ESTIMATION OF HUMAN HEIGHT WITH VIDEO CAMERA

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ESTIMATION HUMAN HEIGHT FROM VIDEO CAMERA

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A dissertation submitted in partial fulfilment of the requirement for the degree of Bachelor of Engineering (Hons) in Electronics (Telecommunications)

Faculty of Engineering

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To my beloved God, family and friends

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ABSTRACT

This paper presents about estimation of human height with video camera. There have been many methods that developed to measure accuracy of human height algorithm with image processing techniques in computer such as non-contact measurement, RGB-Camera, calibrated camera and etc but some of this technique have weakness of the can be detected such as errors. However, uncalibrated camera technique is chosen in my research because it can measure human height automatically, reliable, and can be proved when capture and record the image of subject with using camera of smartphone in multiple images. Therefore, uncalibrated camera technique is implemented in my research project for measurement of human height with video camera from any smartphone. There are three steps for analysis human height algorithm measurements such as vanishing point, line extraction, and image processing technique that involved in my research of estimation of human height. Moreover, MATLAB R2018a is software that be used for process of extraction images because it would execute the value of pixel for each subject and read of all subject's image. Process of extraction images is important because it can subtract image of subjects and image of background such as extract head of human to foot for ensure the subjects can be recognized as a human and non-human. Vanishing point is needed to calculate the height so that it is accurate and reliable. Finally, uncalibrated camera method is proposed based on image background and image of walker.

ABSTRAK

Tujuan projek ini dijalankan adalah untuk mengukur ketinggian badan manusia dengan kamera video. Pelbagai kaedah telah dibangunkan untuk mengukur ketepatan ketinggian tubuh manusia tetapi malangnya terdapat kelemahan yang di kesan. Oleh yang demikian, kaedah tanpa penentuan ukuran kamera adalah satu-satunya kaedah yang boleh dipercayai sebab kaedah ini mampu mengukur ketinggian tubuh manusia secara automatik. Selain itu, kaedah ini dapat dibuktikan apabila pelbagai imej berjaya diambil oleh kamera tersebut. Maka, kaedah tanpa penentuan ukuran kamera dilaksanakan dan diguna sebagai projek penyelidikan saya. Melalui kaedah ini, terdapat tiga cara untuk menganalisis algoritma ukuran ketinggian tubuh manusia. Sebagai contohnya, titik lenyap, pengekstrakan garisan dan teknik pemprosesan imej. Seterusnya, perisian MATLAB R2018a boleh digunakan untuk proses pengekstrakan imej sebab ia akan menunjukkan nilai pixel daripada semua subjek dan mampu membaca semua imej subjek. Proses pengeksrakan imej adalah sangat penting sebab latar belakang imej semua subjek mesti dibuang supaya dapat membezakan latar belakang imej dan imej subjek. Contohnya, ekstrak dari kepala hingga kaki manusia. Manakala, titik lenyap digunakan untuk mengira ketinggian supaya ketepatan dapat dicapai dengan sempurna dan boleh dipercayai ketinggiannya. Oleh itu, kaedah tanpa penentuan ukuran kamera dicadangkan berdasarkan latar belakang imej dan orang yang berjalan semasa kajian ini dijalankan dengan sempurna.

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LIST OF SYMBOLS

2D	–	Two-Dimensional
3D	–	Three-Dimensional
CM	–	Centimeters
V_X	–	Horizontal Vanishing Line
V_Y	–	Vertical Vanishing Line
F	–	Focal Length
V_L	–	Vanishing Line
H	–	Insignificant Distance
C_r	–	Colinear Point
L2	–	Euclidean Distance
I_f	–	Moving Object
I_i	–	Current Frame
Θ	–	theta (angle)
%	–	Percentage
Σ	–	Standard deviation

LIST OF ABBREVIATIONS

BMI	–	Body Mass Index
RGB-D	–	Red, Green, Blue and Depth
CCTV	–	Circuit-Closed Television
IEEE	–	Institute of Electrical and Electronics Engineers
PCA	–	Principal of Component Analysis
MOCAP	–	Motion Capture
PSN	–	Kinect Camera of Perception Sensor Network
PTZ	–	Pan Tilt Zoom
LASER	–	Light Amplification by Stimulated Emission of Radiation
ROI	–	Region of Interest
RCAC	–	Red Color Area Capture
C2B	–	Binary Image
TF	–	Topologic Filter
CGD	–	Center of Gravity Detection
TMM	–	Triangular Measurement Method
MATLAB	–	Matrix Laboratory
TE	–	Total of Errors
CNN	–	Convolutional neural network

