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A FRAMEWORK FOR TRACKING CRIMINALS USING IMAGE-BASED HEIGHT DETECTION TECHNIQUES

Oyekanmi E.O[1], Oluwadare S.A[2], Alese B.K[2]

[1]*Department of MATHS/STAT/CIS,*
Achievers University, Owo,
Ondo State, Nigeria
ezekny@yahoo.com

[2] *Department of Computer Science,*
The Federal University of Technology,
P.M.B. 704, Akure, Ondo State, Nigeria
Samoluwadare2013@gmail.com

Abstract

In recent times, the problem of terrorism has approached a global dimension. The operation of terrorists are indiscriminate. Hence, tracking them requires careful planning, preparation and cooperation among security operatives and nations. Since terrorists have sinister motives, they often hide their identities or use falsified identities. In order to forestall terrorist's attacks, intelligence and warning systems are put in place for detecting and preventing future attacks. In this study, we present a framework for tracking criminals using imaged-based height detection techniques. The framework involves four case studies of different postures. An algorithm was developed to capture the intrinsic parameters. The model developed was able to detect, both in the local as well as global, a person's height with no fore-knowledge of the zooming rate with which the picture was taken. Matlab R2009a was used as a programming tool in the implementation of the developed algorithm.

Keywords: Height detection, image-based, criminal tracking, terrorism

1. Introduction

This study deals with a framework for criminal height detection via submitted image of the person. The proposed method provides a new approach to anomalous person's height detection via calibrated camera. Different approach had been used for background elimination modeling in the past, but Pixel level density difference of the criminal (pdd) is used to determine his/her height from the image frame. The measured pdd is modeled on the submitted person's full picture, taking into consideration both the *intrinsic* and the *extrinsic* parameters of the objects in the submitted frame. Scene model is used to determine the snapshot distance of the object. An algorithm is developed to capture the intrinsic parameter which is our major priority to achieving our aim. Criminal detection could be very difficult and challenging task for security agencies especially in a situation where the crime-person is showing chameleon-action in posture since the criminal may use mask or other forms of disguise. Hence, face-recognition may not be effective in detecting him/her.

There is therefore, the need to ensure that resources being committed to new technologies that are aimed at tracking criminals do not go down the drain. Also, any technology being introduced to track criminals does not generate false positives that would subject innocent persons to unnecessary scrutiny that could impinge on their rights and freedom. Although, there are many tools and techniques in use for crime-person detection this paper

presents a new approach. Existing systems that perform person's identification and tracking have several advantages, but also have drawbacks. For instance, Roger Clarke (2004), reports that people's hands do not differ enough for [hand geometry] to be used as an identification system. The Economist (2003) posits that "around 5% of people do not have readable fingerprints". Leyden (2002) reports that comprehensive tests of 11 consumer-oriented biometric products showed that the devices were "more of the nature of toys than of serious security measures" and that large-scale application of iris technology (by the UNCHR in Afghanistan) has not been used to generate measures of reliability and quality.

Facial recognition is one of the soft-biometric means of tracking criminals, yet it has some drawbacks like eye colour which are easily influenced by light situation. Also, in the use of facial recognition it has been found that there could be a situation where a short person is having a tall face and vice-versa. Hence, it may not be used to judge accurately.

Height has been long used in forensic measures to detect possible suspects, it is however, not distinctive enough to be used in biometric identification. Hence, estimating the heights of the tracked subjects using any camera and assuming any distance in capturing could provide us with an important additional feature, thereby making the object tracking over different scenes more robust. For instance, (BenAbdelkader et. al., 2002) developed a parametric method to automatically identify people in low-resolution video by estimating the height and stride parameters.

In this case study, we focus on uncovering patterns of criminal identity deception based on actual criminal records and suggest an algorithmic approach to revealing deceptive identities.

This paper is organized as follows. Section 2 gives related work on this topic and brief overview of the system. Detailed explanations for each stage are discussed in Section 3. In Section 4, the implementation is presented. In section 5 the results and discussion are presented. The conclusion to the study was drawn in section 6.

2. Related Works

It is a common practice for criminals to lie about their personal data. Hence, the ability to validate identity can be used as a warning mechanism and the deception signals the intent to commit future offenses. Terrorists do not act alone but rather they operate in a network. They may be linked together through various social, ideological, religious and communication networks. This network may be complex to unravel. Hence, there is the need to properly understand the way relationships are formed or communication is maintained within or between terrorist groups. Previous studies have shown that the link structure of the web represents a considerable amount of latent human annotation (Gibson, 1998). Thus, by analyzing and visualizing hyperlink structures between terrorist-generated web sites and their contents, we could discover the structure and organization of terrorist group networks, capture network dynamics, and understand their emerging activities. So an intelligent web portal, called Dark Web Portal, to help terrorism researchers collect, access, analyze, and understand terrorist groups was developed (Chen and Reid, 2004).

