Performance Comparison of Real Time Image Processing Face Recognition for Security System

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Abstract—This research had been developed a system mainly consists of Arduino microcontroller based hardware and neural network based algorithms. The system has been fully assembled and successfully tested. By using two different methods the point feature detector (PFD) method was used as the first method. An Eigen Feature function was utilized to detect feature point of image. The second method is convolutional neural network (CNN) to recognize human face. Using PFD method, a classification value has been setup <11. The classification value is used as classification category of the program to recognize the subject (face image) correctly. By using PFD method, the response of the system from starting of a face image recognition until opening the locker is 20 second. The CNN method used alexnet to classify the image. At least around 300 training input data are use per person. The face recognition’s experiment reached a high recognition’s accuracy of 99.99% level and an average response time of 10 seconds. This research presents how the human face can be recognized and used to control the opening of a door lock.

Keywords—eigen feature, feature point detector, convolution neural network, alexnet, classification value.

I. INTRODUCTION

Visual is the most complicated of our sense [1]. Many of the researcher had studied and conduct lots of experiment in order to achieve the most sophisticated technology by utilize visual feedback. Visual feedback method allowed a device or a certain system to be able to controlled by using image processing and make a final decision of movement. A camera is a passive device to capture patterns from optical energy reflected from the scene. A single camera has a limitation in 3-dimensional structures in scanning and lost in resulting in 2-dimensional image. Despite this problem, a human is particularly good to inferring in 3-dimensional nature of scene. In Fig. 1 shows how the 2-dimensional image can inferred as the 3-dimensional object.

In image processing, MATLAB offers lot of tools that very effective in image signal processing. Image pattern analyses, convolution neural network (CNN), and deep learning is implementable. Additional MATLAB has a function in order to connect microcontroller and camera device.

In this research the image processing method has been implement to control a device by recognizing the human face. To be more applicable the experiment was used solenoid door locker as the actuator.

II. THEORITICAL PERSPECTIVE

A. Image

Image is two of dimension of discrete I(m,n) that is output or response of some of sensor at a series of fix positions (m = 1, 2, …, M), n = 1, 2, …, N) in 2-D cartesian coordinate. An image respectively designated the rows and columns. Image has individual elements or pixels revered by their index or coordinate. An image colour have intensity level or value to every single of pixel location I(m,n).

The size of 2-D pixel stored for each of individual image pixel determine resolution and colour of image. From mathematical view any of 2-D array can be considered as image signal.

Such as measurement data and decision. Image digitization for example image sampling x,y and gray level quantization. Image represent rectangular array integers. the image size and gray level are usually integer of power of 2. Number of each pixel represent the bright and darkness of the image.

Fig 2. Digital image and numerical representation [2]
### B. Neural Network

A neural network is very powerful and most common used in image processing. There are many kinds of neural network method was used to recognize an image. Basically neural network components have been inspired by McCulloch and Pitts’ in 1943 by their paper “A logical calculus of ideas imminent in nervous activity”. The same time Frank Rosenblatt was also developing the computation of human eye.

\[ y = \sum_{j=1}^{N} w_j y_j + \theta \]  

(1)

### C. Convolutional Neural Network

Basically image recognition is classification. Recognizing the image whether recognizing the image of animal or human is the same as classifying. Before CNN the feature extractor has been designed. Therefore it required significant amount of cost. CNN yields the better image classifying. When feature point extractor is deeper. CNN consist a neural network to extract the image and another CNN can classify the feature of the image.

The input image enters into extraction network. After extracted the feature signal enter the classification neural network. Then the classification of CNN operates base on the feature of the image and generate the output.

### III. PREVIOUS STUDIES

Image recognition research have been investigated in many of studies. A study about face recognition base on color vector binary pattern from multichannel face images has been investigated [5]. The study proposes the novel face descriptor based on color in formation. The study perform face recognition by local color vector binary pattern (LCVBPs) feature. The result show the LCBVTs is able to
yield high performance in face recognition. Wang with study “Representing image base on point image” has been conducted [6]. The experiment utilize “verge points” to define the curvature image surface. Yeom [7] developed real time 3-d sensing the dynamic biological of microorganism. The study conducted to reconstruct the object by single-exposure on-line (SEOL) digital holography. The study is used pattern recognition by 3-d morphology and 3-d recognition. The result with sphacelaria alga, tribonema aequale alga, and polysiphonia alga are presented. Most research and study in image processing has been performed to recognize specific object for example bacteria, virus, human face, etc. A study to recognize tuberculosis bacteria [8] and vibrio cholaera base on colors. Hui [9] with study “Research on face recognition algorithm based on improved convolution neural network” had been conducted. the experiment combine Fisher criterion to cover the poor property of CNN. The result that combining the Fisher neural network (FNN) and convolution neural network can achieve good performance. In this study utilize Eigenfeature point detector and alexnet to recognize human face is investigated.

IV. RESEARCH METHODOLOGY

A. Material and Equipment

In this research was used a webcam of computer as the sensor of the image, the input data will calculate by using Eigen Features function to detect point feature to recognize the image pattern. At the end calculating geometry changing of point or utilize alexnet tool in order to learning and classify the image. After that the signal from computer should sent to Arduino port to controlling the relay.

