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The Art of Emotions

Introduction

The study of human facial expressions is one of the most challenging puzzles not only in the science community but also in society. Every facial expression someone makes is generated by non-rigid object formations in the muscles underneath the skin and these formations are unique for every individual. Facial recognition systems have been designed since the 1960s and built to implement a way to make recognizing these human facial expressions easier. In this paper I will talk about Facial Action Coding systems and how they work with facial recognition systems to recognize human facial expressions as well as what they are currently being used for and where scientists plan to take them.

What Are Facial Expressions?

A facial expression is a combination of certain distinct motions of the muscles hidden below the surface of the face. According to a set of possible theories, the movements of the muscles under the skin convey the possible emotional state of the individual to the person they are communicating with. Facial expressions are a unique form of non-verbal communication. They are a means of communicating social information between not only humans, but also in other mammals as well as some other animal species.

Facial recognition is an emotion ridden experience for the brain. The amygdala is an almond shaped part of the frontal portion of the brain located by the hippocampus. It is the

control center for emotions, emotional behavior and motivation, and is also highly involved in the process of recognizing emotions. The eyes can be viewed as important and critical features of facial expressions. Looking at certain aspects of the eyes such as a person's blinking rate can be used to determine whether that person is acting nervous or whether they could be potentially lying. The amount of eye contact someone does can also be considered a very important aspect of communication between people. However, there are many cultural differences that regard the levels of how appropriate it is to maintain eye contact or not.

History of Facial Recognition Systems

A facial recognition system is a computer application that was created to help identify and verify a person out in the community from a photo image or a specific video frame that was collected from a video source. One of the ways the system is able to do this is by comparing the selected facial features from the image and then compare that to the given facial database. There are two kinds of facial recognitions systems that have been present in the history of facial recognition systems. The first being two-dimensional facial recognition and the other, three-dimensional facial recognition. Before the advent of faster computers and complicated imaging software, two-dimensional facial recognition systems were the only systems that were being used. The main problem that arose from this type of facial recognition system was that the person that needed to be identified had to have their face turned at no more than 35 degrees for the camera to accurately make the identification. Other problems such as light differences and varying one's facial expressions were some of the main contributions to low accuracy in identifying a person accurately in such systems. Fortunately, a more flexible version of facial recognition system was created, three-dimensional recognition systems. This new kind of facial recognition systems make use of three-dimensional images that are a lot more accurate than the

ones that were being used in the two-dimensional systems. Just like the two-dimensional facial recognition systems, these systems made use of individual features that were present in a human face and use them as key identifiers to create a face print of a person. However, unlike the two-dimensional face recognition systems, these systems had the ability to recognize a face even when it was being turned a whole 90 degrees away from the camera lens. They also were not as affected when there was a difference in the surrounding light and any possible changes in the facial expressions of the subject.

What Is A FAC?

Facial Action Coding System or FACs is a system that is used to categorize certain human facial movements just by their appearance on the face. FACs were based on a system that was originally created and then developed by an anatomist by the name of Carl-Herman Hjortsjö. Hjortsjö's work was then adopted later by two scientists, Paul Ekman and Wallace V. Friesen, who then published their own work in 1978. The unique movements of the individual facial muscles are monitored and then encoded into the FACS. It is a standard for the scientist running the FACs to categorize the different physical expression of emotions and then put those into a database. Due to individuality and time constraint issues, FACS have then been established as an automated computer system that will detect faces in videos or images, extract the unique features of the faces, and then produce the different profiles of each facial movement.

How does the FAC System work?

The Facial Action Coding system takes every single part of a person's face and then it will break it down into all of the different possible combination of movements. Each separate movement of the muscles is given its own action unit number. For example, a single movement of an inner eyebrow raise has an action unit (AU) number of 1, while the movement of a cheek

has an AU number of 6, and a simple lip corner movement will result in an AU number total of 12. There are a total of 46 basic AUs in the face and a whopping 100 AUs have been identified in total. Every facial expression is made up of the possible combinations of their AUs. If the code of AU-6 and AU-12 showed up as a combination together, it would represent the expression of a sincere smile. The system also recognizes the possibility of differing levels of an expression intensity with the use of a letter (A-E). The possible range of the expression can be from a trace of the action occurring (A) all the way up to the extreme or maximum movement of that facial muscle (E). For example, an extreme inner eyebrow raise would be represented by a code of 1E. The 1 representing the eyebrow raise while the E represents that the action was the extreme or maximum of that individual movement. The FACs provides for an automated computer model of the different mechanisms of an individual face as well as making life much easier for creators of artificial intelligence applications. The system provides a way to replicate the face's movements so all the AI creators simply need to do is go and create a script that will depict the different movements of each AU. Once they have created this series of movements, they will be able to easily join all of the movements together to create many realistic facial animations for either their software or robots.

Where Are Facial Recognition Systems Currently Being Used?