Height detection of objects can be used both for soft-biometrics and as an object tracking feature. Unwanted area are eliminated and the focus object is extracted to determine the identification features (Jeges and Máté, 2006), and use it to search for similar subject in a smaller set of possible candidates. For object tracking, it can be used for temporal and spatial correspondence analysis as well or simultaneously for both in case of disjoint cameras (Madden and Piccardi, 2005).

Gait based identification also strives for extracting human height. The exploitation of gait can be seen in (Lv et al., 2002), where in the camera used is a calibrated one using a walking person. Some other interesting

methods of human height estimations can be found in the literature, like the one in (Bernardin et al., 2006), where the acoustic source localization of the speaking person is used for this purpose.

Also, anonymous motion sensors were used in rooms and switch sensors on daily-use objects, and resident activity models to identify and track their activities and locations. They propose using a particle filter that uses Markov state transition and sensor use models learned from short term training data, obtained using a tag and track approach or manual labelling. The main advantage of this approach is that the simple single-pixel sensors are cheap and easy to install, and are not perceived to be invasive or inconvenient. However, an important drawback of this approach is low accuracy: this system was reported to have 70% accuracy when 3 residents over a week-long period are used. These accuracy rates may be level-headed for some applications, but mystifying the identities of residents more than a third of the time could cause problems in the case of medical monitoring (Wilson and Atkeson, 2005).

a. Overview of Anthropometry

Since the time of Quételet, anthropometry, means the measurement of the entire human body (living or upon the dissecting-room table) with the view to determine the respective proportions of its parts" (Topinard, 1881). Between the end of the 19th century and the first decades of the 20th century, anthropometry was extensively employed in several fields (Landogna Cassone, 1950; Drusini, 1986) which include:

i. Forensics and criminal anthropology and the idea that science had to make its voice heard in court (Guarnieri, 1986). In Italy Cesare Lombroso (1835-1909), by employing the new anthropometrical instruments, wanted to prove that the aberrations of the moral sense and mind were related to body anomalies and especially of the skull (Lombroso, 1878; Bulferetti, 1975; Villa, 1985).
ii. The *Signalement anthropométrique* of Alphonse Bertillon (1853-1914) who set up an identification system based on physical measurements (Bertillon, 1891). This method was employed by several police to identify criminals.
iii. The Antropometria militare and the studies of Ridolfo Livi (1856-1920) to determine the propensity to military service (Livi, 1896-1905).
iv. The clinical anthropometry employed by constitutional medicine and especially in the Italian school of Achille De Giovanni (1838-1916).

b. Application of Anthropometry: Bertillon System

The French criminologist, Alphonse Bertillon, in 1879 developed a system for identifying people, especially criminals. Some of the anthropometric measurements recorded by this system are as follows:

i. **body**: height standing, reach from fingertips to fingertips, length of trunk and head, or height sitting;
ii. **head**: length and width, length and width of right ear;
iii. **limbs**: length of left foot, length of left middle finger, length of left little finger, length of left forearm. These measurements are recorded on cards and classified according to the length of the head. (Bertillon, 2007).

This approach is taken into consideration in getting the height of the criminal regardless of his/her positioning

3. System Design

The distance with which the snapshot is taken from the camera is first determined by measuring the upper point P_2 and lower point P_1 of the tracked object (person). These parameters are passed to the algorithm presented in the next section of this paper to get the camera distance of the object from the image frame.

The height of person is measured based on 2-D view image provided by obtaining the distance of the object using two markers. The first marker is placed at the top of the head (P_{x_2,y_2}) while the second marker is placed at the feet above the ground (P_{x_1,y_1}). The equation is stated as follows:

Given an Image frame

I | $\{P_{y_1}, P_{y_2} P_{y_3} \dots, P_{y_n}; P_{x_1} P_{x_2} P_{x_3}, \dots, P_{x_n}\}$ with dimension $\mathbf{I}_{dim}$; the camera distance C_d is calculated as

$$C_d = \frac{\Delta P}{abs(\mathbf{I}_{dim})} \quad (1)$$

$$H_o = \frac{C_d}{D_{ref}} + \tau \quad (2)$$

Where Ho is the object (Person's) height, D_{ref} is the defined distance reference value to capture the tallest and shortest person-2.23m. τ is the threshold value ±0.5

