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RESEARCH ARTICLE

FORENSIC INVESTIGATION- A TOOL FOR CLASSIFICATION OF GENDER

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ABSTRACT

Gender classification problem is an active research area which has attracted a great deal of attention recently. It is a challenging pattern recognition problem. Generally gender classification involves a process of determining the gender. Gender is among the strongest predictors of crime, particularly violent crime. Arrest, self-report, and victimization data consistently show that men and boys commit significantly more crime, both serious and not, than women and girls. This pattern persists despite data indicating that crimes committed by females may be rising. Evidence also suggests that males are generally more aggressive than females, even before the preschool years. A multidisciplinary approach to crime is crucial for understanding both why crime occurs and the conditions for any possible gender differences. Sometimes during the course of a criminal investigation and its subsequent autopsy the pathologist may find his or herself faced with the task of identifying the gender after decomposition. Obviously before decomposition there are detailed differences between the formations of a male or a female but once decomposition has taken a hold and carried out the unpleasant tasks that nature has intended, all that remains is the skeletal form with teeth and possibly some hair to work with. This paper suggests method for classification of gender since it plays an important role for understanding behavioral pattern of crime.

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INTRODUCTION

Gender-based crimes are those committed against persons, whether male or female, because of their sex and/or socially constructed gender roles. Gender-based crimes are not always manifested as a form of sexual violence. They may include non-sexual attacks on women and girls, and men and boys, because of their gender. The current Compact English Oxford Dictionary defines gender as "1. a class (usually masculine, feminine, common, or neuter) into which nouns and pronouns are placed in some languages. 2. the state of being male or female (with reference to social or cultural differences). 3. the members of one or other sex." Regarding usage, it states: "The words gender and sex both have the sense 'the state of being male or female', but they are typically used in slightly different ways: sex tends to refer to biological differences, while gender tends to refer to cultural or social ones." In the social sciences, the term 'gender' has been introduced to refer to differences between women and men without strictly biological connotations – socially constructed differences that correspond to the two sexes although they are not caused by biological sexual differences. Gender relations are the rules, traditions and social relationships in societies and cultures that determine what is considered 'feminine' and 'masculine', and how power is allocated between, and used differently by, women and men. Gender refers to a social construction of femininity and masculinity that varies over time and place and is enacted through learned, rather than innate, behavior. The great value of 'gender' as an analytical concept is that it directs attention towards social and cultural processes and interventions in terms of their differential effects on women and men, and the relationships between women and men. In this context, gender does not look at women in isolation, and enables differences between women and men, and between different 'identities' and groups of women (due, for example, to class, race, ethnicity, age, ability and sexuality) to become visible. The results of the Biosocial Study confirmed past research which had demonstrated gender differences in the prevalence of crime. Males engaged in more crime and violence than females, and they were more likely to repeat their crimes. However, the Biosocial Study also corresponded with some research and theory which had indicated gender differences in the prediction of crime. With some exceptions, biological

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factors were found to be more predictive of crime among females, whereas environmental factors were found to be more predictive of crime among males.' Also, more factors overall were correlated with crime among females than males. Gender differences in the prediction of crime may substantially affect differences in prevalence. Gender becomes particularly important when assessing the "criminal careers"80 of individual offenders, because predictive influences may vary depending on an individual's age and physiological development. An analysis of a criminal career focuses on two key elements: (1) participation-the difference between those who do or do not commit a crime; and (2) frequency-the number of crimes an active offender commits.81 Certain factors, such as the offender's age at the initiation of a criminal career, the escalation and desistance of the offender's criminal behavior, and the policy approaches for restraining criminal careers, are influential in determining the onset and continuation of criminal careers. 'Gender-based violence' and 'violence against women' are terms that are often used interchangeably as most gender-based violence is inflicted by men on women and girls. However, it is important to retain the 'gender-based' aspect of the concept as this highlights the fact that violence against women is an expression of power inequalities between women and men.

