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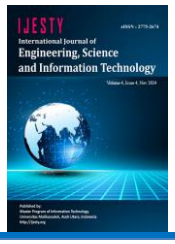

Heigh Detection System Using Russel and Rao Method

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Abstract

Height detection is an exciting area of research with broad applications in fields such as construction, healthcare, and robotics, where measurements are still often done manually. This research aims to automate the height calculation process by developing a height detection system using image processing techniques, which offers improved accuracy and efficiency. The system that will be built works by capturing images of objects through a webcam and using the Russel & Rao cluster analysis method to calculate height later. Borland Delphi 07 was chosen as the programming language because of its ability to handle image-processing tasks. This research draws on a thorough literature review of various books and articles, with the system operating in stages, starting with converting images to grayscale to simplify the data for more accessible analysis and then followed by applying Russel & Rao's method for height measurement. However, the system is sensitive to environmental factors around the object. The system will perform best when there are no other objects near the target because when there are other objects nearby, it can cause the measurement line to shift and interfere with the results. The detection system requires a controlled environment with no foreign objects nearby for optimal performance. Despite these limitations, Russel & Rao's analysis method achieved an accurate detection accuracy of approximately 65%, with three out of eight sample tests yielding correct measurements. While this shows room for improvement if more relevant research is to be done in the future, this system will build a strong foundation for further development in this field. Future enhancements could focus on refining the algorithm to increase detection accuracy, make the system more resilient in dynamic or cluttered environments, and expand its potential applications in various fields.

Keywords: *Height Detection, Image Processing, Russel & Rao Method, Borland Delphi 07, Detection Accuracy*.

1. Introduction

The era of information technology is increasing and becoming complex, and the system's reliability in processing data will produce good information [1]. Today's data processing is closer to image, sound, text, and video data. Measurement is essential in the world of science. These measurements include measuring time from one event to another, measuring an area's temperature, measuring an object's speed, and measuring the height from one point to another [2].

Length and height are the physical quantities often measured for various purposes requiring height data. Height-measuring instruments on the market are less likely to get accurate data because most of these height-measuring instruments are still conventional or manual [3]. They still use manual measurements to get a person's height data. This has an impact on its inefficient use. To measure a person's height, which is done manually, the human in charge, as the tool operator, operates the height measurement and is carried out to read the data that appears in the measurement results [4].

Image processing is processing pixels in a digital image for a specific purpose [5]. Initially, image processing was carried out to improve image quality, but with the development of the computing world marked by the increasing capacity and speed of computer processes and the emergence of computational sciences that allow humans to retrieve information from an image [6]. In the height detection system, image processing can recognize objects and process height detection to get the appropriate results [7]. In this research, the author is interested in building a system that uses video images as input data and uses the Russel & Rao method so that users can easily measure their height.

2. Literature Review

2.1. Height Detection

Height is the vertical distance from the floor to the top of the head, essential to athlete performance [8]. A more proportionate height gives an advantage in the athlete's reach and effectiveness. Measurements are taken standing upright barefoot, hands at the sides of the body, with the back against a wall. Height also reflects past growth and nutritional conditions, meager birth weight, and infant malnutrition [9]. Height-for-age indices are used to monitor development, while weight-for-height indices are used less frequently as changes in height tend to be slow. Detection is examining and using specific techniques to solve a problem, for example, in a disease detection system that identifies symptoms. The main goal of detection is to find a solution, depending on the method applied [10].
So, it can be concluded that height detection measures the vertical distance from the floor to the tip of the head with specific techniques, such as standing upright barefoot, hands at the sides, and back against the wall. A measuring device such as a stadiometer is used for accurate results [11]. This detection is essential in sports to assess athlete performance and in health to monitor growth and nutritional conditions. The results can be used in indices such as height-for-age that reflect a person's development and health status.