CHAPTER 1

INTRODUCTION

1.0 Overall project

Human height is measurement from head to foot and can be measured by using tape measure, wall marking method and etc. Basically, human height is measured in centimeter and feet. Important of measure height is to calculate body mass index (BMI), a school project and etc. However, measure human height in manually are slow and difficult to measure height if have no any suitable tool measurement. Therefore, camera is used to estimate human height because it is fast and easy to use. Besides, camera have many types such as kinect camera, RGB-D camera, calibrated camera, and uncalibrated camera. All of them is used for camera surveillance such as closed-circuit television (CCTV), traffic flow, dome camera, and others. In my research project, uncalibrated camera is used for measure human height from video camera. There are two objectives that must be achieved to make sure the hypothesis can be accepted.

1.1 Background of study

Today, technique of human identification is popular among people in the world such as gait analysis, face recognition, fingertips and voice recognition for surveillance purposed. Human features such as weight, height, eye colour, skin colour or build can be detected via soft-biometric [1]. But, all of these techniques is not suitable to detecting the person by camera surveillance because lack of resolution [2].

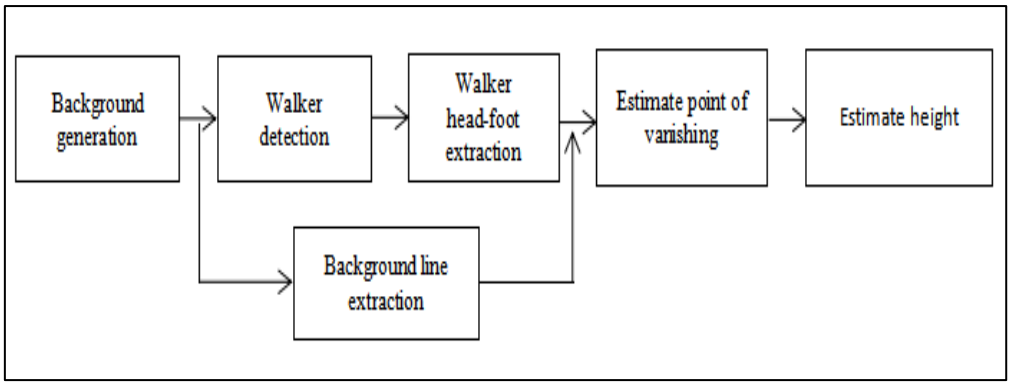

Figure 1.1: Block diagram of human height analysis algorithm [4]

So, estimation of human height measurement from video camera is used because that method can identify the human feature when resolution of image is poor in any method that mentioned before [3]. There are two technique of camera such as calibrated camera and uncalibrated camera. Calibrated camera is need to calibrating before capture images but uncalibrated camera is not need to calibrating during capture motion images. The human height analysis are three steps such as extraction line, estimating vanishing point and estimation of normalized human height and can be shown above in Figure 1.1[4].

Based on E. Jeges et *al*.[5], they mentioned that features can be extracted when the shapes of object is moved on frames in video camera. They also claimed that the metrics can be implemented when the different of two shapes can be described when distance value is applied. Temporal and spatial domain are involved in object tracking system when associate similar to shapes. Moreover, camera that not dependent have ability to coverage big area of scene. They also mentioned that times and places are related to match of shape when object are projected. Object can be determined when the frames that captured by camera is extracted.

Tracking system and soft biometric can be related with estimation of human height. Face, shape of ear and skin colour can be identify and certain feature of various human height can be removed. Also, the changing of characteristics of gait can be extracted when estimate human height [6,7,8]. As a result, any process of identification must involve extraction parameter. To measure the human height from camera, the distance from camera and angle of view must be considered and determined. So, estimate human height is not difficult when the height of human and angle of view are known.

