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ANALYSIS AND PERFORMANCE OF BACK PROPAGATION NEURAL NETWORK FOR IDENTIFICATION RANGE OF MOTION USING BACKGROUND SUBTRACTION AND FEATURE EXTRACTION

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ABSTRACT

The current image processing is used to identify, classification of other process related to the two, can represent the characteristics of creature image optimal for the analysis by algorithm that enable large computing power for it also a combination of computational processing in the image and related computer algorithm or methods used. The human being is the field done by adapting the ability of the method to take information. In the research to get an analysis and performance of hybrid method with Artificial Neural Network for identification of motion the human array the Range of Motion (ROM) in Coronal Plane, the extract is done by background method on binary image. Identification human movement, in each frame extraction results then performed image processing to detect type of the human body motion. Image segmentation is done using background subtraction method to get result into binary image with morphological operation against binary image in the form filling holes and opening area to eliminated noise and improve the result of segmentation, skeleton process and perform extraction. Feature extracted is used to distinguish motion between body object one with the other object body is done through the analysis of morphological forms based on seven grades of moment invariant previously been extracted last step can performed to identifying using Neural Network and to produce the great accuracy and exactly the Range of Motion with 1000 epoch for training. Being in BPNN by combining Moment Invariant for feature extraction whose performance is the highest accuracy about 97.8666%.
Keywords: *Back Propagation, Background Subtraction, Range of Motion*

1. INTRODUCTION

Man is a living creature that has the main characteristics of moving, appropriate motion is done when receiving nerve simulation to certain organs in the body, normal body shape can facilitate human to perform activities such as walking, running, sitting, dancing, eating, drinking and other activities. The human body is designed to be able to perform various types of daily activities of muscle mass weighting almost more than half the load body, allows us to be able to perform activities and do work. One of the simplest human movement and the widening of movements performed by human hands, the human hand movement is a combination of relationship, in which motion of the upper limbs, in which the upper limb have the function of the balancing the movement of the human body in carrying out various activities normally. The movement of the human hand is a movement that is a mutual joint. The body movement and other types of body movements that can be measured using Range of Motion, the introduction of human gestures can be applied in various applications such as entertainment, robotics, health, sports and other applications. The way human movement is smaller scope of many types of complex human movement, because of the many movement performed by human. Motion analysis is currently widely used in research using image processing. Pattern recognition that can distinguish between one object to another object and can perform identification process of the object in question, the process of recognition movement on the human body can be

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used also separate the movement with digital background image body and the other object. The movement of the body focused on a more specific range of motion such a movement on walking, shoulder movement, foot movement. The type of input used in the research is a collection of frame image obtained from the recorded video and contains representation of the type of human movement using the feature extraction. Feature extraction is performed by counting the number of points or pixels encountered in the checking, where checks are performed in various direction of tracking check checks on Cartesian coordinates of the digital imagery analyzed. The last research which connection by motion analysis using human muscle uses Computer Vision, that system which design Physiotherapy for diagnosis rehabilitation process from limit motion (Ahmad S, MB Abdel Halim, AmrBdr, 2012), the analysis detection human motion using image segmentation not only for static and dynamic also use Radial Based Function Neural Network for the best accurate result while training process and the motion analysis (Shih-Chia Huang and Ben-Hsiang Do, 2014) analysis processing with range of motion can use by instructor for the exercise to rehabilitate and measure getting accident to predict normal motion (Kelly A.Larkin-Kaiser,Jefry J.Parr, Paul A Borsa, 2015). The research by George G 1994 about Artificial Neural Network can differ many motion with another motion. Artificial Neural Network to identification of human motion and can help doctor for analysis. The research of shoulder motion, there are scapular, coronal, and sagittal to get center of rotation 61% (Celia Amabile, Anthony M.J. Bull, Angela E.Kedgley, 2015). Research for the human motion analysis using Artificial Neural Network can be used to process classification, design, prediction process and identification (Tunyanoot Prasertsakul, Yodechanan Wongsa Wat, Warakom Charoensuk, 2014). The research for the motion identification use neural network with combination moment invariant and back propagation neural network and background subtraction and feature extraction (Fauziah, Wibowo E.P, Hustinawaty, Madenda, S, 2018). The research for identification use convolution neural network by feature extraction to get identification fix result, and to get the best result (Niall McLaughlin, Jesus Martinez del Rincon, Paul Miller, 2016).