The hardware circuit design is shows in Fig. 5 which is consisted kind of electronic devices. The solenoid door locker is required 12 Volt of input voltage, so voltage transformer is needed in order to obtain the voltage nominal value. Rectifier is attached to covert AC to DC and to get more stable voltage, a capacitor with 50 volt and 450 µF was attached.

B. Software Design

In the Fig. 7 depict the system work block diagram. The first software marked in dotted red line is to classifying and do looping iteration task to collect the images data. The images data is store into memory drive and classifying data is store in RAM (random access memory) of the computer. The second program is in dotted black line. This is part of recognizing the image from camera in real time. Identifying point feature is used to compare the point feature in the new image and old images. By calling the data classify from data base, the point feature analyzing the geometry point of both of the images in order to predict the subject [10].

V. RESULT AND DISCUSSIONS

A. Performance Test Face Recognition Of PFD Method

<table>
<thead>
<tr>
<th>Image resolution (pixel)</th>
<th>Time (second)</th>
<th>Value of variable classification</th>
<th>Output result</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 x 23</td>
<td>0</td>
<td>-</td>
<td>Error</td>
</tr>
<tr>
<td>56 x 46</td>
<td>0</td>
<td>-</td>
<td>Error</td>
</tr>
<tr>
<td>112 x 92</td>
<td>20</td>
<td>10</td>
<td>Recognized</td>
</tr>
<tr>
<td>224 x 184</td>
<td>0</td>
<td>-</td>
<td>Error</td>
</tr>
</tbody>
</table>
B. Performance Test Of Convolution Neural Network Method

<table>
<thead>
<tr>
<th>Subject</th>
<th>Time (second)</th>
<th>Value of variable classification Level of the image</th>
<th>Output result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randi</td>
<td>20</td>
<td>10</td>
<td>Recognized</td>
</tr>
<tr>
<td>Lia</td>
<td>21</td>
<td>17</td>
<td>Recognized</td>
</tr>
<tr>
<td>Tami</td>
<td>20</td>
<td>27</td>
<td>Recognized</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject</th>
<th>Time (second)</th>
<th>Value of variable classification Level of the image</th>
<th>Output result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randi</td>
<td>20.66</td>
<td>7</td>
<td>Recognized</td>
</tr>
<tr>
<td>Randi</td>
<td>20.5</td>
<td>-</td>
<td>Un identified person</td>
</tr>
<tr>
<td>Randi</td>
<td>19.89</td>
<td>-</td>
<td>Un identified person</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject</th>
<th>Loop</th>
<th>Time (second)</th>
<th>Value of variable classification Level of the image</th>
<th>Output result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Randi</td>
<td>1</td>
<td>8.8</td>
<td>1</td>
<td>Recognized</td>
</tr>
<tr>
<td>Randi</td>
<td>5</td>
<td>9.07</td>
<td>2</td>
<td>Recognized</td>
</tr>
<tr>
<td>Randi</td>
<td>10</td>
<td>9.2</td>
<td>1</td>
<td>Recognized</td>
</tr>
<tr>
<td>Randi</td>
<td>15</td>
<td>9.44</td>
<td>2</td>
<td>Recognized</td>
</tr>
<tr>
<td>Randi</td>
<td>20</td>
<td>9.82</td>
<td>1</td>
<td>Recognized</td>
</tr>
</tbody>
</table>

VI. CONCLUSION

The experiment studied here is to analyze the best method to build a system which is robust and easy to create in order to serve another device where security system is required. In this research the face recognition by using feature-point object detection method have been investigated. In training part the Eigenfeature function to detect feature point was used. Then by analyzing the point movement per frame to tracking the face. In recognition part the Eigenfeature used to detect the new feature point. Estimate the geometric transformation of old points and the new point give the ability to recognize a human face. Using PFD method, a classification value has been setup <11. The classification value is used as classification category of the program to recognize the subject (face image) correctly. By this method sometime it was found error result because the point of the image is not detected completely. The phenomenon led the calculation of geometric point is wrong and make the value of variable classification Level which is contained the calculation give error result. This problem appeared when capturing face in training part is not in centre of the screen frame and led the system making
error in calculation. Geometry point transformation is can be used to recognize facial movement in order to increasing performance of the system. By adding the geometry transformation method the system can differentiate between living human or a picture and run the Arduino to switch the door locker.

The second method to recognize the face is using convolution neural network (CNN) has been investigated. By using alexnet tool an image can be predicted. In training part, the image must be contained a human face object to activate the face detector. The image captured and store in the memory or drive directly. Before run the training part the image resized in 227x227 pixel in order to make fit with alexnet’s layer. The result of training saved in memory in variable newnet where the recognition part should call this variable when running. In recognition part the image capture from camera in real time. The image directly resize in 227x227 pixel to make it fit toward images that had been learned before. After that to run the prediction function to classify the image and compare the result toward the newnet data. The experiment result reach high accuracy at 99.99% level in training part and time response average at 10 seconds. This is how the system can recognize the human face. By this method is very robust and accurate because lots of data input can be set make the system can learn more. In the hardware part it found not much error when uploading and running the software but in this research is only used one pieces of Capacitor 50 Volt and 450 µF in order to get DC voltage more stable. The instability of voltage led the solenoid of door locker shaking. To get it more stable, attach another smaller Capacitor 16 volt and 50 Volt and 450 µF will be helpful. Adding another capacitor led the input DC voltage being purer.

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REFERENCES