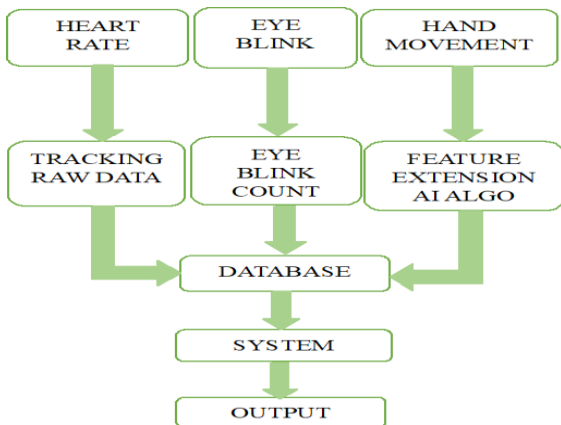


Fig.1. Proposed System

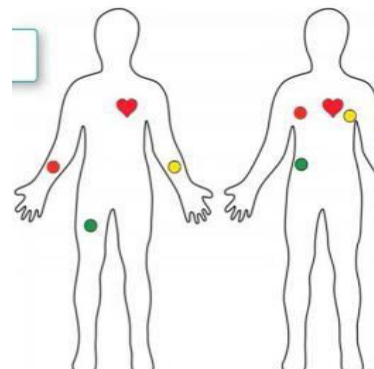


Fig.2. ECG machine connector

Investigator will then suspect the accused person by interviewing with a set of questions called a GKT (Guilty Knowledge Test). Once the GKT is done, processing of the data will be performed where for a given duration of time, the suspect’s eye blink rate, heart rate and voice frequency under a normal condition will be calculated and stored in the database. Then the system will be trained using the Random Forest Classifier. Once the training of the data is done, suspect will be cross questioned and the responses to which will be used as a testing data. Here a threshold is set for the eye blink rate, heart rate, and voice frequency of the current accused/suspected person based on his / her behavior under normal circumstances (training phase). For testing of a lie, we will feed the classifier with the testing data to compare it with training data, if the value for eye blink rate, heart rate and voice frequency for the current testing data falls above the threshold, it will be assumed the suspected person is lying otherwise the suspected person is not lying.

IV. IMPLEMENTATION DETAILS

Fig.3. shows the project hardware and the details of major hardware required are given below :

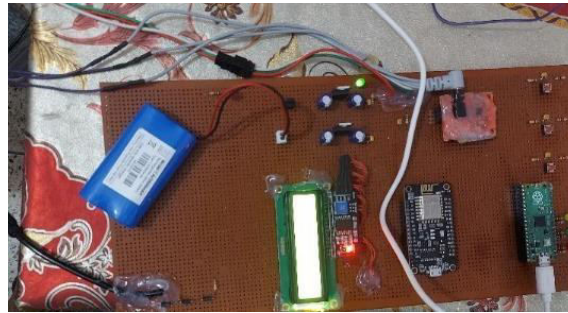


Fig.3. Project Hardware

4.1. Camera

Laptop's webcam is used to capture and analyse the eye blink rate whether it is decreasing or increasing / remains stable, to detect lies. Fig. 4 shows how the camera will capture an input to the system. That video will be further processed to examine the eye blinks. The camera is used to capture and analyse facial expressions and micro expressions of the individual being tested. By leveraging the camera's capabilities, the portable cognitive lie detector enhances the accuracy and reliability of lie detection by incorporating visual cues and nonverbal behaviour analysis.