Facial recognition systems are being used in a handful of places around the world. A few examples that I have looked into are crime fighting, problem gambling, taking attendance at schools, finding underage drinkers, and catching thieves. Facial recognition systems can be used as a crime-fighting tool. Law enforcement agencies can use these systems to be able to recognize criminals based on how their eyes and face look. An example of this software is MORIS (Mobile Offender Recognition and Information System). MORIS is a handheld device that uses

biometrics and can be easily attached to a smartphone. All the officer has to do is just snap an image of the individual in question and if the person has a criminal background, the software will send it to the phone. Another way facial recognition systems are being helpful are to help problem gambling. The Ontario Lottery and Gaming Corporation has recently gone around and installed facial recognition technology at its slots located at Rideau Carleton Raceway in hopes to help problem gamblers. What this system does is go through the database and match the faces of whoever is playing at the slots with the images of self-proclaimed problem gamblers. If there is a match, the owners are alerted of the problem gamblers presence. On a more fun note, in the United Kingdom, The City of Ely Community College has started to use a facial recognition system to go through and call roll of the students for each class. This new system scans the faces of each student with an infra-red light and matches them up with the archived images in the school's database. A really important new use of the facial recognition systems is to help identify underage drinkers. Underage drinkers can now be easily identified through the use of facial recognition technology. It works by installing face recognizing cameras to help the staff prevent selling alcohol to minors who try to use fake IDs. The system has collected a database of customers' pictures and will alert the cashiers if it recognizes an individual who has been unable to prove he or she is 18 before. The final example of facial recognition systems I looked into was to help the prevention of theft and fraud. A few states like New York have started to use facial recognition technology to help catch identity thieves and other criminals who are attempting to commit fraud. These criminals try to get driver's licenses to help aid them in their attempt in fraud and facial recognition can be a powerful tool to stop these imposters.

What Are the Flaws in the Software?

With any kind of computer software, there are always flaw in it. There are a wide range of flaws

in facial recognition systems but I will focus on four flaws including privacy, plastic surgery, hackers, and accessories. In the first issue of privacy, the idea of uploading an image of yourself that will go into an enormous database isn't the most ideal situation that everyone is going to be up for. While the usual method of having a card and using a PIN system allows the user to have greater control over their privacy. There is also the issue of creating the database in the first place which is going to end up using a lot of time and money as well as the possibility of the records getting hacked or tampered with. Then there is the second issue, the possibility of a person undergoing plastic surgery that will alter how their face looks. The facial recognition software will have difficulties working if an account holder undergoes plastic surgery, or somehow suffers disfigurement as a result of an accident. It will have a hard time recognizing the person because their face isn't the same as the one that was stored in the database. There's also the important issue that criminals would be willing to undergo plastic surgery in order to impersonate another person and then go empty their bank accounts. The third flaw in the facial recognition software is the possibility of hackers of any kind. There was a case where a handful of researchers were able to crack into the biometric authentication embedded in Lenovo, Asus, and Toshiba laptops. They were able to do this by spoofing the biometric systems by using a photo of the authorized user and then they also used brute-force hacking with the use of fake facial images. They were able to successfully bypass the securities of Lenovo's Veriface III, Asus' SmartLogon V1.0.0005, and Toshiba's Face Recognition 2.0.2.32. Each laptop was set to its highest possible security level. This demonstrates the different vulnerabilities in the systems that could lead up to an attacker cheating the laptop securities with false photos of the user and gaining access to all the documents on the laptops. The last flaw with facial recognition systems is that some systems have a hard time accurately reading someone's face depending on what they are currently

wearing, the lighting around them or if they vary their facial expressions. Some examples of accessories that render the system useless are when people wear sunglasses, have long hair, or objects covering their face. If there is poor lighting or when people vary their facial expressions such as changing their smile, it makes it difficult for the software to read the face and accurately identify them.

Where Do They Plan to Take It?

There are a few places that scientists plan to take facial recognition systems. Scientists have started to alter the software in a way that hospitals would use it on children to determine their pain levels. Children have a harder time communicating how they feel in general and especially when it comes to them being in pain. What the software will do is analyze the child's face and then compare it to a database of children's expressions to determine what level of pain the child is having regardless of the child being able to communicate it or not. Scientists are also trying to add a few different features to the facial recognition software. A few options they are currently trying out are adding the ability to have audio, video, and gesture to the software. The audio and video would be able to help law enforcement agencies solve crimes because not only will they have the facial images but they will also have audio to match to the criminal.

Conclusion

Facial recognition systems were built to help make reading human facial expressions easier as well as assist in a handful of other operations such as catching criminals, take class attendance, and identify underage drinkers. Facial recognition systems use facial action coding to run. FACs use action units to identify the expression a person is using and if it is a trace or extreme movement of that muscle. Even though there are flaws such as hackers getting into the

database and possibilities of people undergoing plastic surgery, scientists hope to continue to advance the software to aid in hospital and law enforcement uses.

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