2. LITERATURE RIVIEW

Physiotherapy of motion is part of medical science of non- pharmacological physical intervention, the main purpose of curative and rehabilitative health disorders. Physiotherapy of physical therapy is a language of treatment techniques with physical modalities, broadly speaking, physiotherapy techniques are widely used to overcome injury. In addition to overcome injuries, health problems in adults who often require physiotherapy interventions include post stroke neurological disorders, joint disorders by injury or impaired immunity. The other conditions that often encounter physiotherapy intervention include back pain, muscle disorders (strains) and other disorders. The goal of therapy in physiotherapy depends on the type injury or physical impairment experienced. In the case of injury, physiotherapy is performed to increase muscle strength, accelerate the healing process, reduce and restore mobility of post muscle flexibility, balance, posture and physical endurance can also be examined by various methods. Physical examination varies from Observes abnormalities or limitations of mobility and the type of impaired functionality of the motion perform, Physiotherapy Basics on Sport Injuries. Range of Motion according to (Potter, 2012).ROM is the maximum amount of movement that can be done in the joint, in one of three areas: frontal/coronal, sagittal and transversal Range of Motion is a movement that under normal circumstances can be done by the joints concerned. The terminology of anatomical motion of the human body can be explained by relative motion not human body in the room. In space anatomical field of the human body motion can be described in three dimensions based on system of field and axis. The three areas of the body at such an angle intersecting at the center of the body mass. In the anatomical position, the center of gravity of the anatomical field includes: sagittal areas that can divide the body extending from front to back and from top to bottom, can be said to be done split the body into 2 parts of the medial (left) and there so that it can be sagittal is a field that is media area. Frontal/Coronal is an imaginary field that extends from side to side and from top to bottom. This field divides the body into anterior (front) and posterior (back) frontal areas are also referred to as Coronal field (Lateral). Transversal fields, is an imaginary field that stretches from side to side and from front to back, dividing the body into the superior (up) and interior (bottom). This transversal field is also frontal/coronal as the horizontal field. Image segmentation is a process intended to get the object contained in the image into the form of an area with each object or region has similarity attributes. Image segmentation aims to divide the homogeneous regions, in an image containing only

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an object, the object is distinguished from its background. The division of the segmentation process depends on the problem to be solved. Segmentation is a very important step or method used to change the image input into the output image in the process based on the attributes taken from the image. Background subtraction is usually used in the desired object segmentation technique of a screen, and is generally used for surveillance system. The purpose of using background subtraction generates the frame sequence of the video and detects all foreground objects. (Weifeng Ge, Yuhan Dong, Zhenhua Guo, Youbin Chen, 2014). Research conducted by (Arno HA, Arvid QL, 2015) the visualization process on flexion movement, abduction and adduction which not used an algorithm that identifies motion and the value of accuracy not mentioned. Research by (Kaveri V Sonani, Mukesh A Zaveri, Sanjay Garg, 2016), performs image segmentation process with skeleton foreground extraction process using vector feature and motion recognition with LCS algorithm. Extraction movement on hand and foot movement used for physiotherapy process, accuracy value has not been mentioned. Research conducted by (Tae Soo Kim, 2017), using Temporal Convolution Network (TCN) algorithm, extraction movement performed on the ankle and pelvis. An accuracy 0f 83.1 % uses dataset. Research done by (Tavipia Rumambi, Hustinawaty, Sarifuddin Madenda, Eri Prasetyo Wibowo,2017) skeleton tracking process with gray depth, extraction process for low back pain at waist with accuracy 94%. The research done by (Thiago Bruno Caparelli, Eduardo Larazo Martins Navaes, 2017) uses Artificial Neural Network (ANN) and Pearson Correlation for data validation process. extraction process of movement on the foot. Extraction of movement, in frame rate 30 fps. Validation value is 75%. Research by Ahmad Sedky Adly, 2012), perform analysis of ROM (Range of Motion) on the anatomical field of ROM (Range of Motion) body done by human shoulder on flexion movement, abduction and adduction the visualization process of movement for program rehabilitation process to help, the process of healing human shoulder using skeleton determining erosion value and thinning algorithm. Using Euclidean distance but the classification value and accuracy are not mentioned. Research by (Kelly A.Larkin-Kaiser,Jefry J.Parr, Paul A Borsa, 2015) uses ROM (Range of Motion), the motion of abduction, flexion, internal rotation, external rotation, but not explained the result of identification and accuracy, using ANN (Artificial Neural Network) for the process of classification and pattern recognition with fps value of 100 result by human postural experiments especially in the ankle joint, but have not mentioned the value of accuracy. The process performed in the field of Coronal clearly visible balance of motion. Based on previous research on previous research on motion analysis on human body the data used generally dataset and algorithm not yet combined with moment invariant. So research on identification of human shoulder motion with several different algorithm and methods can be done using skeleton model. Feature extraction it is a technique used to capture an existing object from the image captured during the acquisition process. Feature extraction is a feature taking or feature from a later from when the acquired will be analyzed for the next process, feature extraction is performed by counting the number of dots or pixels encountered in the checking at the Cartesian coordinates of digitized imagery moment invariant represents a group representing try from the image form and provide information on the types of image geometry. Moment invariant was introduced by Hu in 1961(Hu, 1961) Hu introduces the moment invariant for digital images with the size of M x N pixels. Then the equation of moment invariant can be written as the following 1 equation:

$$M1 = \eta_{20} + \eta_{02}$$
$$M_2 = (\eta_{20} + \eta_{02})^2 + 4\eta_{11}^2$$
$$M_3 = (\eta_{30} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2$$
$$M_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{21} + \eta_{03})^2$$
$$M_5 = (\eta_{30} - 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$$
$$M_6 = (\eta_{20} - \eta_{02})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03})$$
$$M_7 = (3\eta_{21} - \eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] - (\eta_{30} + 3\eta_{12})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2] \quad (1)$$

3. ARTIFICIAL NEURAL NETWORK

The Artificial Neural Network (ANN) is a learning algorithm commonly used by multiple layers of perceptron to alter the weight associated with its hidden neurons. Artificial Neural Network is one of representation of the human brain to process simulation on learning. Artificial are used and implemented using computer programs to sort out of a number of calculation process learning.

Artificial neural network is determined 3 points:

a. Pattern of neural relationship
b. Method for determining the weights of connectors
c. Activation Function

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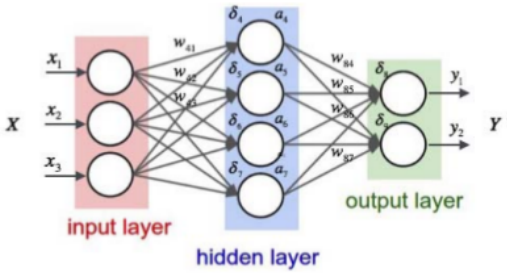
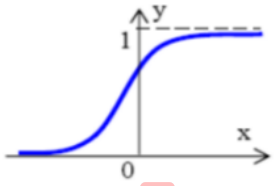


Figure 1: Description of the Artificial Neural Network

From the figure1, the information processing in the Artificial Neural Network can be abbreviated as follows: Potential appears as a unit input layer, the effect of each signal is expressed as a multiplication with a weighted value to indicated of the input, all signals are weighted, are summed one another to produce an activation unit is compared to a threshold value, the result is inserted into the transfer function (the produces an output). In summary, the process can be describes in the signal with hidden layer and the result output layer.

3.1 Artificial Neural Network Component

Neural Network Components there are several types of neural networks almost all of the same components have their components. These neurons will transform in formation receive through the connections to other neurons. In Neural Networks, relationships are known by weights. The information is stored at a certain value on the neuron. The artificial neural network works in the same way as a biological neuron. The information (input) is sent to the neuron with the arrival weight certain. This input will be processed by a propagation which adds up the value of all the weights. The result is compared to a certain threshold value by activation function of each neuron. If the input passes a certain threshold value, the neuron will be activated, but otherwise the neuron will be not be activated, the neuron will infect the output through the weight of its output all the neurons associated with neural networks. In Neural Network, neuron will be collected in layers called of layers of neurons (layer neurons). The neuron on the neuron in one layer will be connected to the layer before and after (except the input layer and the output layer), information provided on the neural network will be propagated layer to another layer. Starting from to input layer to output layer which is called as hidden layer (SMN Arosha Senanayake, 2014), offering neural network with a single layer. Artificial Neural Network (ANN) is learning



algorithm commonly used by perceptron with multiple layers to alter the weight of the weights connected with neurons present in the artificial neural lines. The figure 2 explain about the activation function for binary sigmoid

Figure 2: Description of Binary Sigmoid

From the Figure 2, the information training with back propagation neural network, the function have range 0 until 1

3.2 Back Propagation Neural Network Method

Artificial neural network can be given the connection that human try to make the original neural networks whereas the purpose of BPNN is a model computational system, that can be transferred network. Back propagation is a supervised learning algorithm. Algorithm uses output error to change the value of weight to backward hidden layer name back propagation backward neuron is activated by an aquatic function.