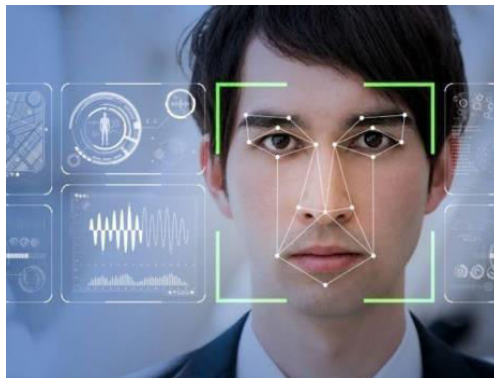


Fig.4. face detection

Eye Blink Feature:

- Eye blink patterns can be indicative of a person's cognitive load and emotional state, which can be helpful in detecting deception.
- PCLD uses a high-resolution camera or specialized eye-tracking sensors to capture and analyse eye blink patterns.
- The device measures the frequency, duration, and intensity of eye blinks during questioning.
- Patterns such as rapid blinking, prolonged blinks, or inconsistent blinking can indicate heightened cognitive load, anxiety, or potential deception.

Smile Feature:

- Smiles can be a potential indicator of emotional responses and can help determine a person's level of sincerity.
- PCLD employs facial recognition technology and image analysis to detect smiles and evaluate their authenticity.
- The device analyzes factors such as the intensity, duration, and symmetry of smiles.

- Genuine smiles, known as Duchenne smiles, involve the activation of specific facial muscles, including those around the eyes, and can signify genuine emotions.

Voice Feature:

- Vocal characteristics, including pitch, tone, and speech patterns, can provide valuable cues about a person's emotional state and potential deception.
- PCLD utilizes advanced audio processing algorithms to capture and analyze vocal features.
- The device measures elements like vocal pitch modulation, speech rate, and micro-tremors in the voice.
- Vocal inconsistencies, such as variations in pitch or speech patterns, can suggest potential deception or heightened stress levels.

4.2. ECG

The Generic ECG module AD8232 which is basically the Pulse heart monitoring sensor Kit for Arduino, is used to measure the electrical activity of the heart. The AD8232 is reliable instrumentation amplifier, it used basically for taking EC, EG, ECG Signals.

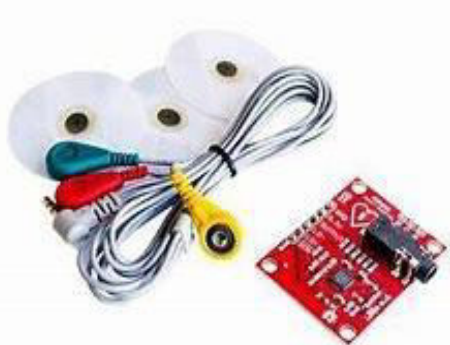


Fig.5. ECG sensor

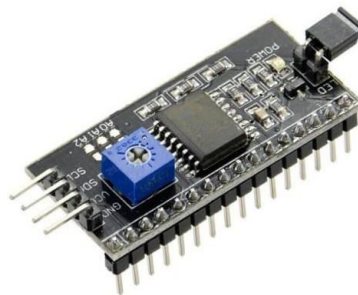


Fig.6. I2C interface module

4.3. I2C interface for LCD

This LCD2004 is a great I2C interface for 2x16 and 4x20 LCD displays. With this I2C interface LCD module, you only need 2 lines (I2C) to display the information

4.4. Raspberry Pi Pico

It is a microcontroller board based on the Raspberry Pi RP2040 microcontroller chip. It is connected to the NodeMCU using the TX and RX pins (21st and 22nd pins), and receives a 3V power supply from the first regulator.



Fig.7. Raspberry pi PICO

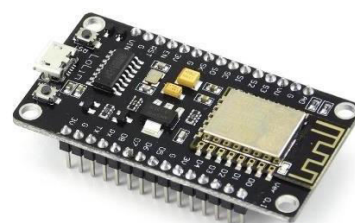


Fig. 8. Node MCU esp 12

4.5. Node MCU esp 12

NodeMCU is a **low-cost open source IoT platform**. It initially included firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which was based on the ESP-12 module. Later, support for the ESP32 32-bit MCU was added. It sends data to the server, connected to the LCD to display the IP address of the server, and receives a 3V power supply from the first regulator.