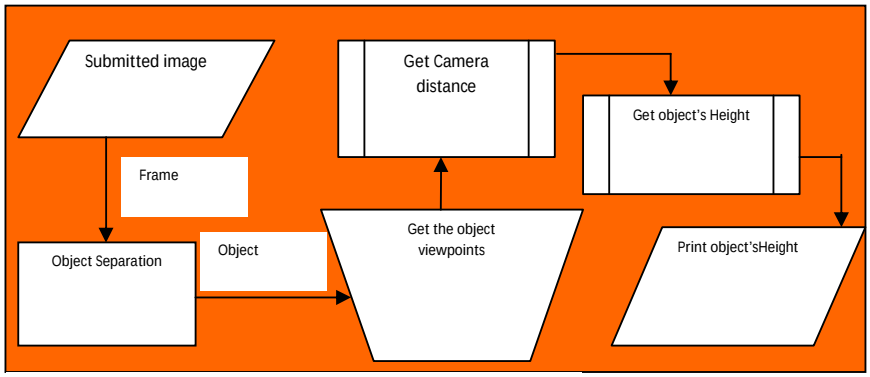

Figure 1: Architectural Design of the System

A lot of researches have been carried out on getting the focal length of an object from camera; two of the techniques used are discussed below:

i. Use of extrinsic parameter of the camera only. This involves the use of the view angle, under which the bottom of the object (the feet of the person) is visible, the altitude of the camera from the floor and the orientation of its optical axis (IstvánKispál, 2011).
ii. Calibrated camera to track the extrinsic parameter via different observation timing(Srinivasan, 2011).

However, with the use of Matlab software and image processing techniques the following steps (algorithm) was used the study:

1. Get an image file as input.
2. Read the image using imread() function of Matlab.
3. Manually select the Top point (head of the person) and the Bottom point of the object (feet of the person) if the object is standing uprightly to get the pixel length value ELSE
4. Use anthropometric measure method by Alphonse Bertillon to get the object pixel length value.
5. Get the image dimension.
6. Get the ratio of the distance measured in either step 3 or 4 above of the object and the actual length of the image in step 5
7. The Scale ratio in (6) is the camera distance.

b. Object's Height Estimation

What we deed was to convert the scale used to a defined scale ratio of 2.23m (our defined distance to capture the tallest and the shortest person) and the result is the object height value/estimation. The error value in this case is $\leq \pm 0.5$.

4. System Implementation

We simulated different person's images in different posture form into our algorithm using MATLAB with different camera pixel rating. The following results were obtained.