2.2. Image Processing

An image represents an object or scene, typically created using cameras or sensors [12]. In digital form, images consist of pixels, each with specific color or light intensity values [13]. Images can be binary, grayscale, or color, with binary showing black and white, grayscale displaying shades from black to white, and color images using RGB (red, green, blue) channels [14]. They undergo digital image digitization to process analog images, which involves spatial sampling and intensity quantization. The number of bits representing each pixel determines the image's detail, ranging from simple binary pictures to color images with millions of colors [15].
Image processing is digitally manipulating images using computers to enhance their quality for more straightforward interpretation by humans or machines [16]. It involves converting images into formats suitable for digital processing, typically using binary data. Digital images are represented numerically, with each pixel containing light intensity values across one or more channels (such as RGB for color images). Image processing aims to improve image quality or extract information, with joint operations including resampling, editing, and compression. A typical initial step is converting color images (with three RGB layers) into grayscale to simplify further processing. To convert a Red, Green, and Blue (RGB) image into a greyscale image, we use the following formulation:

$$Grayscale\ (S) = \frac{R+G+B}{3} \quad \text{..... (1)}$$

In image processing, several stages are applied to image data, including binaryization, morphology, filtering, slicing, and resizing [17]. Binaryization converts a color or grayscale image into a binary image with two intensity values, black (0) and white (1), based on a threshold. Next, opening-closing morphology and median filtering are used to remove noise and smooth the image. Once the image is noise-free, resizing is performed on individual characters using nearest neighbor interpolation, which assigns pixel values based on the closest point in the original image, ensuring uniform pixel size for further processing.

2.3. Russel and Rao Method

Distance determines the similarity degree or dissimilarity degree of two feature vectors. The degree of similarity is in the form of a score, and based on the score, two feature vectors will be said to be similar or not [18]. Distance is a number that shows how far an object changes position through a particular trajectory. In physics or everyday terms, distance can be an estimation of the physical distance between two positions based on specific criteria.

Table 1. OTUS Expressions of Binary Instances i and j

j/i	1 (Presence)	0 (Absence)	Sum
1 (Presence)	a = i*j	b = i*j	a+b
0 (Absence)	c = i*j	d = i*j	c+d
Sum	a+c	b+d	n=a+b+c+d

Based on the table above, i and j are represented by binary feature vectors. Suppose n is the number of features (attributes) or the dimension of the feature vector. It can be seen that Vector "i" is obtained from training results while Vector "j" is obtained from test results. The definition of binary similarity and distance shown by the Operational Taxonomy Unit (OTUS) as seen in Table 2. 1, which explains that attribute "a" is the number of features where the values of i and j are both (1,1), or presence meaning 'positive' attribute "b" is the number of attributes where the values of i and j are (0,1) meaning absence of concordance, attribute "c" is the number of attributes where the values of i and j are (1,0), meaning j presence of concordance and attribute "d" is the number of attributes where both i and j have the value (0,0) or absence, meaning 'negative'. The short diagonal becomes the overall total point "SUM," i.e., the sum of a + b + c + d is always equal to n. The formula of the Russel and Rao method is as follows [19]:

$$Srussel\&rao = \frac{a}{a+b+c+d} \quad \text{..... (2)}$$

Description:
a = vector values i and j show the number of coordinates from (1,1)
b = vector values i and j show the number of coordinates of (0,1)
c = vector values i and j show the number of coordinates of (1,0)
d = vector values i and j indicate the number of coordinates of (0,0)

3. Methods

After planning the research, the stage that needs to be done is to collect references regarding the Russel & Rao method, image processing, image processing operations, and the data required to support the system development process. The data used in this research is in the form of video taken in real-time using a webcam, with the 24-bit avi video format.
The system scheme for pattern recognition designed in this study is illustrated in Figure 1 below:

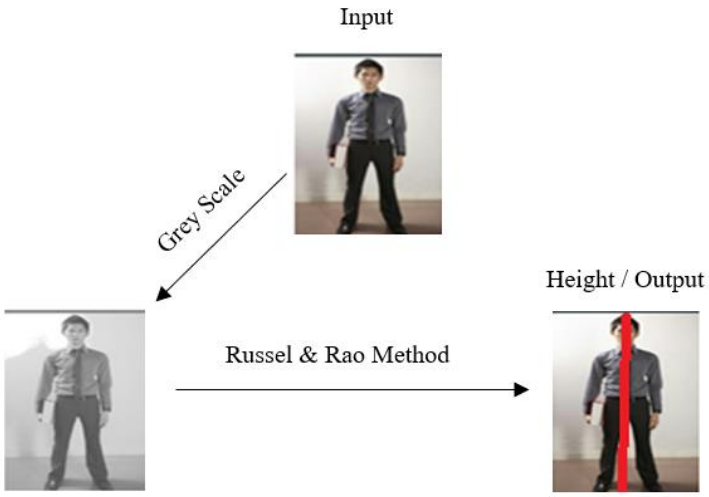

Fig 1. System Schematic

The stage carried out after the system receives video input is grayscale, which is the stage for converting the original image into a gray image. After that, go directly to the main stage in this system, the stage of measuring height using the Russel & Rao method.
The Russel & Rao method scheme is a flowchart design that describes the application process of the method formula to determine the results of systematic calculation values based on the input image detection [20].

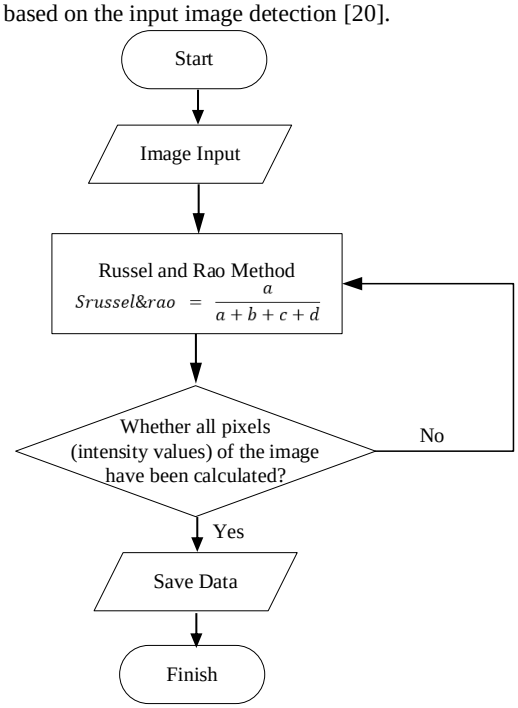

Fig 2. Russel and Rao Process Flowchart

Based on Figure 2 above, several processes can be implemented, namely:

1. Inputting the value of the image search result.
2. Detect files in .bmp format and get the value of N.
3. The N value obtained will then be calculated using the formula from the Peirce method based on the provisions.
4. From the calculation process, check whether the value of S = N-1 or the condition is if the value of S (Similarity) is greater than 0 or smaller than 1.
5. If the result is Yes, it shows that the image value has been obtained; otherwise, repeat the previous recalculation process if No.
6. If everything has been obtained and the results/output will come out by the provisions.
7. After all processes are complete, the calculation will stop.

4. Result and Discussions

Problem analysis is essential in determining the application details for designing a computer-based system. Problem analysis is a step in understanding the problem before taking action or making final resolution decisions. System analysis aims to identify issues in the system, where the application being built includes the operating environment, users (users), and related elements. This analysis is the basis for the design stage of the height detection system if height is usually measured manually. Therefore, a system is needed to simplify the measurement process.

System design is the depiction/sketching or arrangement of several separate elements into a unified whole by the wishes of users and technical experts.