V. RANDOM FOREST ALGORITHM

- **Data Collection:** First, data is collected from the person being tested, such as their heart rate, skin conductance, and breathing patterns, using sensors and other monitoring devices.
- **Feature Extraction:** Next, relevant features are extracted from the collected data. For example, the heart rate variability or the level of skin conductance could be important features for lie detection.
- **Training Data Preparation:** A set of labelled training data is prepared, where the features extracted from the data are used as inputs and the corresponding labels of whether the person is lying or not are used as outputs.
- **Random Forest Training:** The Random Forest algorithm is trained on the prepared training data. The algorithm builds multiple decision trees on different subsets of the training data and selects the most important features at each node of the tree based on their information gain.
- **Random Forest Prediction:** Once the Random Forest algorithm is trained, it can be used to predict whether a new set of features extracted from the data of the person being tested indicates whether they are lying or not. The algorithm aggregates the results from each decision tree to make the final prediction.
- **Performance Evaluation:** The performance of the algorithm is evaluated by comparing the predicted labels with the actual labels of the testing data. The accuracy, precision, and recall of the model can be calculated to assess its performance.

VI. PROCEDURE

- Check the connections properly
- At first, make the client/person familiar with the project, and the facial expressions, blinking of eyes, heart rate, hand gesture(conductivity) should be in normal condition
- Connects the electrodes (skin pads) to the specified/relevant areas and sanitised the area with sanitizer having more alcohol content:
 - a) Red- right arm side
 - b) Yellow-left arm side
 - c) Green-lower belly part (right side)
 - d) Hand electrodes- left hand fingers
(connect with index, middle, ring finger for more accuracy and chooses the left side because it is closer to the heart than right side and will be more accurate)
- After the connection: ECG module which is connected to the coloured electrodes gives the information about heart rate and the hand electrodes which is connected to the fingers of left hand gives the information about conductivity of the body and the software which we used for face detection gives the information about the variations in facial expression and eye blinking
- After these connections/observations we are going to check/monitor/detect/test the lie of the client/person by asking some question .
- We must maintain silence with in the room for not disturbing the person (whom we test) for proper observations and after that we can start questioning
- The first 5-6 questions should be simple and easy to answer in positive way (yes) for making the person comfortable with the questioning or making him/her relaxed and after that the hard question (the questions which are regarding the lie) that makes them uncomfortable. So, we can calculate/observe the conductivity or resistivity or changes in their facial expression and eye blinking easily all the questions one by one.
- By changing the question easy to hard helpful in calculations and accuracy of the data.
- We get all the information or observation on our device screen



Participants:

The participants will consist of volunteers who are willing to take part in the study. They will be required to sign a consent form before taking part in the experiment. The participants will be screened for any pre-existing medical conditions that could affect the results of the ECG readings.

Training Algorithm: Random Forest algorithm is used for detecting whether a person is lying or not. For detecting purpose, we are checking the audio file of answers which is given by the suspect with similar trained data of voice.

How data is used: The Lie Detector constitutes different layers. We recorded heart rate using ECG, eye blinks and voice frequency and based on these parameters we are detecting whether user is lying or not. If parameter goes beyond threshold value then result will be lie.

VII. RESULTS AND OBSERVATION

Baseline measurements: The participant's heart rate and ECG readings will be recorded while they are at rest.

Stimulus presentation: The participant will be presented with a series of stimuli, such as images or sounds, designed to elicit emotional responses. The stimuli will be presented in a random order, and the participant's heart rate and ECG readings will be recorded during each stimulus presentation.

Environmental data collection: The IoT devices will collect data on the participant's environment, This data will be used to analyse the participant's responses to the stimuli.

Data Analysis according to Training and Testing: The data collected from the ECG headset and IoT devices will be analysed to identify patterns in the participant's heart rate and environmental responses that are associated with lying.

Lie detection: The analysis of the data will be used to identify patterns in the participant's heart rate and environmental responses that are associated with lying. The experimenters will look for changes in heart rate, ECG readings, and environmental responses that may indicate that the participant is lying.