Structure of Back propagation Neural Networks are attracted to a set of elements of neurons or nodes or cells interconnected and organized in layers. Each cell processes with it activation function sigmoid. Then the equation of function sigmoid can be written as the following 2 equation:

$$f(x)=1/(1-e^{-x}) \quad (2)$$

In figure 3 explain about the structure of Back Propagation Neural Network

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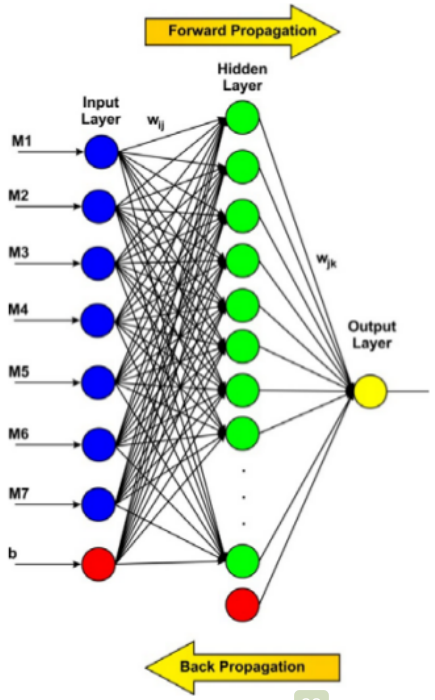

Figure 3: Description of Structure Back Propagation Neural Network

From the figure 3 the back propagation neural network algorithm is used as follows:

1. Initial weight
2. Set maximum epoch target and learning rate
3. In socialize epoch value with targeted epoch data and targeted MSE (Mean Square Error) wear appropriate steps as long as the value Maximum Mean Square Error > Target Error. The source figure from the (Fauziah, et. al,2018)

3.3 Normalization on Artificial Neural Network

On Artificial Neural Network normalization is scaling of values into a certain range it is done input and output targets correspond to the range of activation functions used in network. Then the equation of Normalization can be written as the following 3 equation:

$$x' = \frac{0.8x - a}{b - a} + 0.1 \quad (3)$$

From the equation 3 x' is: result of normalization, x is: data input, a is: minimum data, b is: maximum data. From the normalization is done to get the data are in the interval 0 to 1. This is because the value of the sigmoid activation function in Binary is between 0 and 1. But it would be better if transformed into smaller intervals. For example on the interval [0.1 until 0.9], because given the Sigmoid function Binary value never reaches 0 or 1.

4. METHODOLOGY

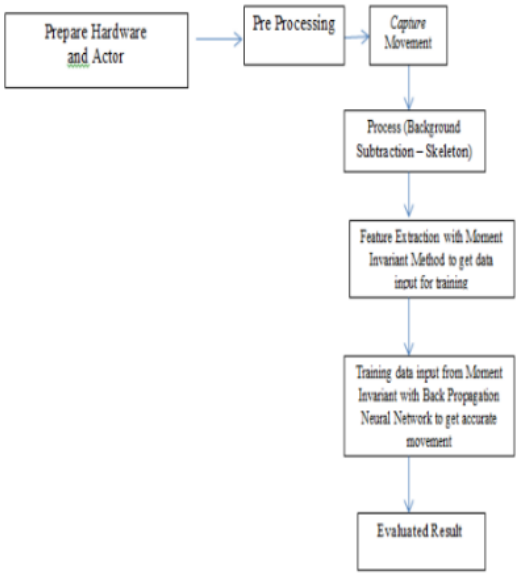

Figure 4: Description of research methodology

From figure 4 research methodology explain about in the figure shows the main contribution. On the breaking line it contains the acquisition process of human body motion in the anatomical position of the body (based on frontal or coronal plane). The feature extraction process uses moment invariant, other uses algorithm that have been developed by previous researchers. Which is done in figure9 with the initial stage, prepare the actors who will be as human object in the process of taking gestures. The acquisition process is done 8MP resolution Camera. Data is contains motion in the anatomical position of the body based on frontal/coronal plane. The result of acquisition a human object with motion in the process consist frame images with the number 30 frames/second. The acquisition of the next video is extracted into several frames. In this research (new initial test results), the totaled 1443 frames from the feature extraction, in each frame the results are performed image processing to detect human body motion (including the Scope of Motion joints/Range of Motion on the anatomical field of the human body of frontal/coronal plane by identifying the flexion, abduction, adduction and the ROM type corresponding to the shoulder human movement).