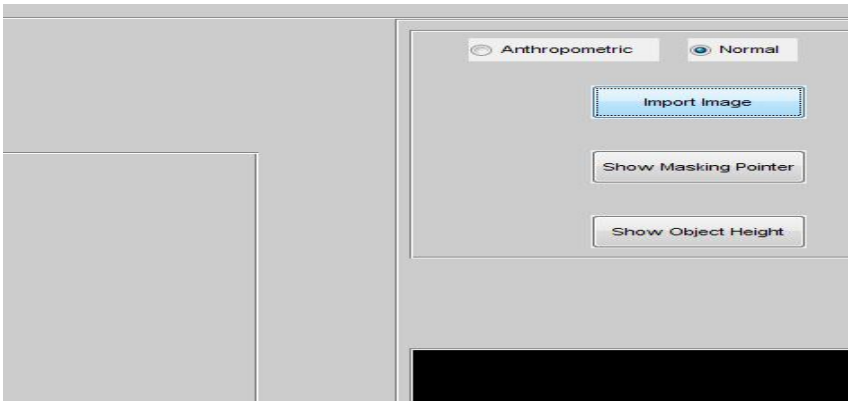

Figure 2: GUI of the Height detection System

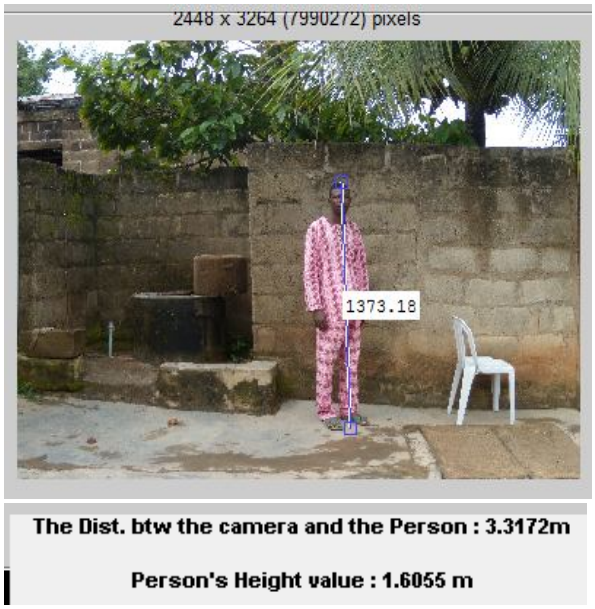

Figure 3a: Person's height while standing with 8.0MP Camera

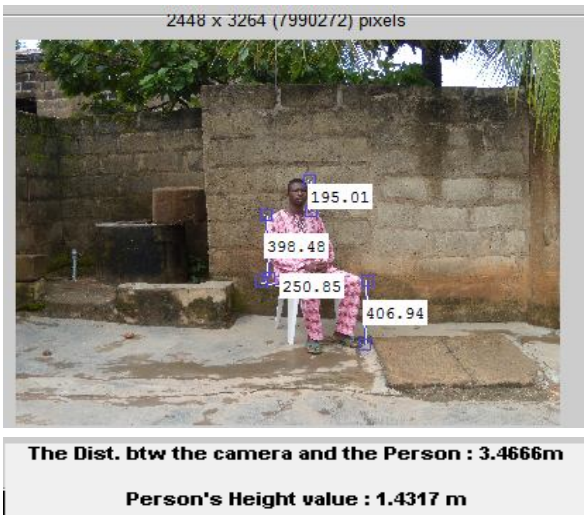

Figure 3b: Person's height while sitting with 8.0MP Camera

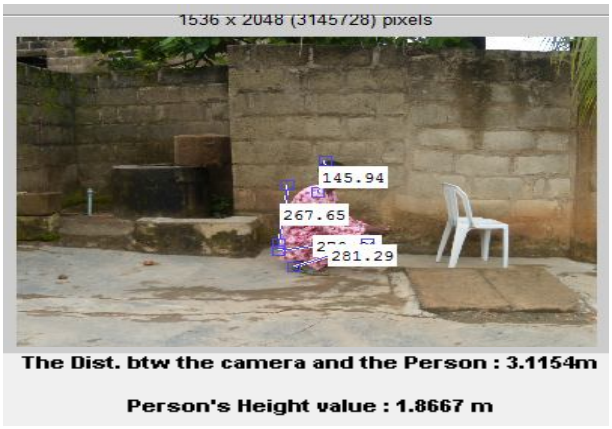

Figure 3c: Person's height on squared with 3.0MP Camera

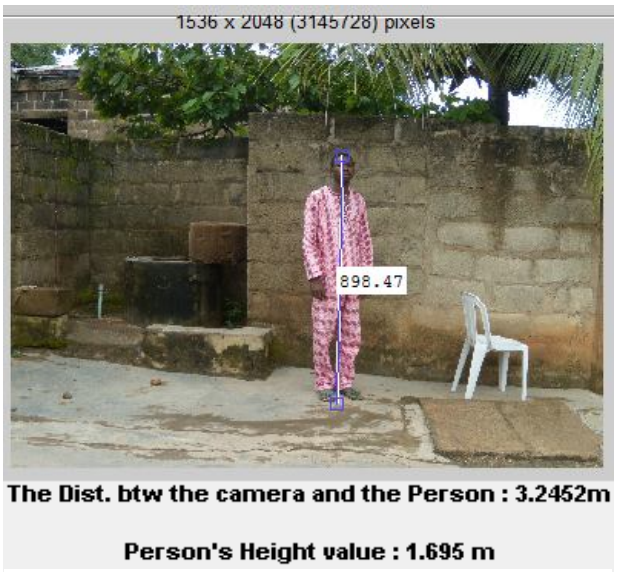

Figure 4a: Person's height while standing with 3.0MP

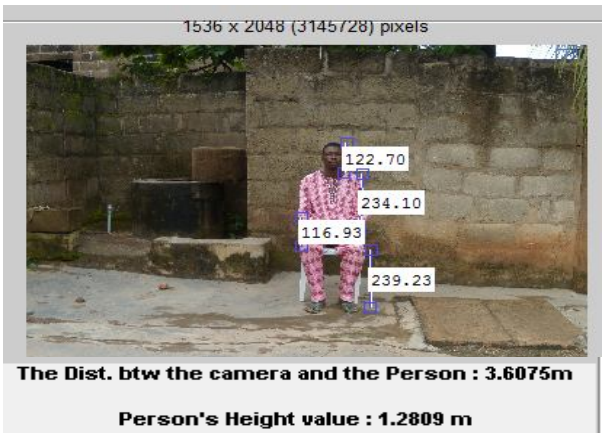

Figure 4b: Person's height while sitting with 3.0MP Camera

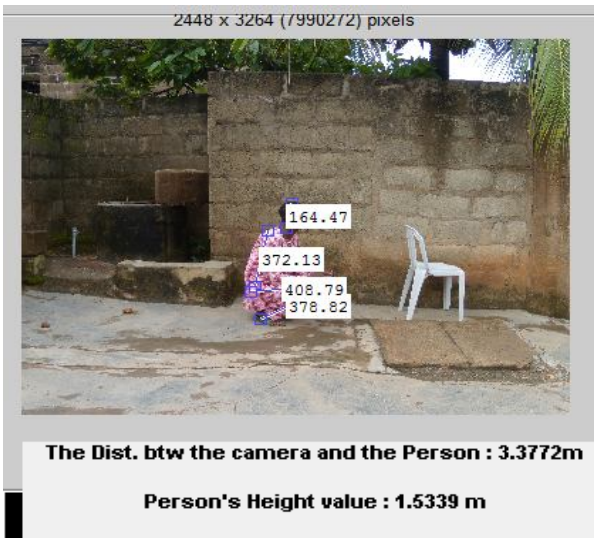

Figure 4c: Person's height on squared with 8.0MP

5. Results and Discussion

The results obtained using two different cameras with pixel values 3.0MP and 8.0MP are as shown in Table 1 below. The actual height of the person used in the study is 1.7m. The distance used for capturing the tallest and smallest person is 2.23m. The results displayed in Table 1 are based on the pictures depicted in Figures 3a to 4c. The object heights used ranges between 1.28 and 1.87. The percentage difference obtained ranges between 0% and 24.7%. Table 2 further revealed that the standard deviation and standard error are 0.207 and 0.084 respectively.

Table 1: Results of the Person's Height at different posture

Figure number	Experimented Object's Height (m)	Difference	% Difference
3a	1.61	0.09	5.3
3b	1.43	0.27	15.9
3c	1.87	-0.17	10.0
4a	1.70	0	0
4b	1.28	0.42	24.7
4c	1.53	0.17	10.0

Table 2: Descriptive Statistics

N Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Standard Error	Standard Deviation Statistic
6	1.28	1.87	1.57	0.084	0.207

6. Conclusion

In this paper, a framework for tracking of human height using image-based technique was developed. In addition, the developed method could be used in photogrammetry and robot vision. Because of the simplicity of the approach, computation-intensive techniques, such as pattern recognition and image analysis methods, may not be required for obtaining a satisfactory measurement. The analysis of the results obtained from our experiments showed that crime-persons could be tracked using image-based techniques with minimal error rate. The next phase of our research is to combine facial recognition technique with image-based technique in the authentication of the tracked crime-person.