Gender perspective requires an understanding of differences in status, power, roles, and needs between males and females, and the impact of gender on people's opportunities and interactions. This will enable the Crime Office to gain a better understanding of the crimes, as well as the experiences of individuals and communities in a particular society. Gender-based crimes and sexual violence originate in the pre-existing social, political and cultural context in which women live. Gender-based crimes are exaggerated in armed conflict as tolerance to violence increases, and as communities begin to accept violence as a legitimate way of expressing anger, asserting ethnic dominance, addressing historical (perceived or actual) injustices, claiming political and financial control, and resolving conflict. Women's vulnerability during armed conflict is compounded by traditional attitudes to women's rights. The pre- existence of gender inequality and violence towards women in a community provides the context for targeted violence against women in armed conflict and war, and also impacts upon efforts to address gender based crime in armed conflict. Understanding the extent and operation of that violence is a fundamental step in assisting women victims and survivors who seek to be dynamic and self-determining in the process of justice and in their rehabilitation. Our task in this paper to analyze Gender for underlying differences and inequalities between women and men, and girls and boys, and the power relationships and other dynamics which determine and shape gender roles in a society, and give rise to assumptions and stereotypes. In the context of the work of the Office, this involves a consideration of whether, and in what ways, crimes, including sexual and gender-based crimes, are related to gender norms and inequalities.

Review Works

Over the period of time, classification of gender has gained enormous significance and has become an active area of research in criminal investigation. Many researchers have put a lot of effort and have produced quality research in this area. Still, there is an immense potential in this field because of its utility in many areas like monitoring, surveillance, commercial profiling and human-computer interaction. Security applications have utmost importance in this area. The significance of Gender Recognition and its Classification has been recognized and greatly identified in the field of research and development since the inception of research work on this field at the beginning of 1990s. Initially Golomb *et al*. (1990) used multi -layer neural network to generate a solution to the problem of gender classification. The facial image was manually aligned for the experimental purpose. Around 900 unit images were squeezed into 40images on which the classification was performed. An error rate of 8.1% was reported. En-Sheng Chu *et al*. (2010) performed yet another experiment on the same problem by considering un-aligned face image, which uses only single face from which various poses were cropped and were combined into a set. The image set were converted into subspaces and correlation coefficient was used to generate the similarity between two subspaces. They used discriminate analysis of Canonical Correlation (DCC) for finding most accurate gender. FERET and MORPH face database were used for the experiment. Shobeirinejad and Gao (2010) proposed Interlaced Derivative Pattern (IDP) to extract facial features.IDP produces feature vector by extracting distinctfacial features. The IDP image is a four-channel derivative image representing four directions that are 0°, 45°, 90°, and 135°. Thus this method contains more important information about gender face recognition. LU *et al*. (2009) detected different facial regions to accomplish the task of gender classification. Support Vector Machine (SVM) (Gregory Shakhnarovich Paul and Viola Baback Moghaddam, 2002) classifier was used on face images.

Facial parts Identification is a technique that is mainly used to identify gender of criminals based on the clues given by the eyewitnesses. It is evident that facial parts detection plays an important and critical role for the success of any face processing systems. The face detection problem is challenging as it needs to account for all the possible appearance variation caused by change in illumination, facial features, occlusions, etc. In addition, it has to detect faces that appear at different scale, pose, with in plane rotations. Often the size of the image is very large, the processing time has to be very small and usually real-time constraints have to be met. Therefore, during the last decades there has been an increasing interest in the development and the use of parallel algorithms in image processing. Face detection is attached with finding whether or not there are any faces in a given image (usually in gray scale) and, if present, return the image location and content of each face. This is the first step of any system that analyzes the information contained in faces (e.g., identity, gender, expression, age, race and pose). Facial images are probably the most common biometric characteristic used by humans to make a personal recognition (Vending machines recommend based on face recognition, 2011; Jain *et al*., 2004). The face region, which may include external features such as the hair and neck region, is used to make gender identification. The image of a person's face exhibits many variations which may affect the ability of a computer vision system to recognize the gender.

