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An Examination on Computer Vision System for Numeric Pattern Recognition

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Abstract:
Technology of digital learning at this time applies many computer systems, therefore learning in the field of computer vision for a renewal of innovation in some devices in the era of the industrial revolution is required. In this study, a study on computer vision system for numeric pattern recognition is proposed, where the neural network method was implemented. The computer vision system studied can recognize arithmetic and operand numbers to do simple calculations and produce sound output. Generally, the technique applied in this study is image segmentation which consists of four stages in the form of grayscale, thresholding, trimming, and resizing. Furthermore, the images obtained will be processed using computer vision. The results showed that the neural network method applied to computer vision systems was effectively used for numeric pattern recognition which served as a learning media in the digitalization era.

Keywords: *Service-oriented Organizational Citizenship Behaviour, social resources, work engagement, Malaysia, hospitals, nurses*

I. INTRODUCTION

The learning system in education underwent significant changes [1], partly due to the digital revolution that created a lot of renewal technology. New technology creates large learning opportunities for elementary schools to universities [2]. One example of technological progress is the use of the computer vision system. Computer vision system takes the concept of how human eye works that are visualizing or capturing the object being seen, then sending the object's information to the brain and making a decision on the object [3][4]. The computer automation system that can recognize objects previously developed based on computer vision which combines the concept of image processing with how the eyes works [5][6]. Several studies have been developed based on computer vision concepts [7][8], one of which is the numeric patterns recognition [1]. Computer vision systems are built using cameras as eyes and computers as processing units [9].

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In this study, the computer vision system proposed for mathematics learning media that is able to recognize images on a number card and can perform mathematical operations based on the cards displayed. Neural network (NN) method is used by Computer vision system in recognizing image patterns listed on a numeric card. The Computer vision system built was only able to perform addition and subtraction operations of 2 digit numbers. The computer vision system that is built consists of three parts, namely the input part in the form of a camera on an android phone, a processing part in the form of a computer that has software which can recognize the image pattern of the card number using the NN methods and the output in the form of a speaker which sound the numbers, operand and the results of calculations.

II. Design System for Numeric Patterns Recognition

This system is designed by combining several digital image techniques, as well as the NN method that is applied as a learning method and classification. The hardware needed to build a number and arithmetic pattern recognition system and its calculations are cameras on Android phones, PC / laptops, and speakers. Generally, this system will capture the arithmetic numbers and operands that exist using a camera phone, then the numbers and operands captured by the camera will be processed by the PC and produce a calculation value according to the recognized arithmetic operand command. Block diagram of the computer vision system can be seen in Fig. 1.

