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GAIT ANALYSIS IN FORENSICS

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Abstract: In this paper we will explore the possibility of using Gait Analysis in forensics. We will describe the most common technologies used in forensics, analyze their disadvantages and see in which ways Gait Analysis can come and supplement those methods. In the end, we will take a look at how a human identification system based on Gait Analysis would look like.

1. INTRODUCTION

Gait analysis is a part of biomechanics mostly known for its involvement in domains like sports and medicine. In sports, the aim is the to improve competitor's performance by modifying their movement. That technique is common and it can nowadays be found in every high-performance sportive environment. The first step is building a model of „the perfect motion" - usually the way a champion moves - and the athlete is forced to perform similar motions, with the purpose of increasing his performance. In medicine, Gait Analysis is known to be useful mostly for helping people regain or improve their walking abilities, also following what is considered to be „a perfect model" for walking. From all this, there is a first conclusion which can be extracted: from the Gait Analysis perspective, people walk and perform activities involving motion differently from each other. From this came our idea that, if people walk differently, the walking pattern can be used as a „mark" of each individual (as in fingerprinting) and the information would be useful in forensics.

2. THE MOST COMMON TECHNIQUES USED IN FORENSICS

There are four main methods of human identification used on a large scale; those are fingerprinting, face recognition, iris identification and retina scan. We will roughly describe the basics of each one (the way in which every technique works might differ for each implementation, but the main principles remain the same).
In fingerprinting, the ridges of the fingers of potentially dangerous individuals are captured on paper or a special surface. Those impressions are then held in a database. After an aggressive event with unknown subjects occurs (robberies, crimes, terrorism etc.), the crime scene is investigated and the finger impressions are collected. Afterwards, the crime fingerprints are compared with those in the database in order to identify the aggressors.
In facial recognition, a surveillance system consisting of one or multiple video cameras must be in place. As in fingerprinting, unique data for individuals is collected, in this case the considered data is consisting in different physiognomy aspects (diameter of the eye cavity, length and thickness of the lips, forehead length and width etc.). From here on, the method works as the previously presented one: a database of facial biometrics is created and when an event occurs, the aggressor's facial patterns are ran through the system in order to identify him.
When human identification at the eye level is considered, we have two directions: retina scan and iris recognition. In iris recognition, the unique pattern which differentiates one human from the other is the iris, unique for each individual. In retina scan, the unique identifier is represented by the vascular system of the retina.

3. COMMON FORENSIC TECHNIQUES - MAIN DISADVANTAGES

From the forensic point of view, each of the methods presented in the previous chapter has serious disadvantages. Despite the low error rate and the massive improvements gained recently, fingerprinting becomes obsolete if the aggressor is wearing a pair of gloves. Facial recognition has the same destiny if the suspect uses a mask or other form of facial disguise. Facial recognition has some advantages in specific situations, when the suspect cannot hide his face (while a person wearing gloves might not be observed by others, a person wearing a mask is easily recognized and

identified as a threat), the method becomes unreliable if the suspect's face is caught on film at an angle of (usually) 20º or more. The main disadvantages for the eye identification (both iris and retina scans) is the very low distance necessary to collect data (in the order of centimeters).

4. ADVANTAGES OF USING GAIT ANALYSIS IN FORENSICS

Considering the main disadvantages of the most common human identification techniques, we feel that Gait Analysis would successfully fill a gap in the area of human identification methods for forensics. It is very hard to hide the motion of an individual, or to modify or cover his body segments (for example, modifying the length of the arm - the segment from the elbow to the shoulder - is close to impossible). The distance needed for capturing the data is decent, in order of meters (in our experiments we found that serious loss of information happens at more than 3 meters). Like the other commonly used human identification techniques, a Gait Analysis system for forensics would capture the motion of individuals, write the data in a database and then use the „event" data (data captured at a crime scene) in order to identify potential suspects from the database.

5. CONCLUSIONS

The human identification techniques commonly used today suffer from major issues. Gait Analysis is an area which can be researched in order to resolve those issues and therefore improve the forensic human identification techniques on the market today. To be able to use Gait Analysis in forensics, we have to prove that the motion patterns are specific for each individual.

6. FUTURE WORK

We aim to find an algorithm in order to prove that the motion patterns are specific for each individual. To be able to do that, we need to find out those motion patterns which are both stable and unique for each individual. Stability means that a pattern remains the same for each individual, every time he performs motion in a normal manner. Uniqueness means that the same pattern, compared between multiple individuals, brings sufficient differences between those subjects for them not to be confused with each other. After determining the unique identifiers, we aim to develop a complete solution of an human identification system based on Gait Analysis (a hardware-software solution starting from implementation, to data capture and analysis and ending with human identification).

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