Intelligent Surveillance and Evaluation System in Courtroom Trials

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1 INTRODUCTION

Our country relies on a long established judicial system to determine the ramifications of questionable acts by members of society. Courtroom trials, law practices, and execution of sentences are common phenomena we rely on to address any misconduct and violence. Although the law is a system practiced almost to perfection, a single wrong decision made by a jury can have a catastrophic impact on the population as a whole. According to [1], there is an estimated 4.1% error rate for death-penalty cases, which accounts for only 0.1% of all prison sentences. The error for non-death-penalty cases, according to [2], is 2-5% due to false confessions, guilty pleas, flawed forensic evidence, and faulty eyewitness identification. An incredible reality lies in the fact that many tried and carried out cases are based on crimes that are not even committed in the first place. This means that as many as 100,000 people in the United States are found guilty and sentenced to prison but are innocent.

Such an error rate in verdict shows that juries are not sufficiently capable to evaluate trials and make life-altering decisions about a person. Should there exist a complementary, scientific facts-based system that will aid the jury in learning and understanding how the case is presented and acted out, the possibility of causing an error in judgment will decline to a great extent. This paper aims to address this problem by suggesting a likely solution using an intelligent system that determines these elements. We will discuss about our intended surveillance system, possible working principle, evaluation methods and how it will change the course of law practice and in turn our judicial system.

2 IDEA

A typical court trial has an accumulation of people who are involved, directly or indirectly, in the case or the persons of interest. Apart from the suspect and plaintiff, the advocates, friends and family of each party are the ones mostly aware about the incidence in question. Although it is the duty of a law practitioner to use his skills to restore justice to a case, it is not uncommon for a lawyer to tweak evidence and statements to prove his guilty client as innocent. The same can be said about the people emotionally close to the persons of interest. Studying the reactions of these members of the court, it is possible to figure out lies and other unfair means being used in the trial for the suspect's benefit.

Our system focuses and analyzes the behavior of these members throughout the proceeding of the case. We aim to utilize facial recognition, gesture analysis, and voice modulation techniques to detect inconsistencies that can indicate possible lie detection and role play. With the help of a number of high-resolution video cameras located smartly around the courtroom, the system will track these behavioral traits, record and link them with proven traits to evaluate the integrity of the statements. Only the jury will be able to access this information after the trial. They can use the feedback provided by the system in combination with their personal judgment to present a fair, final verdict.

This system has the possibility to revolutionize the law and order system, but there are certain prerequisites that should be met. One of them is to get members of the jury familiar with the surveillance system and how it determines inconsistencies. This can be achieved quite simply. When a certain person is tested for eligibility of jury duty, one of the test modules can be based on our surveillance system. Candidates will basically learn about the tracking mechanism and what different gestures mean. This additional module is advantageous to all because it will give the potential jury members to recognize these traits as well. Also, this system needs to be a very confidential tool used in courtrooms so that potential suspects are not aware of exactly how the system works.

3 DESIGN FOR SOLUTION

A potential design for our system would include approximately three sensors placed strategically throughout the courtroom. Some possible placements might include one in the jury's point of view, so the sensor can "see" what the jury sees; one in the judge's point of view facing the defendant, plaintiff, lawyers, and audience members; and one in the audience's point of view facing the witness stand. These locations are meant to capture as many people as possible in order to pick up on their gestures and facial movements. The sensors will transmit the data to a central source location, where the algorithm and software can analyze the data and determine a confidence interval showing the probability of the truth or falsity of the given statements.

Each individual sensor would contain a few cameras and microphones to record several people at once and to detect variances in a person's speech and language. They would likely be mounted in an inconspicuous location such as the ceiling. The intention is that the sensors will be more passive in picking up data so that people don't have to communicate directly to the sensor, it doesn't cause any distractions, and the way trials are done can remain nearly the same. Since the sensors would be several meters away from the persons of interest, they will likely not be able to pick up on very subtle cues like pupil dilation. However, they should be able to pick up on slight changes in body temperature as well as body gestures and facial expressions to determine emotion.

The central software that analyzes the data must convey the results obtained from the sensors very clearly so that the jury can make conclusions without having to analyze raw data. The main system should be able to compile all the statements given by the different people and divide the statements up between truthful and deceptive with a probability associated with each to aid the jury in making a final verdict.