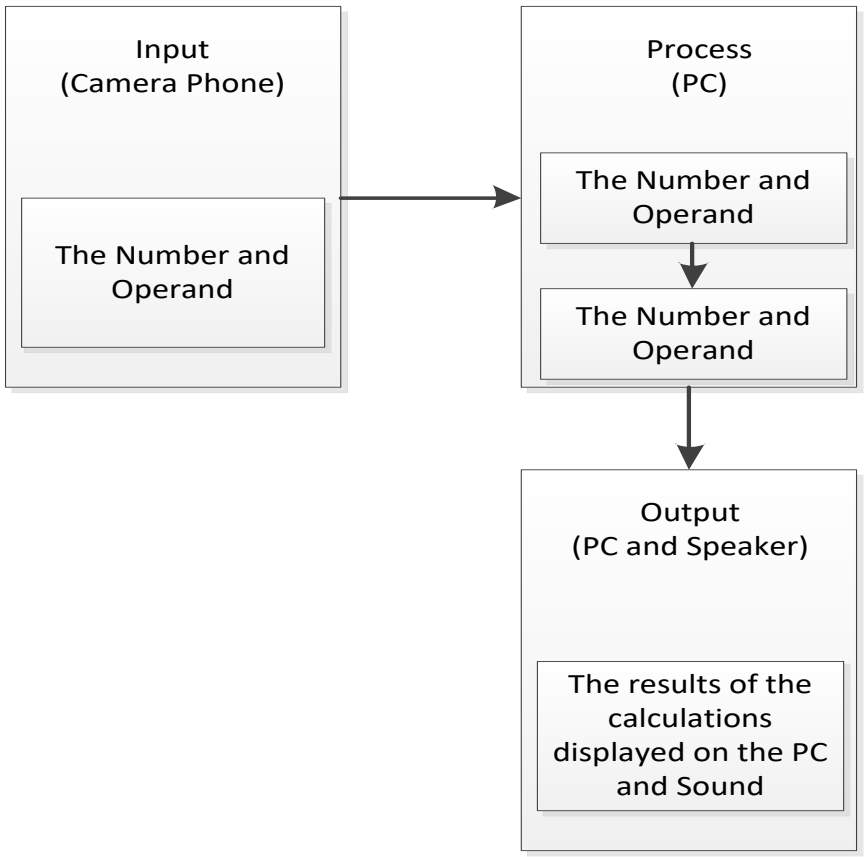

Fig. 1 Block Diagram of Computer Vision System

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A. Image Processing

At this stage, a program will be created that can learn to recognize arithmetic numbers and operands to calculate the patterns identified by the system at the testing stage. The creation of this software uses Visual Studio compiler with C# programming language and Open-CV library. The images segmentation technique used consists of four stages, the grayscale technique, binary image thresholding, cropping the image and resizing.

1) *Greyscale Technique:*

Greyscale images or commonly known as black and white images have a color gradation ranging from white to black in each pixel [10]. This range shows that each pixel can be represented by 8 bits or 1 byte. The greyscale technique is used for processing before getting binary images that will be obtained by using thresholding techniques. At each pixel, the image of greyscale is the composition of RGB values [11]. This value serves to indicate the level of intensity. The range of greyscale image values is represented by 8 bits for each pixel, which means the range of each pixel is $2^8 = 256$ (0-255), with a combination of black (0), ash, and white (255). Greyscale values can be obtained from equation 1bellows.

$$IG(x,y) = \frac{Ir(x,y) + Ig(x,y) + Ib(x,y)}{3} \quad (1)$$

Where IG(x,y) is grayscale values on coordinate pixels (x,y), Ir(x,y) means red pixels on coordinate (x,y), Ig(x,y) as green pixels on coordinate (x,y), and Ib(x,y) as blue pixels on coordinate (x,y). The greyscale image values obtained from the calculation of equation 1 with 320 x 240 pixels.

2) *Thresholding*

The threshold *is a technique in image* processing that aims to separate the background and the actual object from an image. Thresholding produces a binary image by comparing all pixels with the specified gray level value. After getting the value of the comparison of each pixel with the gray level value specified, the desired information from an image will be obtained. The threshold value will separate the background category or object in a pixel. The binary image which is the result of processing Thresholding technique where the value f (x, y) <T is the representative of black and f (x, y)> T is the white representative. In this study the value of T will be selected between the T values determined manually with the track bar tools in visual studio, the best results between two will be applied to the system. After the threshold value is obtained, then the binary image value is determined.

3) *Cropping*

At this stage, the image that has gone through several previous stages will be cropped to get accurate information and facilitate the next process to be carried out. Image resolution used previously is 640 x480 pixels, after cropping the image, the resolution changes to 20x20 pixels. This amount was chosen to facilitate the training input process in the NN algorithm. Cropping image is done by looking for each side (top, right, bottom and left) of the arithmetic numbers or operands to be trained.

4) Resizing

The resized result image with a size of 20x20 pixels then converted into binary form. After going through these stages, the next process is the binary image information obtained will be processed using the NN algorithm used for learning or pattern recognition.

B. Neural Network Method

The Neural Network (NN) method is used to train sample data. Sample data is a collection of numeric images and arithmetic operands captured using a camera phone and then processed using PC assistance and image processing techniques. The

input number for the NN algorithm is 400 inputs for each character according to the number of pixels of the binary image that is worth 20x20 pixels.

After the training process is complete, it will generate weight and bias values for each arithmetic number or operand which will be stored in the database system and will be used for the testing process. In the testing process, it will be seen to what extent the system recognizes the numeric patterns or arithmetic operands that have been trained.

C. *Testing and Classification System*

This testing phase is designed to recognize arithmetic operands (addition or subtraction). When an image is captured by the camera phone, the image will be converted into a digital image by the computer. Therefore digital images that have several numbers and one arithmetic operand in them must be separated first so that the test system can recognize them properly. After each arithmetic number and operand was separated, the data will be input to the test system. After getting input information needed by the system, the input will be processed and produce the output as expected. The flowchart system is shown in Fig. 2.

In fig.2. the process of system begun from taken picture by camera phone, then picture will be send to PC to continue training process in computer vision, if training data success and the weight values is obtained, data will be continue to testing on the system until the number or operand is recognized, and produce output in the form of sound and images.