We can categorize these variations as being caused by the human or the image capture process. Human factors are due to the characteristics of a person, such as age, ethnicity and facial expressions (neutral, smiling, closed eyes etc.), and the accessories being worn (such as eye glasses and hat). Factors due to the image capture process are the person's head pose, lighting or illumination, and image quality (blurring, noise, low resolution). Head pose refers to the orientation of the head relative to the view of the image capturing device. The human head is limited to three degrees of freedom, as described by the pitch, roll and yaw angles (Murphy-Chutorian and Trivedi, 2009). The impact of age and ethnicity on the accuracy of gender classification has been observed. Benabdelkader and Griffin (9), after testing their classifier with a set of 12,964 face images, found that a disproportionately large number of elderly females and young males were misclassified. In empirical studies by Guo *et al*. (2009) using several classification method on a large face database, it was found that gender classification accuracy was significantly affected by age, with adult faces having higher accuracies than young or senior faces. In (Gao and Ai, 2009), when a generic gender classifier trained for all ethnicities was tested on a specific ethnicity, the result was not as good as a classifier trained specifically for that ethnicity. After the face is segmented from the image, some preprocessing may be applied. It helps to reduce the sensitivity of the classifier to variations such as illumination, pose and detection inaccuracies. Graf and Wichmann (2002) pointed that cues such as brightness and size will be learnt by the classifier such as SVM to produce artificially better performance. Preprocessing that may be applied to the face image include: ─ Normalize for contrast and brightness (e.g. using histogram equalization) ─ Removal of external features such as hair and neck region ─ Geometric alignment (either manually or using automatic methods) ─ Downsizing to reduce the number of pixels For efficiency, it is preferable that the face image does not undergo alignment as it requires significant time (Shakhnarovich *et al*., 2002). In a study by Mäkinen and Raisomo (2008), it was found that automatic alignment methods did not increase gender classification rate while manual alignment increased the classification rate a little. They concluded that automatic alignment methods need to be improved. Also, alignment is best done before downsizing. If alignment is not done, deliberately adding misaligned faces to the training data seems to help make the classifier robust to face misalignments (Mayo and Zhang, 2008).

Proposed Method

Image processing is referred to processing of a 2D picture by a computer. An image may be considered to contain sub-images sometimes referred to as regions-of-interest, ROIs, or simply regions. This concept reflects the fact that images frequently contain collections of objects each of which can be the basis for a region. Before going to processing an image, it is converted into a digital form. Digitization includes sampling of image and quantization of sampled values. After converting the image into bit information, processing is performed. These processing techniques are image preprocessing, Image enhancement, Image reconstruction, and Image compression. Preprocessing functions involve those operations that are normally required prior to the main data analysis and extraction of information, and are generally grouped as radiometric or geometric corrections. Image Enhancement refers to accentuation, or sharpening, of image features such as boundaries, or contrast to make a graphic display more useful for display & analysis. This process does not increase the inherent information content in data. It includes gray level & contrast manipulation, noise reduction, edge crispening and sharpening, filtering, interpolation and magnification, pseudo coloring, and so on. Image Restoration is concerned with filtering the observed image to minimize the effect of degradations. Effectiveness of image restoration depends on the extent and accuracy of the knowledge of degradation process as well as on filter design. Image restoration differs from image enhancement in that the latter is concerned with more extraction or accentuation of image features. Image Compression uses with minimizing the number of bits required to represent an image. Application of compression are in broadcast TV, remote sensing via satellite, military communication via aircraft, radar, teleconferencing, facsimile transmission, for educational & business documents , medical images that arise in computer tomography, magnetic resonance imaging and digital radiology, motion , pictures ,satellite images, weather maps, geological surveys and so on. Image Classification and Analysis operations are used to digitally identify and classify pixels in the data. Classification is usually performed on multi-channel data sets and this process assigns each pixel in an image to a particular class or theme based on statistical characteristics of the pixel brightness values. There are a variety of approaches taken to perform digital classification. The two generic approaches which are used most often are supervised and unsupervised classification.