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Completed using background subtraction method separate from foreground/human body motion object from anatomical field with background/the other object than human). The next step is convert grayscale image of subtraction result into binary image through threshold operation perform morphology operation on binary image such as filling holes and opening area to eliminate noise to improve segmentation result for silhouette making process, then do skeleton, against the binary image of the segmentation result. After the object in the image separate with background, then performed the feature extraction step. Extracted are used to distinguish the type motion between one body object such as motion in the anatomical position of the body based on frontal/coronal plane. In this research feature extraction is done through morphological analysis based on seven moment invariant values. The values are extracted from each image to distinguish the 8 output classes (in temporary test data) are: no object class, flexion motion class, extension motion class, abduction motion class, adduction motion class, hyperextension motion class, and the other motion. The seven values of the moment do not change with translation, scales change, reflection and rotation. The extracted moment invariant is then used as input in the identification algorithm. The identification process is done to recognize the type based on input value in the form of seven moment invariant values previously extracted. The last step is to perform the identification process using Artificial Neural Network algorithm (Back Propagation) will be seen from the characteristics or type of data processed, so that the resulting method or algorithm ANN hybrid with Moment invariant as input data resulting from the formation of skeleton characteristic formed through 1443 frames (after the video extraction process) it is clear, there is change of movement from the previous frame to the frame afterwards, the result of combination and processing of moment invariant to try and get identification human movement and motion and produce the best and maximum result with accuracy percentage and get best value.

5. RESULT AND DISCUSSION

Stages of research conducted are as follows:

1. Preparing from the human as an actor who will provide example of body movement based on the anatomical position of the body on frontal/coronal plane. Perform process are preprocessing from:
   a. Image acquisition process when taking data in video with 47 seconds duration.
   b. The next step process of video extraction to form 1443 frames the anatomical position of the body based on frontal/coronal plane, in each frame the extraction result are then process can perform of identification the type movement

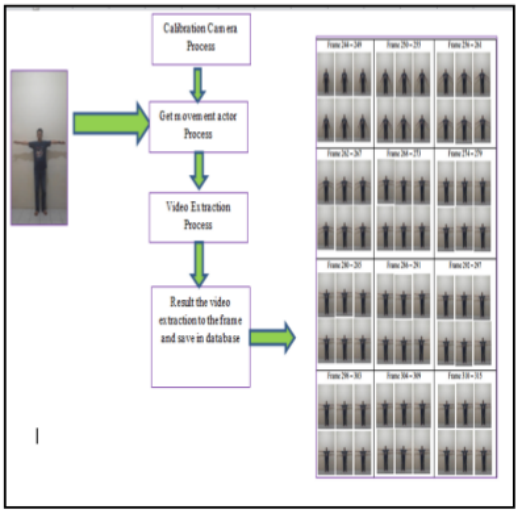

Figure 5: Description Image acquisition process and feature extraction process

From figure5, the result video extraction being frame store are: the moving human object, motion acquisition process, extraction result from motion frame.

2. Image segmentation, the segmentation stage in this research is very important step to get the silhouette of the object of gestures of the human body. The form of motion is based on the anatomical position of the body in frontal/coronal plane. Stages in the process of segmentation consist of preprocess stages and silhouette formation. Each process is describes in full as follows:

   a. **Preprocess** stages are: (grayscale, subtraction and Cropping). The stages performed in this process can be seen in Figure6.