A use case diagram is a model of the system's behavior to be built, and it describes an interaction between one or more actors and the system. The following is a use case diagram of a height detection system using the Russel & Rao method:

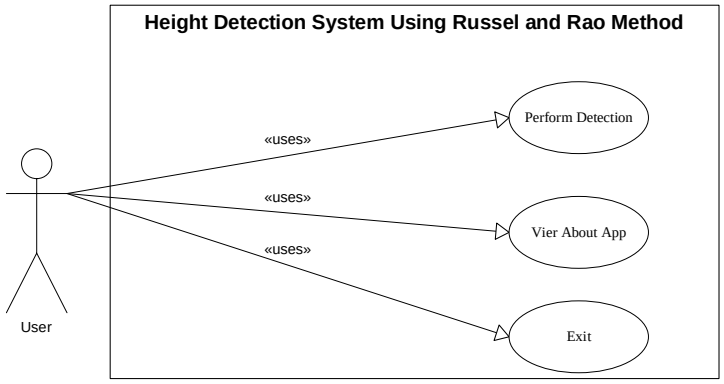

Fig 3. Use Case Diagram

Based on the picture above, users can access three system work processes: the detection process, the About app process, and the exit process.

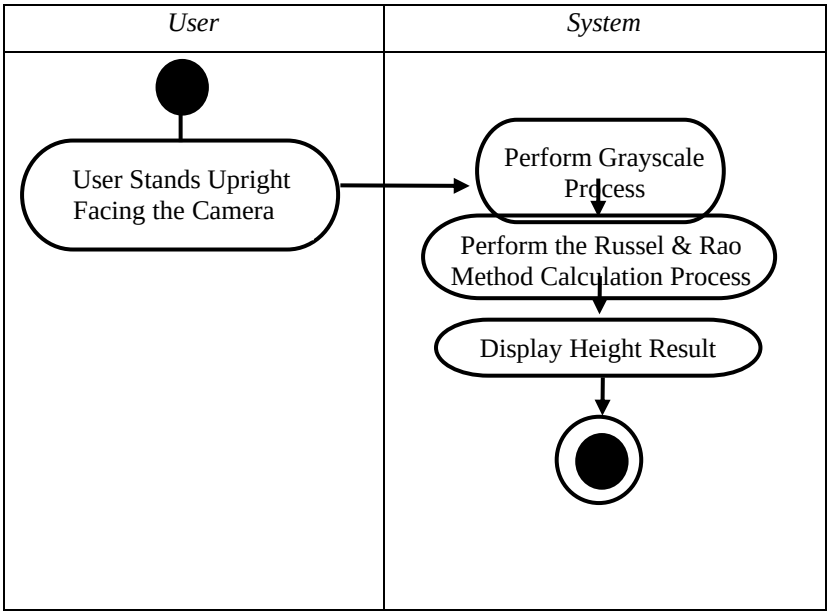

Fig 4. Activity Diagram

Determining the RGB (red, green, blue) intensity value is the first step in performing other processes.

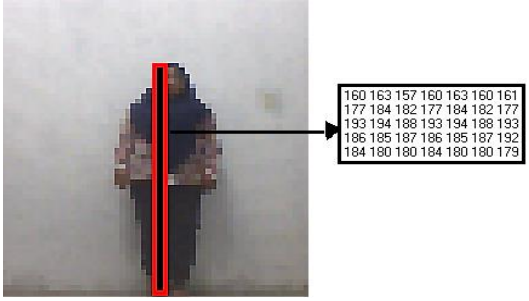

Fig 5. Example of Pixel Intensity Value of an Image

From the picture above, it is concluded that the digital image stored by the memory is only the intensity values, which are in the form of a matrix size of x rows and y columns. If the digital image is written in mathematical form, as in the following table:

Table 2. Mathematical System for Image Pixels

x,y	0	1	2	3	4	5	6
0	160	163	157	160	163	160	161
1	177	184	182	177	184	182	177
2	193	194	188	193	194	188	193
3	186	185	187	186	185	187	192
4	184	180	180	184	180	180	179

Based on Table 2 above, where x (row) and y (column) are function values that express the amount of image intensity or color level of the pixel, and f(x,y) is described as an intensity function.