Self-Organizing Map (SOM) is a well-known artificial neural network, which uses unsupervised learning process. Here the learning process is dependent on the input data, which is known as unlabeled data and is independent of the desired output data. The success rate of SOM network is dependent on the number of training data we are using, higher training data means higher success rate. SOM can also be termed as topology preserving map. There is a competition among the neurons to be activated and only one neuron that wins the competition is fired and is called the "winner". Kohonen rule is used to learn the winner neuron and neurons within a certain neighborhood of the winning neuron. This rule allows the weight of neuron to learn an input vector so this makes it perfect for recognition. Hence in this system SOM is used as classifier. In our proposed approach we populate the training data set with 40 training images. As we are doing gender recognition, we need to store images for every gender. In our proposed approach we have used twenty different types of images for each gender. The following algorithm first divided image into different parts. Next compare each part with the existing database to search for the best match.

Algorithm 1:

Step 1: Split the image into six equal parts as hair, forehead, eyes, nose, mouth, and chin.

Step 2: Now the face has been divided into individual parts, which is an easy way to create new faces and match the criminal with the database.

Step 3: Use these individual parts to create new faces as per opinion of the eye-witness.

Step 4: Compare all the face partitions with the database available. It would generate a list of matched responses from the database i.e. may be more that one.

Step 5: Initiate a process of comparison to match the complete image with the images which are having some similarities so that we could get the most suitable suspect from the available database among all the suspects.

Step 6: Thus with recursive match computations done to all the parts of the image against database images, we arrive at a particular image which showcases maximum match.

The following figures shows extraction of different parts from face of a body found in a crime location.

Fig. 1. Original grayscale image

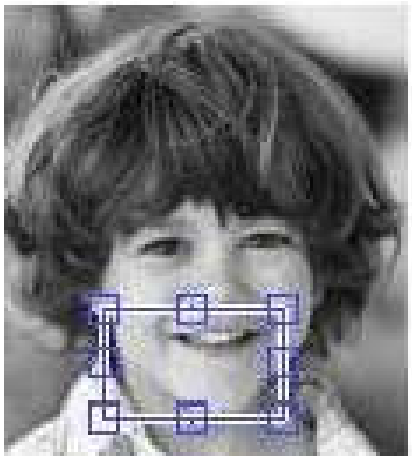

Fig. 2. Detected region of interest

Fig. 3. Extracted feature

The following algorithm finds gender for criminal investigation from crime scene.

Algorithm 2:

Step 1: Read Input Image Set.
Step 2: Metamorphose individual image to grey scale.
Step 3: Extract the primary features from the facial image.
Step 3.1: For each extracted feature image, we perform the following steps.
Step 3.1.1: Reshape the extracted image from 2D to 1D.
Step 3.1.2: Generate a Feature Vector for each extracted feature image(s).
Step 3.1.3: Associate with each image that is for each row vector, a class label. Assign +1 to female image and -1 to male image.
end
Step 4: Shuffle the Feature Vector matrix.
Step 5: Perform cross-validation of the shuffled matrix and generate the train data set and the test data set.
Step 6: Select appropriate kernel functions and the kernel parameters of the SVM classifier and train the appropriate known data set.
Step 7: Apply test method of SVM to test the unknown data set.
Step 8: Obtain the resultant classified data.

RESULTS

The following diagrams will show how the concept of SOM is applied in gender recognition. Here we use two patterns „Male‟ and „Female‟. In our system we have used 100 male training face images for male pattern and 150 female training face images for female pattern. When an input face image is given, we will look for a face image that will best match the input image. In the following diagram, the left-hand side image is the input face image, and the right-hand side image is the training database image, which best matches the input image. As the gender tag associated with the training face image is „Male‟ we can say that the gender pattern of the input image is „Male‟ (Fig. 6). Figure 9 will reflect the same concept for female gender.