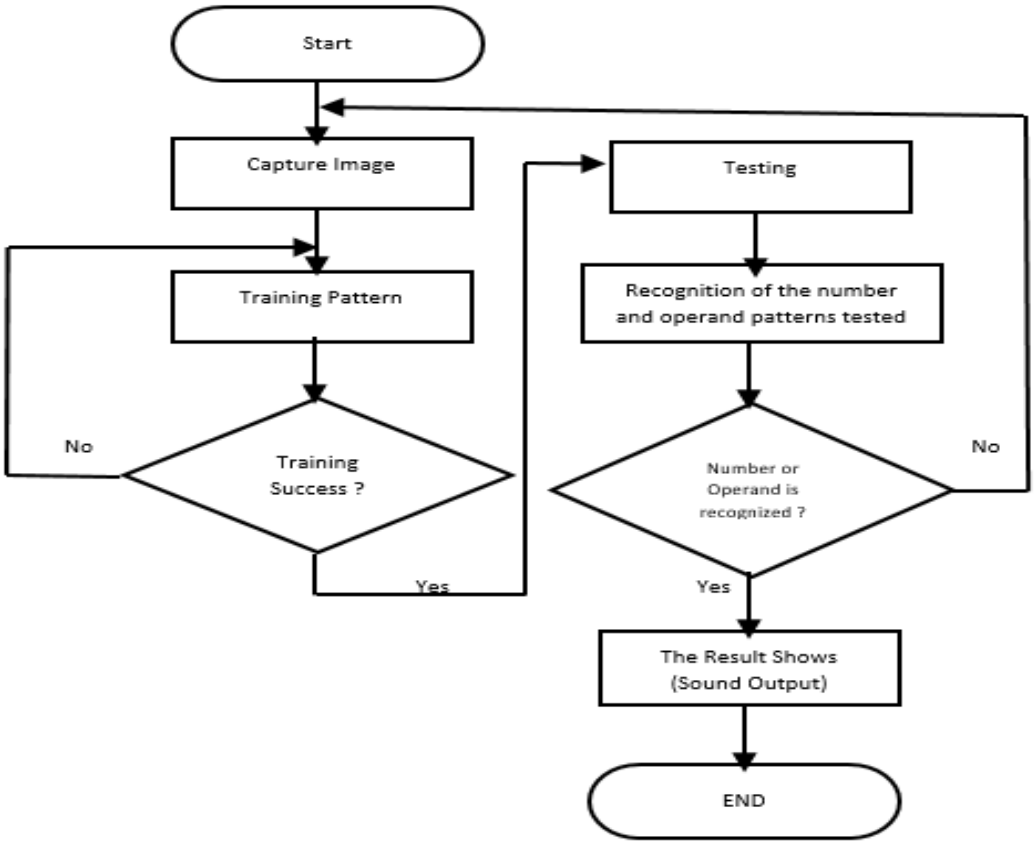

Fig.2. Flowchart System

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Classification methods are needed in addition to the weight values used as references for making a decision. Classification method used for the testing system is uncertainty using the *maximax* criterion. *Maximax* criterion will look for the best alternative for each choice, then make a decision based on the maximum value of the result [12], the *maximax* criterion is also referred to as an optimistic or alternative criterion decision with the highest to lower possible profit. After combining the input data and the weight value, the output will be obtained in the form of number reading sound and the result of calculation by the computer-based on arithmetic numeric patterns and operands recognized by the system.

III. RESULT AND DISCUSSION

In the testing phase, it will show the results of the techniques and methods that are used, so that the arithmetic number and operand recognition system is running well. The testing phase is divided into two, namely the testing phase of the image before the training process using the NN method and the testing phase of the arithmetic numbers and operands after the training process is complete.

Tests performed on the system are limited to addition and subtraction. The number and operand values tested consist of (1 + 1), (5-2), (10 + 8), (12-6), (8-10). The test was carried out 10 times against each operand. The test results will be declared successful if the addition or subtraction tested is well recognized by the system, if there is an arithmetic number or operand that is not able to be recognized by the system, the test is considered a failure.

As an example of the addition being tested is "10 + 8", if the system recognizes the arithmetic numbers and operands with "10 + 8 = 18" then the test is successful, but if the system recognizes the arithmetic numbers and operands with the results "10 + 3 = 13" , then the test is considered a failure. One testing sample is shown in Fig. 2.