4 IMPORTANCE

The mission of our surveillance system is not only to help juries make better decisions in trials but help the judicial system overall. Cases and trials are quite subjective and the impact of setting a guilty person free due to our lack of recognizing behaviors in the trial reflects negatively on our society. The surveillance system is an effective method that can avoid such an occurrence. Since one of the primary persons of interest of this system is the lawyers of each party, it has the potential to recognize corrupt law practitioners and audit their eligibility to proceed in this profession in the future. Also, this system helps juries to overcome professional bias, since it focuses on the behaviors of the people instead of their physical appearance, race, and insignificant features like attractiveness that are unrelated to lie detection techniques.

5 IMPACT OF SUCCESS

If this proposed device works accurately, the projected impact will be the entire population. Whenever the legal system wrongly imprisons someone or frees a guilty person, everyone is affected. The consequences of a "not guilty" verdict on someone who actually committed the crime is very high. As a society, we rely on justice and fairness, and the population could start to feel that the judicial system is ineffective if too many wrong verdicts are made. Furthermore, allowing a criminal to go back into society without justice being served could cause other people to be adversely affected from that person's future criminal actions. Thus, reaching a true and correct verdict is extremely important.

In addition, a great amount of stress is placed on the jury. Twelve random peers must determine the fate of one person, which is a life-altering decision. Members of the jury are typically not experts and have a difficult time keeping track of all the evidence and everything that people have said during the long and drawn-out trial that may take up to a year of courtroom appearances. Also, the jury is subject to implicit biases that they may not be aware of. For example, if the suspect reminds the jury of someone they liked or didn't like, it could influence whether they choose guilty or not guilty. So, this system is also expected to decrease the burden placed on juries in determining the outcome of a trial.

6 RELATED WORK

Polygraphs are rarely admissible in court, despite being 90% accurate [4]. Current polygraphs are made of several components, including two pneumographs that measure respiratory rate, a blood pressure cuff to measure blood pressure and heart rate, and galvanometers that measure galvanic skin resistance (sweat on the fingertips), and very few polygraphs are able to record basic arm and leg movements [4]. Also, polygraphs must be performed while the suspect is sitting still in a chair, and they must only respond "yes" or "no" to each question asked. In addition, the type of question being asked as well as its phrasing are crucial to a polygraph's accuracy. For example, some questions can be worded in such a way that requires more explanation than just a simple yes/no response, and the suspect can interpret a question differently than what was originally intended [5].

There are many more indicators that detectives use to figure out if someone is lying, which current lie detectors are unable to detect. Behavioral pauses or delays in speaking, a verbal and non-verbal disconnect (e.g. someone saying yes while shaking their head no), hiding or covering the mouth or eyes, clearing the throat or swallowing, touching the face, and grooming gestures (e.g. fixing a piece of clothing) are some indicators that a person may be lying [6]. Some other indicators include the person's eyes darting back and forth, rapid blinking, closing the eyes for more than one second at a time, looking to the right (for right-handed people), face touching, pursed lips, wiping excessive sweat off the face and neck, blushing, and shaking their head would normally not be considered when a person is undergoing a standard polygraph examination [7]. Other common indicators include a person changing their head position quickly, standing very still, repeating words and phrases, providing too much information, touching or covering their mouth, covering vulnerable body parts like the throat, shuffling their feet, difficulty speaking due to dry mouth, staring without blinking too much, and frequently pointing with their fingers [8]. All these cues for lie detection are not considered during standard polygraphs. Our system would monitor the above signs in order to give a more accurate estimation of whether or not someone may be lying.

Tselia Data Lab developed a camera algorithm that detects lies based on facial signals, but it takes several calibration questions to achieve its maximum 75% accuracy rate [9, 10]. Thermal imaging has also been shown to be 70% accurate in determining when a person is lying. The thermal camera is focused on a person's skin around the eye (because the skin is thinner there), and the camera can detect a warming in the face of just 0.1°C [11].

TruthTek is a system that uses facial, gesture, ocular, speech stress, voice stress, environmental, thermal/infrared, and physiological sensors to provide over 99% accuracy in emotion and lie detection [12]. However, this sensor must be placed in very close proximity to the person's face, but this will most likely not be feasible in a courtroom, where we plan on using a few sensors several meters away from the person. These sensors also only focus on the person's face, rather than their gestures like hand, arm, and feet positions and movements.

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