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NOTE: All the references to the *Morpologia del corpo umano* (1891) are from the english edition (1909).

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Research groups and links

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A Brief Authors Biography

Ezekiel Olufunminiyi Oyekanmi is a lecturer in the Department of Mathematics/Statistics/Computer and Information System, Achievers University, Owo, Ondo State, Nigeria. He obtained his Bachelor of Technology from Ladoke Akintola University of Technology, Ogbomoso and Master of Science in Computer Science from the University of Ibadan, Nigeria. He is currently on his doctorate degree in Computer Science. He is a software developer and has carried out a lot of online projects and desktop applications. He is proficient in C#, PHP/MySql, Java and Matlab languages. His research interests are in the area of image processing, intelligent language processing, data analysis; and computer security.

Samuel Adebayo Oluwadare is a lecturer in the Department of Computer Science, The Federal University of Technology, Akure, Nigeria. He holds Master of Technology and Ph.D Degrees in Computer Science. Before joining the Department, he had over 10 years experience as Systems Programmer at the University Computer Centre where he rose to the position of Senior Systems Programmer. His research interests include design and analysis of algorithms, high performance computing, evolutionary computing, database management system; computer-based statistical analysis; and Information and Communications Technology. He has published several papers in both local and international journals. Apart from academic work, he has served as consultant to governments and World Bank Agencies.

Boniface Kayode Alese is an Associate Professor of Computer Science in the Department of Computer Science, The Federal University of Technology, Akure (FUTA), Nigeria. He received his B.Tech, M.Tech and Ph.D degrees from the University and has published several papers in the areas of Computer and Information Security in both Local and international Journals. He has delivered several award winning papers in both local and international conferences. He occupies the Professorial Chair in Computer Science, endowed by the First Bank of Nigeria. He is also the Dean of Students Affairs in the University.