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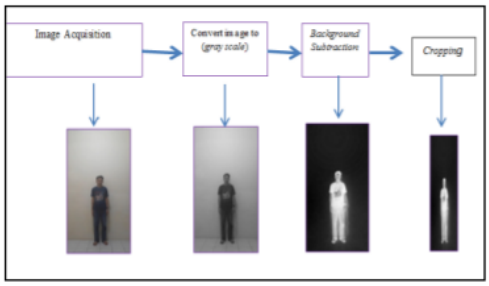

Figure 6: Description Preprocessing stages: grayscale current frame, background subtraction and Cropping

From the figure6, consists of stages of acquisition of human body motion image in according with the anatomical field of the body with measurement of Range of Motion with stage grayscale current frame and background subtraction and the cropping process.

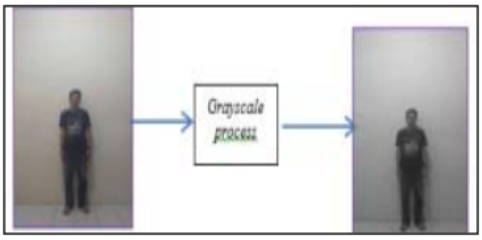

Figure 7: Description Preprocessing stages: grayscale

From the figure7, the Preprocess for grayscale stages it is a step to convert the color space of the original image RGB (Red, Green and Blue) to grayscale to frame selected, the equations used to convert the RGB color space into grayscale image can be seen in equation following 6:

$$Grayscale = 0.2989 * R + 0.5870 * G + 0.1140 * B \quad (6)$$

The next steps from the preprocess steps is background subtraction, in figure8, can be seen the background subtraction process.

The next steps from the preprocess steps is background subtraction, in figure13, can be seen the background subtraction process.

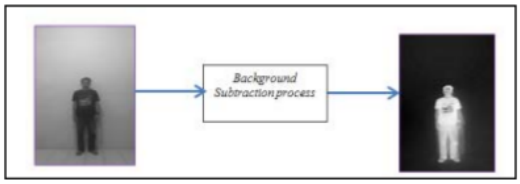

Figure8 Background Subtraction Process

From the figure8, the preprocess for background subtraction or foreground detection is one of the technique in digital image processing and computer vision to perform the process of detecting an image that is or take the according to the object motion position direction foreground from the background based on frontal or coronal plane. Background subtraction one of the usually an input to be processed at a further level such as a motion object that can be used from background subtraction to generate frame sequence from video and detect all foreground reduction process is done by subtracting each pixel from the background image frame with the human body motion image, where P[F(t)] is the resulting image, P[I(t)] is the background image, P[B] is the image gestures in anatomical position of the body based on frontal/coronal plane can be seen equation following 7:

$$[F(t) = P[It)] - P[B] \quad (7)$$

The next step is cropping, in figure14, can be seen the stage of cropping. The cropping process is used to execute the resulting image size.

b. **Stages Performed on the silhouette process**, the process of conversion of binary image with threshold, performing morphological operation on binary image in the form of filling holes and opening area to eliminate the result of segmentation, and the result is formed the appropriate silhouette.

The process performed at the silhouette stage can be explained in figure9.

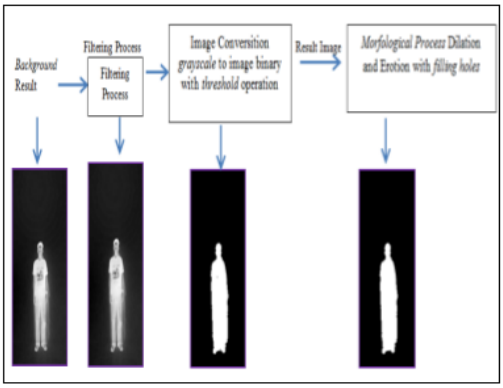

Figure 9: Description Silhouette process: filling holes and opening area

From the figure9, stages of filtering is step 1, the filtering process is used to perform the noise of spots that exits in the image processing after the process background subtraction, spots that exits on the image of the result processing background subtraction can be regarded as noise or noise results from the stages of the filtering process can be seen in figure10.

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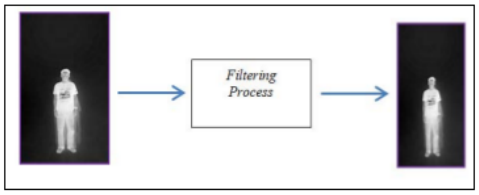

Figure 10: Description Filtering Process

The next step from silhouette process is step 2, to convert the binary image with threshold from the given input is the background subtraction image is the binary image of the threshold resulted, the threshold result value of conversion process binary image with threshold can be seen in figure11.

