

Machine Learning Based Polygraph Test Using Skin Sensations

Pooja Sharma¹, Aniruddha², Adit Vats³, Sunny Patel⁴ and Tushar Singh⁵

Department of Computer Science (Artificial Intelligence and Machine Learning), GNIOT Group of Institutions, Knowledge Park II, Greater Noida 201310 UP India

¹poojasharma7448@gmail.com, ²tkdaniruddha@gmail.com, ³vatsadit.2002@gmail.com, ⁴patel844732sunny@gmail.com, ⁵messitushar22@gmail.com

Abstract -- In the paper, we describe a unique method for polygraph tests using skin sensation and its conductivity with the help of a machine learning technique, specifically supervised learning. The method features three stages: skin conductivity acquisition, data processing and pattern classification or graph visualization. For verification and validation, lie detectors are crucial in numerous fields, including counter-terrorism, police investigations, and airport security. Facial micro-expressions and sensors, which are quick involuntary expressions people do make when they're trying to conceal or repress emotions. Micro-expressions are difficult, time-consuming, and incorrect to measure manually. The development of a Lie Detection System using direct skin connectivity is much more efficient at the lower level. The automated polygraph system that is being presented was created utilizing Arduino and the machine learning technique. Data collected from the subject's interview and other sources are captured using an Arduino Micro-controller System. We have devised two-step testing procedure and results are given.

Keywords: Micro-expressions, Lie detector, Machine Learning, Polygraph test, Arduino, Supervised learning

I. INTRODUCTION

POLYGRAPH test detects people who pose security threats. A lie detector test determines if the person is giving truthful answers to the questions. Trained psychologists are present during testing. Physiological variables namely blood-flow rate, breathing-rate, or respiratory-rate are monitored.

There is a uniqueness and efficiency in our proposed 'lie detection model' that separates it from others. All other models use the various techniques but there is one common thing in all those techniques that they directly work on the real-time data received from the victim's body without knowing their biological patterns that his/her body releases during testing. Our skin's conductivity depends on different moods and behaviors. It is called Electro-dermal activity (EDA) [6]: our skin changes its conductivity depending on how we feel and behave, which we used to train our machine learning model for a polygraph test.

More specifically, we used the 'Logistic regression', which is a

calculation used to predict a binary outcome either something happens, or does not. This can be exhibited as Yes/No, Pass/Fail, Alive/Dead, etc. In our case scenario, it can be exhibited as Truth and False.

The figures represent and show off the difference between the technology previously used and used by us to collect the input for the polygraph test.



Figure 1 (a) Previous technology



Figure 1 (b) Through Skin sensation + ML Model

II. BACKGROUND

In many fields, numerous systems were developed to detect hidden subjects. The lie detector records a variety of physiological indicators such as irregular heartbeats,

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blood pressure, respiration and skin response. Intentionally misleading answers result in physiological reactions that can be distinguished from those brought on by honest responses. Nevertheless, a number of counter measures aim to resist lie detector tests [3].

Noje and Malutan [4] proposed a head movement analysis in lie detection and found that the participants' head movements differed depending on whether they were telling the truth or lying.

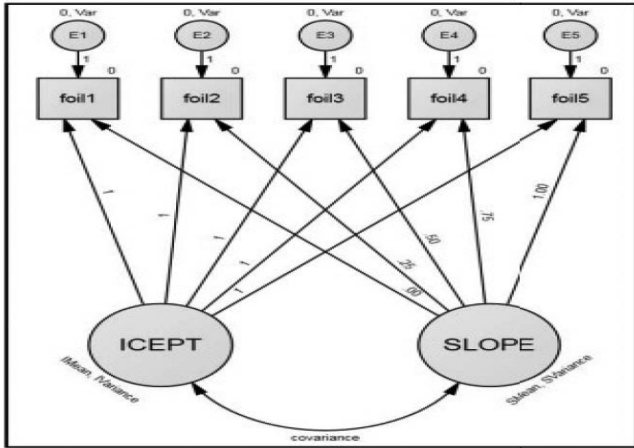


Figure 2. Eye deception detection.

An investigation of pupil diameter variation in electronic deception detection was demonstrated by Proud Food *et al.* in a study [5]. The results demonstrate that pupil diameter rapidly decreases during deception.

Numerous studies have been carried out using a variety of physiological methods to recognize lies and detect anxiousness. Heart rate-based lie detection has received little attention, though. In order to ascertain whether the suggested technique would increase and enhance the accuracy of the lie detection system, the impact and connection between lie detection techniques and Heart Rate signals will be investigated.

III. METHODOLOGY

Machine learning classification of biomedical datasets necessitates a strict training and testing process [8]. In this research, we propose polygraph machines that work in two phases:

(i) *Training Phase:* The lie detector is attached to the victim's body and we begin asking control questions to train our model. Idea of the training phase is to measure the range of truthfulness during participant's reactions.

(ii) *Testing Phase:* Testing phase is the outcome-based phase in which we set up the machine on the victim's body and

start the polygraph interview. Now the machine is quite efficient to represent whether the person is lying or not as the model knows the range of truth and falsehoods of the victim's body. The proposed work takes the simplest possible approach. The system primarily uses skin conductivity to acquire signals, and process that information to produce a real-time polygraph signal. There are two components: hardware and software.