The result summary of typical data set obtain from the different inputs were shown in the table below :

Table.: Readings of different parameters

S.No.	HEART RATE (RESISTIVITY)	HAND GESTURE (CONDUCTIVITY)	EYE BLINK RATE/second	FACIAL EXPRESSION	LIE- RESULT
1.	29	1	3	Normal	True
2.	25	1	3	Normal	True
3.	65	7	8	Nervous	False
4.	66	8	10	Nervous	False
5.	66	14	10	Nervous	False
6.	73	14	14	flurry	false
7.	76	20	14	Flurry	False

NOTE: We could not be able to detect the lie by asking single questions, for obtaining accuracy in Detection of lie we should ask at least 14-15 questions.

POINTS TO REMEMBER:

- Good connectivity of internet is required.
- Surrounding environment should be very silent.
- Make the person familiar with the project, he should not be nervous.
- Area of connectivity of electrodes (skin pads) should be clean and sanitized properly.
- HEART RATE (RESISTIVITY): Initially the heart rate of the person should be normal.
- HAND GESTURE (CONDUCTIVITY): Hands of the person should be clean and properly sanitised (with more content include alcohol sanitizer) and should be dry.
- EYE BLINK RATE: the normal eye blink of average person is 12-15 per minute, so, at the start eye blink rate should be normal.

VIII. CONCLUSION

This system is based on building a Lie Detector capable of detecting, monitoring and transmitting suspect's physiological parameters such as eye blinking, hand gestures, heart rate, etc. and to create a system that tells whether a suspect is lying or not based Machine Learning Algorithm. For the implementation of the proposed system, devices like ECG recorder, Camera is used for recording the data and Database approach is used for storing the data and Machine learning is used to make the system capable to classify / predict whether a person is lying or not. The main idea or motive behind the project is to tell whether a person is lying or not for which there is no exact way to identify. But with the correct implementation of this device we can expect a rather close to perfect result for most of the cases.

REFERENCES

- [1]. Amanda Chow and John Louie "Detecting lies via Speech Patterns", "Department of Computer Science, Stanford University" 2015.
- [2]. Hartwig, M., et al. Strategic use of evidence during investigative interviews: the state of the science. In: Raskin, DC., et al., editors. *Credibility Assessment: Scientific Research and Applications*. Academic Press; 2014. p. 1-36.
- [3]. Honts, RC.; Hartwig, M. Credibility assessment at portals. In: Raskin, DC., et al., editors. *Credibility Assessment: Scientific Research and Applications*. Academic Press; 2014. p. 37-61.
- [4] Evans JR, et al. Validating a new assessment method for deception detection: introducing a psychologically based credibility assessment tool. *J Appl Res Mem Cogn*. 2013; 2:33-41.
- [5]. G. de Haan and V. Jeanne. Robust pulse rate from chrominance-based rppg. *IEEE Trans. on BEng* 60(10):2878-2886, 2013.
- [6]. Addis D, Schacter DL. The hippocampus and imagining the future: where do we stand? *Front Hum Neurosis*. 2012; 5:1-15.
- [7]. Vij A, Granhag PA. Eliciting cues to deception and truth: what matters are the questions asked. *J Appl Res Mem Cogn*. 2012; 1:110-117.
- [8]. Sharon Leal, Aldert Vrij, "Blinking During and After Lying", *Journal of Nonverbal Behaviour*, Vol. 32, pp. 187-194, 2008.
- [9] G.R. Miller and J.B. Stiff, "Deceptive Communication", *Deceptive Communication*, Vol.14, Pp. 32-39, 1993
- [10]. Ekman and M. O'Sullivan, "Who can catch a liar?", *American Psychologist*, Vol. 46, Pp. 913- 920, 1991.



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.423



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

9940 572 462 6381 907 438 ijirset@gmail.com



www.ijirset.com

Scan to save the contact details