Converting an RGB image value to a grayscale image is a conversion process from a color image with three layers (R-layer, G-layer, and B-layer). So, the three layers are still considered for further processing. If each calculation process uses three layers, the same three calculations are performed. So, the concept is changed by converting the three layers into one layer of grayscale matrix, resulting in a grayscale image. One grayscale image represents 8 bits; a 24-bit image means it has three registers / 3 channels. Here is the process of solving the value calculation:

Table 3. Manual RGB to Grayscale Conversion

x,y	0	1	2	3	4
0	(160,163,157)	(163,157,160)	(157,160,163)	160,163,160)	(163,160,161)
1	(177,184,182)	(184,182,177)	(182,177,184)	(177,184,182)	(184,182,177)
2	(193,194,188)	(194,188,193)	(188,193,194)	(193,194,188)	(194,188,193)
3	(186,185,187)	(185,187,186)	(187,186,185)	(186,185,187)	(185,187,192)
4	(184,180,180)	(180,180,184)	(180,184,180)	(184,180,180)	(180,180,179)

The process to get the RGB to Grayscale manual conversion results that can be seen in the table above requires a calculation using the following formula:

$$s = \frac{r + g + b}{3} \quad \text{.....(3)}$$

Description:
S = Grayscale Color
R = Red Color
G = Green Color
B = Blue Color
Each coordinate requires calculation with the formula, so the results of the calculation process obtained at each coordinate of the image matrix that has been converted from RGB to Grayscale will form the following table:

Table 4. Grayscale Manual Conversion Calculation Results

x,y	0	1	2	3	4
0	160	160	160	161	161
1	181	181	181	181	181
2	192	192	192	192	192
3	186	186	186	186	188
4	181	181	181	181	180

The following is an example of the description of the formula of the Russel & Rao method to determine the distance of two vectors in this application is as follows:

$$i = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \qquad j = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

In the matrix above, vector i is the training value pattern vector while vector j is the test value pattern vector, both of which will be processed by calculating the Russel & Rao method. Before calculating the vector distance, determine the a, b, c, and d values for the Russel & Rao formula. The calculation stages can be seen below:

Russel & Rao method:

a(i,j)= (1,1) = 3

b(i,j)= (0,1) = 0

c(i,j)= (1,0) = 6

d(i,j)= (0,0) = 0

$$Russel\ \&\ Rao = \frac{\mathrm{a}}{\mathrm{a}+\mathrm{b}+\mathrm{c}+\mathrm{d}}$$
$$= \frac{3}{3+0+6+0}$$
$$= \frac{3}{3+6}$$
$$= \frac{3}{9}$$
$$= 0.3$$

The formula described above is a manual calculation process to find the distance value. Based on the value obtained through these stages will become a guideline for image similarity with patterns that have been trained in the system. The value of Sij = 0.3 states that the pattern is detected because the distance value of the image pattern is between 0 and 1.

5. Conclusion

The research results provide several conclusions that will be described as follows:

1. This height detection system uses the Borland Delphi 07 programming language, and object capture is done using a webcam camera. Then, the measurements are measured using the Russel & Rao method. The process has several stages: resize, grayscale, and russel &rao.
2. Russel & Rao's performance has an actual detection percentage of around 65%. Based on 8 sample tests that have been carried out, only three have been successfully detected correctly.
3. At the time of measurement, to get the right results. Environmental conditions must also be considered, including light, distance, and object position.
4. The background used during detection must be white and not blocked by any object because it will block the detection process.
5. This height detection system will not work correctly if other objects are around the object to be measured because the measuring line will move to these different objects. So, to make the measurement more accessible, you can choose the right place.

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