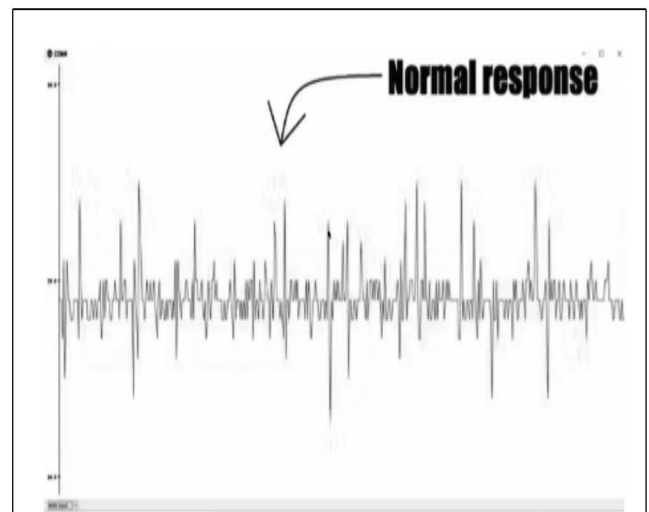
Hardware: It comprises of a basic tool kit of Arduino Nano, Velcro, 2K resistors, LEDs, foil, cardboard, hot glue and craft knives, connected on a breadboard, which a solder-less construction base used for developing an electronic circuit and wiring for projects with micro-controller boards like Arduino [10].

Finger clips collect the input data: The galvanic skin sensor measures output variations in the electrical properties of the skin, known as the electro-dermal response [9].

Software: The analysis of input signals from the Arduino IDE makes up the software portion. The circuit's portable USB power source is used to power it. The Arduino IDE converts the signal from analog to digital.

IV. RESULTS

Plotter is an Arduino library which is used for easy plotting on host computer via serial communication. The data collected from Arduino micro-controller is used by plotter library to plot graph. It generates plots against time as well as 2D plotting of X vs Y variable. Multiple graphs can be displayed at once, with all formatting and scaling handled automatically. The library plots the graph in the real-time scenario and we can see that, there is a quick change/shift in the Arduino software real-time line graph that indicates that the person is lying. During the test, this is represented as a deflected line in the graph as compared to the normal one.



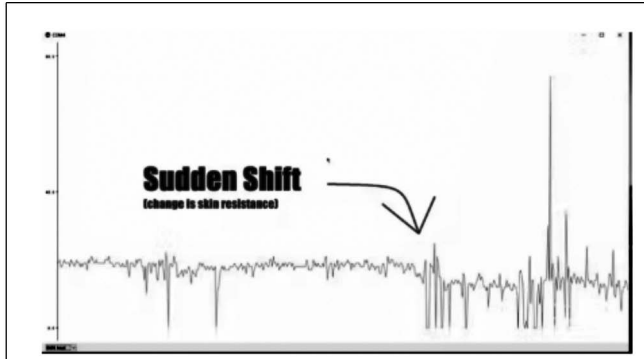


Figure 3. Results

The efficiency of this project can be enhanced by Applying Neural Networks [7].

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Mrs. Pooja Sharma is an esteemed researcher pursuing her PhD in the field of WSN (wireless sensor networks). With a profound passion for advancing knowledge and understanding in networking and micro-controllers, Mrs. sharma has dedicated her career to conducting groundbreaking research and making significant contributions to the field.

She has held positions at prestigious institutions, including various Professional Affiliations, where she has consistently demonstrated exceptional expertise.



Aniruddha is a dedicated student currently pursuing B.Tech-CSE (AI-ML) at Dr. APJ Abdul Kalam Technical University with a passion for Data science and Machine learning. Throughout his academic journey, he actively engaged in various research projects, seeking to explore new frontiers in Data science. He has worked closely with experts to develop a deep understanding of the subject matter and acquire essential research skills & Machine Learning. He actively participated in

conferences and seminars related to Data science. This provided him valuable opportunities to exchange ideas and gain insights from fellow researchers and experts in the field.



Adit Vats is a dedicated student currently pursuing Bachelors in technology in Artificial Intelligence at Dr APJ Abdul Kalam Technical University with a passion for Cyber Security and Artificial Intelligence, he has consistently demonstrated a strong aptitude for academic research and a genuine enthusiasm for expanding knowledge in Cyber Security and Ethical Hacking. Throughout his academic journey, he was actively engaged in various research projects, seeking to explore new

frontiers in Ethical Hacking and AI.



Sunny Patel is a dedicated student currently pursuing Bachelors in technology in Artificial Intelligence at Dr APJ Abdul Kalam Technical University with a passion for Data Science. Throughout his academic journey, he actively engaged in various research projects, seeking to explore new frontiers in Data science. He actively participated in conferences and seminars related to Machine Learning and Microcontrollers like Arduino, Raspberry pi etc.



Tushar Singh is a dedicated student currently pursuing Bachelors in technology in Artificial Intelligence at Dr APJ Abdul Kalam Technical University. With a passion for Computer Science and engineering specialization in artificial intelligence and Machine Learning, he has consistently demonstrated a strong aptitude for academic Research and a genuine enthusiasm for expanding knowledge in Machine Learning. Throughout his academic journey, he actively

engaged in various research projects, seeking to explore new frontiers in CS-AI-ML. He has worked closely with experts to develop a deep understanding of the subject matter and acquire essential research skills.