Error can be existed if vanishing point is not accurate [9,10]. Reference point is important because to indicate the position of object from top to the bottom and at same time the reference object must be accurate. Furthermore, plane must be equal with object that be targeted in reference point and body of person should be clear when estimate their height [11]. They suggest that accuracy and algorithm can used when estimate human height and walker have own moving trajectory on a road plane so it is important to ensure the human height can be determined accurately [12]. To avoid the clash between height and the movement of walker, they come out with idea of novel algorithm to make sure the result of detection on road is valuable information.

When camera is in motion, the algorithm is cannot supervised. To solve that problem, view from top until down is needed so that the algorithms can be corrected [13,14]. They also assumed that plane is same when develop size distribution for motion of walker. The combination of metric on the plane ground is crucial when the motion object can be tracked [15]. According to Stau et *al*. [16], they explained there are three characteristics that related to far-field such as object height, length and size of object. But, all method has weakness especially when measure parameter.

In addition, vertical and horizon line that related to vanishing point should be computed [17]. Secondly, body human can be assumed as vertical poles so that the human body from head to foot can be extracted to distinguish the human and object when use video camera. Thirdly, they want create vanishing point when two line are used for measure parameter of camera because human height can be represented as information for their research. Then, all parameter can be implemented when they applying it.

1.2 Motivation of the project

To find a reliable and widely applicable semi-automatic method for extraction of a person's height information that can be implemented in many systems for various purpose as can be such as monitor crime scene, human-tracking and etc.

1.3 Research objectives and hypothesis

Aim of my research is to evaluate the height of human body by using uncalibrated camera. There are two objectives that must be achieved in my research such as.

- To measure the human height in multiple images from uncalibrated camera.
- To analyse the accuracy of existing estimation of human height algorithm.

To achieve the objective of this project, the accuracy produced by the proposed method must be accurate with the existing estimate human height measurement algorithms. Thus, hypothesis is accepted.

1.4 Problem statement and solution

Firstly, mostly camera calibration is use for determining the object such as body part of human [4]. Usually, camera calibration need special pattern and can be called as method before capturing multiple images from video camera. So, when that method is applied, the camera can be installed anywhere. Besides, camera commonly used for surveillance usually involve significant geometrically such as measurement of distance from camera and target object. Calibration can be semi-automatic when they extract the human height from top until bottom of human body [2]. But, J. Jung et *al*.[4], mentioned that it is difficult to do correction of vanishing point if line parallel cannot be extracted perfectly. In addition, camera calibration cannot detect perfectly if number of motion object is too large because information of human height is normalized when extracting the motion object [2]. To deal the problem, my method is proposed that uncalibrated camera is suitable for estimate the human height measurement because uncalibrated camera is not need calibrating during capture images.

1.5 Project report outline

In my project, there are three chapters that must be completed for final year project 1 and 2 such as introduction, literature review, methodology, result and discussion and conclusion. All of these chapter can be described as shown below.

Chapter 1: Introduction

In chapter 1, introduction describe about background of study especially in estimation of human height, overall project, motivation project, objectives and hypothesis, problem statement and solution, and lastly conclusion of introduction.

Chapter 2: Literature review

In chapter 2, literature review describes about past research that already done by many researchers around the world. Then, the literature review must be related to my project.

Chapter 3: Methodology

Chapter 3 explain about the method that related to my research. Each method can be implemented from past research such as IEEE. Example of method are vanishing point, line extraction, and so on. MATLAB R2018a can be considered as method to create algorithm.

Chapter 4: Result and Discussion

Chapter 4 explain about the result, discussion and analysis of data from the implementation conducted from research project

Chapter 5: Conclusion

This chapter is mentioned about the conclusion and future recommendation research project in the related topic to present study.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

In chapter 2, all previous research that related to my research project is reviewed and discussed such as IEEE, Science direct, and etc. Also, vanishing point, extraction technique and method to measure human height is highlighted in each previous research. However, some critics must be made to mentioned the weakness of each previous studies and at the same time mention the advantages of each previous research so that it will be research reference for my research project.

2.1 Single Camera View Technique

Based on M. Momeni-K et *al*. [18], the technique to measure height of an object can be estimated by using a single camera view. The position of camera such as height and pitch of angle of the camera with respect to the ground is a valuable information. Even any kind environment, the object still can be placed and some rough object is easily detected by using detection techniques during recognize the object in the scene but the object will be different from the background. Thus, the vertical vanishing line, the reference direction vanishing point is not needed to estimated. Also, the 3D properties are not detected even changes from 2D images.