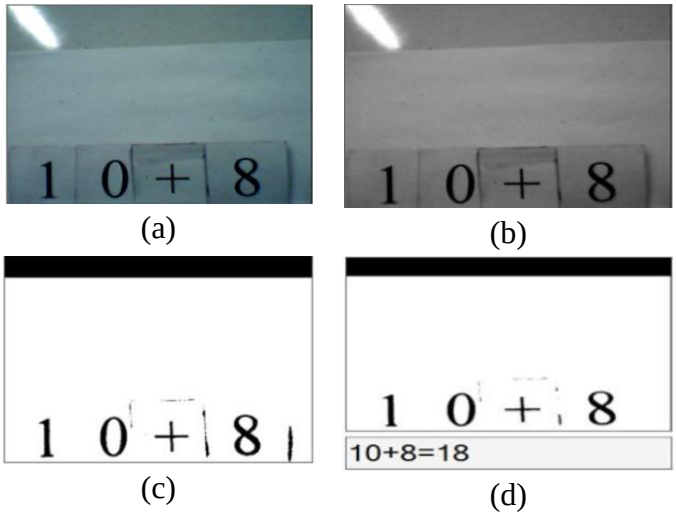

Fig. 2 (a) Real-times Images, (b) Greyscale Images, (c) Threshold Image, (d) Testing Result

From data sample in addition, "1 + 1" there is an error of 10% in the 4th test where the second number 1 is identified as number 7. The reason for this error occurs because the classification method of the *maximax* criterion determines the number 1 has the greatest value when testing numbers. Other factors allow for the similarity of numerical patterns tested with a number pattern identified by systems that have been trained with the NN method.

Furthermore, in the subtraction test "5-2" there was an error of 10% in what happened during the first test. An error occurs when number 5 is not recognized by the system. The error factor is due to a classification system that does not find the value of (F) function above 0. For the addition of "10 + 8", subtraction of "12 - 6", and subtraction of "8-10" there is no error. This shows that the system is capable of learning, separating the arithmetic

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numbers and operands tested, managing the required image information and recognizing properly.

Based on the tests, the system has almost recognized all the arithmetic number patterns and operands test, there are only 2 tests that failed to recognize. So that the percentage of error values obtained from the entire test is 4% and the percentage of system success recognizing the arithmetic number and operand patterns tested is 96%.

IV. CONCLUSION

In this study, the results showed that the neural network method which was implemented in the computer vision system for numeric pattern recognition in the digital learning media could run well using image processing techniques, such as greyscale, thresholding, cropping the image and resizing, and could perform simple calculations with sound output well. The success of this system can be seen from the level of system accuracy in recognizing the pattern of numbers tested at 96%.

In further research, more complex arithmetic forms can be added by combining some classification methods to obtain more optimal results in pattern recognition.

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REFERENCES

1. D. Y. Harvey and M. D. Todd, "Automated Feature Design for Numeric Sequence Classification by Genetic Programming," *IEEE Trans. Evol. Comput.*, vol. 19, no. 4, pp. 474–489, 2015.
2. A. Collins and R. Halverson, "Rethinking Education in the Age of Technology: The Digital Revolution and the Schooling in America," *Teach. Coll. Press*, pp. 1–11, 2018.
3. C. Szegedy, V. Vanhoucke, and J. Shlens, "Rethinking the Inception Architecture for Computer Vision," 2014.
4. S. S. S. Kruthiventi, K. Ayush, and R. V. Babu, "DeepFix: A Fully Convolutional Neural Network for predicting Human Eye Fixations," *IEEE Trans. IMAGE Process.*, vol. 7149, no. c, pp. 1–11, 2017.
5. D. Geman, S. Geman, N. Hallonquist, and L. Younes, "Visual Turing test for computer vision systems," *Proc. Natl. Acad. Sci.*, p. 201422953, 2015.
6. R. Szeliski, "Computer Vision : Algorithms and Applications," *Springer*, vol. 5, p. 832, 2010.
7. A. M. Lakhwani, K. H. Shah, A. S. Vaghela, D. S. Panchal, and S. R. Rathod, "Review on Basics of Computer Vision and Its Applications," *Res. \& Rev. J. Comput. Biol.*, vol. 6, no. 2, pp. 33–40, 2018.
8. S. S. Rautaray and A. Agrawal, "Vision based hand gesture recognition for human computer interaction: a survey," *Springer*, vol. 43, no. 1, pp. 1–54, 2015.
9. M. Heimberger, J. Horgan, C. Hughes, J. Mcdonald, and S. Yogamani, "NU PT AC," *IMAVIS*, 2017.
10. T. Kumar and K. Verma, "A Theory Based on Conversion of RGB image to Gray image," *Int. J. Comput. Appl.*, vol. 7, no. 2, pp. 5–12 2010.
11. W. Burger and M. J. Burge, *Digital Image Processing An algorithmic introduction using Java*. 2016.
12. N. Gravel, T. Marchant, and A. Sen, "Conditional Expected Utility
13. Criteria for Decision Making under Ignorance or Objective Ambiguity," *Elsevier, J. Math. Econ.*, no. 14, 2018.