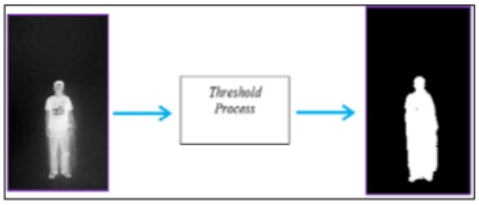

Figure 11: Description Threshold Process

From the figure11, threshold process is a process that has been done after process background subtraction on threshold is an existing method of image segmentation process that can separate the motion of the anatomical body based on frontal/coronal plane, as a foreground with a background that is at a brightness level or a dark and light level. The intensity value of the region of an image will be perfectly black, than the intensity 0 and the region of an image will be perfectly bright or white the intensity value being 1. At the threshold stages is a process after done the stage of background subtraction and filtering, the process of obtaining done by partial cutting of the existing image, the cutting done on the part of the background located on the image stage of morphological operation with filling holes. The next process is using a morphological operation is a common operation used in binary image operations(black and white) in order to alter the structure of the object shape contained in the image. For example, on human objects when performed anatomical position of the body based on frontal/coronal planes, there are holes or holes contained in the human image and can be closed by morphological operation The erosion and dilation operation is use morphological processed, the operation is used to obtain a widening of 0 pixels (Gonzales& Woods, 2002), where erosion has the effect of reducing the image structure. The process performed to produce a better image. The opening operation is to smooth the contour of the objects and remove all the pixels in the area too small to be occupied by the structural element, means that with all the foreground structures smaller than the structure elements will be eliminated by erosion. The equation applied to the opening operation seen equation following 8:

$$A \circ S = (A \otimes S) \oplus S \quad (8)$$

The next step is filling holes, can be seen in figure 12.

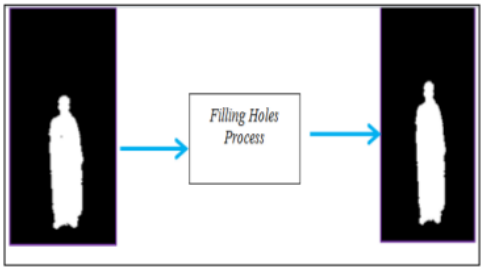

Figure 12: Description Filling Holes Process

d. **Skeleton process**, in the process there are several way used for skeleton represented for skeleton represented for the introduction of the structure of the human body shape structure of motion based on the anatomical body of frontal/coronal plane, in MATLAB skeleton can be obtained which can be with using function in MATLAB to produce skeleton. The skeleton process can be seen in figure13.

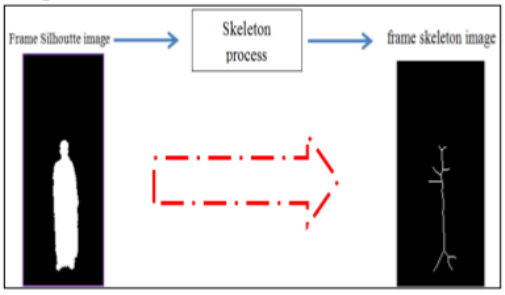

Figure 13: Description Skeleton Process

From the figure13, the following picture is the skeleton process from frame silhouette image, the process are results of morphological operation stage by black-white morph function to produce skeleton model.

Feature extraction, is a technique used to obtain the existing object from the image captured during the acquisition process. Feature extraction is a feature retrieval or feature of a later form when the value obtained will be analyzed for the next process, feature extraction is done by counting the

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number of points or pixels encountered in the checking process, where checks are performed in various direction of tracking checking at Cartesian coordinates of digital image analyzed. The feature image used in this research is feature extraction with moment invariant based on anatomical body plane. Moment invariant is used in feature extraction process in image processing step for shape recognition and classification.