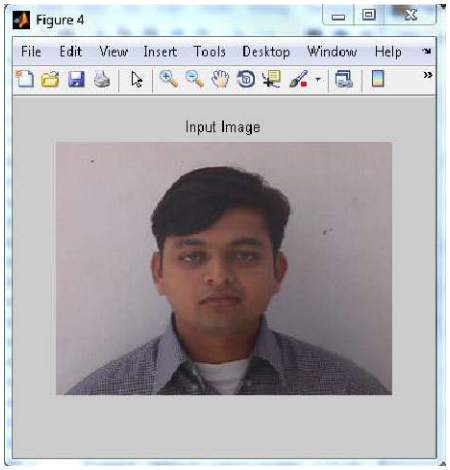

Fig. 4. Input image

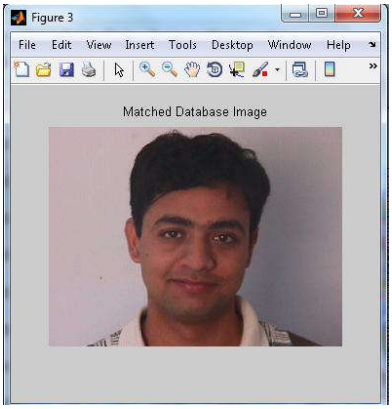

Fig. 5. Matched database image

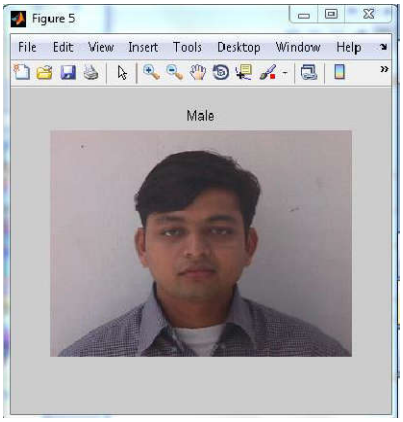

Fig. 6. Input image with gender details in the top

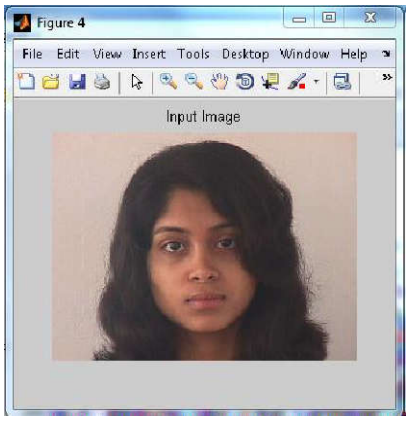

Fig.7. Input image

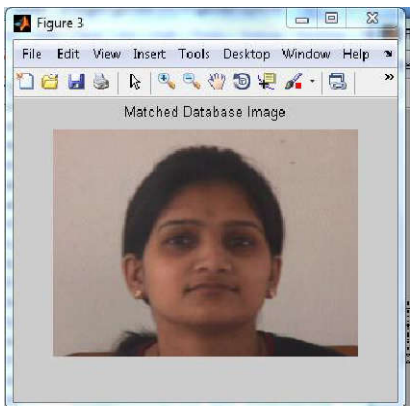

Fig. 8. Matched database image

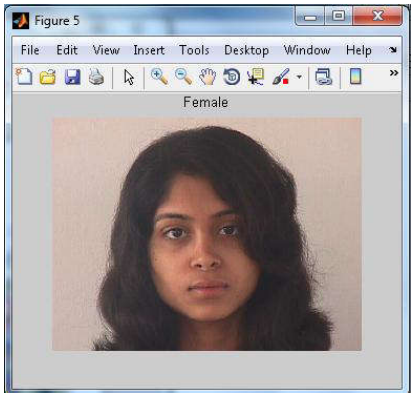

Fig. 9. Input image with gender details in the top

Conclusion

The majority of girls and women involved in the criminal justice system have committed ordinary crimes—mostly minor thefts and frauds, low-level drug dealing, prostitution, and misdemeanor assaults against their mates or children. Some of them commit crime over several years and serve multiple jail or prison terms in the process. But they are not career criminals, and women are far less likely than men to be involved in serious crime. These generalizations hold true regardless of data source, level of involvement, or measure of participation. The gender gap for criminal offending is remarkably persistent across countries, population subgroups within a given country, and historical periods. This persistence can be explained in part by historical durability of the organization of gender and by underlying physical/sexual differences (whether actual or perceived). Human groups, for all their cultural variation, follow basic human forms. Self-Organizing Map has been proven as a great approach in face recognition, facial expression recognition. Now SOM can also be used efficiently in gender classification. Not only gender classification, SOM can be used in any type of pattern classification problem.

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