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Crime Detection and Criminal Recognition to Intervene in Interpersonal Violence Using Deep Convolutional Neural Network With Transfer Learning

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ABSTRACT

Interpersonal violence, such as physical and sexual abuse, eve-teasing, bullying, and taking hostages, is a growing concern in our society. The criminals who directly or indirectly committed the crime often do not go into the trial for the lack of proper evidence as it is very tough to collect photographic proof of the incident. A subject's corneal reflection has the potentiality to reveal the bystander images. Motivated with this clue, a novel approach is proposed in the current paper that uses a convolutional neural network (CNN) along with transfer learning in identifying crime as well as recognizing the criminals from the corneal reflected image of the victim called the Purkinje image. This study found that off-the-shelf CNN can be fine-tuned to extract discriminative features from very low resolution and noisy images. The procedure is validated using the developed datasets comprising six different subjects taken at diverse situations. They confirmed that it has the ability to recognize criminals from corneal reflection images with an accuracy of 95.41%.

KEYWORDS

Criminal Identification, Deep Convolutional Neural Network, Interpersonal Violence, Purkinje Image

1. INTRODUCTION

Interpersonal violence, usually referred to as the intentional use of physical force or power, threatening, psychological torture, or deprivation by someone against another individual (Mayo Clinic, 2017). It is a growing concern in our society as children and adolescents are more likely to be targeted, but anyone can be a victim of this brutality including women, children, and disabled persons. It might

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not be easy to identify these types of violence because it is very hard and sometimes impossible to collect the evidence during the offense. Also, these types of crimes often start subtly and get worse over time. For these reasons, the victims may suffer lifelong consequences. For example, kids who get bullied are more likely to suffer from clinical anxiety, depression, and feelings of social isolation. They usually tend to avoid school, and eventually, these continuous chronic strain makes them physically sick (Nansel, Craig, Overpeck, Saluja & Ruan, 2004). Moreover, the chances of being suffered from agoraphobia, panic disorder, and anxiety are 3 to 5 times higher for adults due to these reasons (Copeland, Wolke, Angold & Costello, 2013).

Social awareness programs as well as necessary laws are enforced but criminals are often getting unpunished for the lack of proper evidence. In all the above-mentioned incidents, photographs play a very crucial role in criminal investigations. If photographs (face images) can be taken during the incident, then it gives us a visual knowledge of the offender as well as the surrounding environment that is desirable to identify the crime as well as criminals. Recently, Jenkins and Kerr (2013) performed a primitive investigation through the conventional method on the detection of bystanders from the corneal reflections of a subject known as Purkinje images (Sigut & Sidha, 2011). However, a detailed study of practical perception is not performed yet. Due to technological advancements capturing these images is possible through an IoT-based tiny camera and can be processed using deep learning. Motivated by this research gap we are trying to investigate on criminal identification from the corneal images with advanced technologies. The current paper focuses on the very crucial work on detection and recognition of faces of the criminals from the Purkinje images as these are of low resolution and poor quality.

Moreover, there are lots of variations in image appearance, such as pose variation (front, non-front), occlusion, image orientation, illuminating condition, and facial expressions. Nowadays, computer vision has numerous applications in every sector of our life, such as load forecasting for smart grid (Mukherjee, Mukherjee, Dey, De & Panigrahi, 2020), prediction of possible health issues (Mukherjee & Mukherjee, 2019), intelligent sensing (Mukherjee, Panja & Dey, 2020), etc.

Recently, deep learning through deep convolutional networks (CNNs) show promising results in object detection and classification (Chen, Li & Li, 2020). The deep CNN approach has been gained significant improvement in face detection (Garcia & Delakis, 2002; Osadchy, Cun & Miller, 2007), facial point detection (Sun, Wang & Tang 2013), human attribute inference (Zhang, Paluri, Ranzato, Darrell & Bourdev, 2014), plant phenotyping (Jiang & Li, 2020), organism detection (Huang et al., 2019) and in many other applications. These models achieve state-of-the-art results on several data sets and can enhance the success rate of criminal identification as compared to conventional as well as other shallow machine learning methods. However, currently, no work has done so far using deep CNNs. So, a method is proposed here that takes face images from the corneal reflections and after pre-processing trains using the off-the-self CNN along with transfer learning.

The contributions of this work are summarized as follows:

1. Criminal identification and recognition through benchmark CNN methods have been implemented to reduce interpersonal violence.
2. Transfer learning is applied to retrain CNN models to handle the problem with fewer efforts and improved accuracy.
3. Developed a dataset of 6000 unconstrained images of six different subjects (1000 of each category).
4. Robustness of the technique is tested using noise, occlusion, rotation, and low-resolution images.

The rest of the paper is assembled as follows: a literature review is presented in Section II. Section III consists of methodology along with the description of the dataset. Experimental results and discussions are described in Section IV. Eventually, it is concluded in Section V.

Query Optimization: An Intelligent Hybrid Approach using Cuckoo and Tabu Search

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