Algorithm for identification movement human shoulder:

a. Algorithm for Feature extraction

1 .Read result skeleton
2. Process M:

$$M_{pq} = \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} x^p y^q f(x,y)$$

3. If M = M'

```
Feature1 =Cell (7, 2)
Feature 1(1, 1) = 'M1';   Feature1 (1,
2) = num2str (M1));
Feature1 (2, 1) = 'M2;    Feature 1(2,
2) = num2str (M2));
Feature1 (3, 1) = 'M3;    Feature1 (3,
2) = num2str (M3));
Feature1 (4, 1) = 'M4';   Feature1 (4,
2) = num2str (M4));
Feature1 (5, 1) = 'M5';   Feature1 (5,
2) = num2str (M5));
Feature1 (6, 1) = 'M6';   Feature1 (6,
2) = num2str (M6));
Feature1 (7, 1) = 'M7';   Feature1 (7,
2) = num2str (M7));
Row1 = cell (7, 1)
  For I = 1 to 7
        Row1 (I) =num2str (I)
  Else M'
End if
End for
```

b. Algorithm for identification

1. Read data training
2. moment invariant from feature skeleton
3. [m, n] = 0
4. For x = 1 to m
5. For y = 1 to n
6. Normalization data training
   M(x, y) =0.1+0.8*(training data(x, y) - min training data(x))/(max training data(x)-min training data(x));
7. Result data
   Result data = simulation (normalization data training)
   result_test2 = round ((result_test2-0.1)*(max train-min result)/0.8)+min result;
8. identification result_test2:

If result_test2= = 0 then move=' no object

Else
If result_test2= = 1 then move='flexion'

Else
If result_test2= = 2 then move='extension'
Else
If result_test2= = 3 then move='abduction'
Else
If result_test2= = 4 then move='adduction'
Else move='no result'

9. End if
10. End For

Result feature skeleton for identification with Moment Invariant Method

Table 1: Skeleton for M1-M2

M1	M2
274,427,278,255,838	261,144,010,653,257
204,040,558,174,623	119,381,620,988,461
391,360,967,840,061	518,861,498,286,783
642,397,883,167,108	404,943,777,048,395
719,718,311,451,100	504,483,530,859,288
904,434,592,242,624	784,915,210,310,877
294,403,442,245,223	324,884,180,499,187
272,314,566,153,067	251,387,136,973,507
295,400,212,724,850	233,883,930,561,192

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Table 2: Skeleton for M3-M4

M3	M4
0.612884921225619	0.466832913438374
0.300512340491790	0.252719050352068
964,971,699,882,234	795,513,401,827,724
603,119,874,054,366	422,998,795,991,744
108,664,054,443,013	678,777,265,056,298
348,954,767,422,277	132,822,756,310,644
101,370,714,040,605	115,176,515,054,050
270,312,215,848,624	267,393,275,211,574
263,389,266,707,933	316,616,855,692,833

Table 3: Skeleton for M5-M6

M5	M6
-0.312719693434416	-0.0488739030192988
0.0710544299966920	0.268837600952026
509,338,031,066,001	120,886,441,007,497
179,465,156,324,330	266,691,699,522,096
490,470,642,149,905	470,273,494,649,951
309,695,482,566,366	785,415,443,632,268
127,741,973,086,592	203,934,354,184,601
736,654,608,574,010	410,718,948,840,904
104,075,225,245,380	476,719,301,446,193

Table 4: Skeleton for M7-Result

M6	Result
0.273922835266494	0
-0.00828729155105925	0
669,550,036,022,559	0
0.979838471874154	1
377,734,898,769,074	1
273,013,995,492,621	1
0.103829937484812	2
-0.335064614101787	2
-0.828743253973176	2

From table1 to table4, explain the result feature skeleton with moment invariant, M1-M7 feature of skeleton can result identification of the motion. The value moment invariant to get input data for training in back propagation neural network.

The accuracy value 97.8666% with the Back Propagation Neural Network, training epoch for 1000 however the training process stops at the epoch to 299 and error train 2.1334% from the training with back propagation neural network algorithm.

6. CONCLUSION

1. Using back propagation neural network method for identification Range of Motion and using moment invariant method at feature extraction process as with basic inputs for training on ANN and can result in the classification of objects and the identification of the resulting objects with the characteristic of motion (the class no object, flexion motion class, extension motion class, abduction motion class, adduction motion class, hyperextension motion class).
3. Algorithm Back Propagation Neural Network and Moment Invariant whose performance is the highest accuracy is 97.8666% for this research.
4. Each method is used is seen, it the data used as input has a suitability or accuracy of the method and the type of characteristic of data process, especially for the Back Propagation Neural Network method and with moment invariant for feature extraction.
5. Future work can be tasted with various movements not only in the anatomical body for frontal/coronal plane it can be implemented also for the sagittal and transversal plane.

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