2.2 Calibrated and uncalibrated camera method

Calibrated camera is using to tackles problems of height estimation. This can be supported by P. Viswanath et *al.* [19], that error distribution in a simple model can be as a function of the location of the object and recovered height of the camera. But, they also claimed that vanishing point and horizon line is estimated so that the height of camera is computed. Besides, they claimed that low resolution of surveillance camera will affect the ability to identify sufficient features.

According to C. BenAbdelkader et *al*. [6], calibrated camera is used for estimate the stride length and their distance over a period of time is estimated. At the same time, they also claimed that the number of steps is main factor especially during counting. Also, they also assumed that the velocity of human walking is constant so they can estimate the stride within 1cm. In addition, they mentioned that method is more to works in low resolution and robust for changes in lightning, clothing and tracking.

The steps of camera calibration are determination of camera parameters that describing the mapping between 3D and 2D image coordinates. According to the following equations [20]:

$$\begin{pmatrix} x \\ y \\ 1 \end{pmatrix} = AP_0G \begin{pmatrix} X \\ Y \\ Z \\ 1 \end{pmatrix} \quad (1)$$

Where the x, y and z are plane coordinates of a projected point. 3D coordinates are including X, Y and Z. A is represented as a matrix of intrinsic camera parameter such as focal length and principal point. Besides, P_0 is represented as a normalized matrix of perspective projection. G is represented as a matrix of extrinsic camera parameters such as translation and vector of rotation.

The uncalibrated camera is used for human characteristics retrieval algorithm. Thus, there are three steps to estimate human height from uncalibrated camera such as line extraction, estimation of the vanishing points and camera calibration. Secondly, the algorithm of automation human height analysis consists of three steps such as vanishing point, line extraction and normalized human height estimation. Besides, the advantages of uncalibrated camera are not need calibrate camera before capture individual images and easy to install at target place because it is not need special pattern like calibrated camera. Figure 2.2 shows the process of human height analysis algorithm in uncalibrated camera [4].

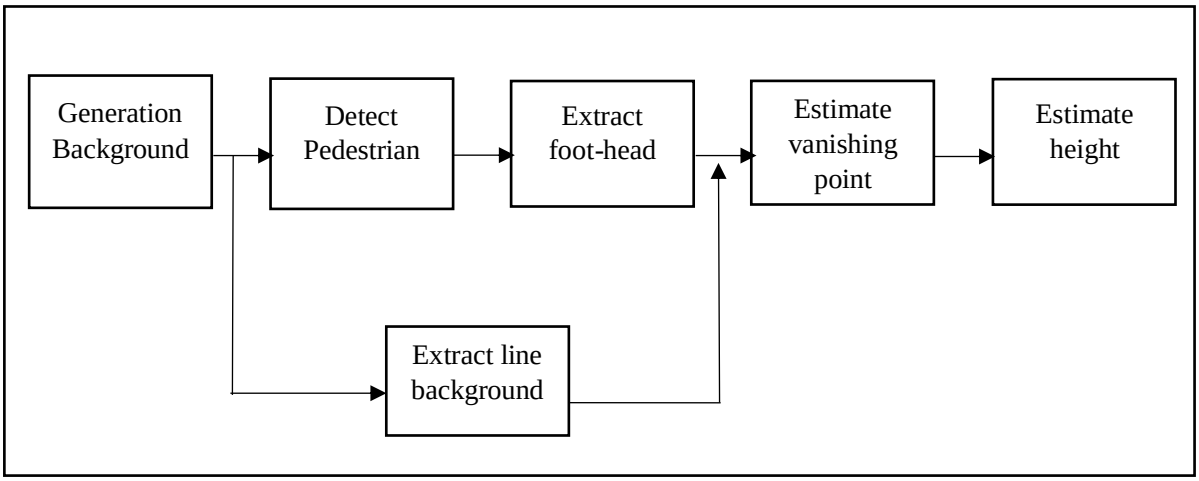

Figure 2.2: The block diagram of human height analysis algorithm [8]