Gesture Recognizing using Naïve Bayes Algorithm and a Leap Motion

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Abstract: This article presents the methods to recognize poses of the hand. The Naïve Bayes algorithm is used to identify four gestures. These gestures are applying in a customized game. The leap motion as a gesture sensor is utilized in this study. Five subjects are performing the attempt after the training their gestures data. Roll left, roll right, and palm face down are the gestures to be trained and tested in this study. The experiment results show that this system enabled to read the poses of the user's hands. To demonstrate the abilty of the proposed method, a customized game is created. Moreover, the users enable to play a game with no difficulty.

1 INTRODUCTION

Human Machine Interface (HMI) is a part of the machine to make it easy to use the equipment. To control the equipment more convenient for the user, the gestures of the human are used. Hand and fingers are the popular human body part which used to manage the machine using their poses.

Human gestures, especially human hand poses, can be divided into two groups, static pose and dynamic movement, respectively. A static pose is a pose that is in idle condition and almost with a constant shape. On the other hand, the active activities are poses with the pattern motion (Sonkusare, 2015). Comparing both gestures in the computational term, the dynamic movements are more complicated than the static ones (Huang, 2015). However, these dynamic gestures have many applications for HMI.

Robotics (Andrean, 2019), health (Andreoni, 2007), and also playing a game are several examples of HMI applications using dynamic gestures. To interface the human gestures with the machine, there are several instruments to be used, for instance, using Electromyograph (EMG) or muscle signal (Andrean, 2019), brain signal, or Electroencephalography (EEG) (Andreoni, 2007), and camera (Liu, 2019).

In this article a leap motion which is used for the instrument to detect the movement of human poses. Moreover, the Naïve Bayes algorithms are applied to recognize the movement of the subjects. Also, a costumed game is establishing to examine the effect the proposed system.

To deliver a complete discussion, this paper is organized as follows: the next section purposes of providing information about the previous researches to identify human hand gestures. Section III presents the proposed system. Then proceed with next, Section IV, which offers the tests on the proposed method by examining the effectiveness of the proposed system using a real game. In final part provides the concluding remarks and the future work of this investigation.

2 BACKGROUNDS

The hand poses identification has become the research topic which be applied in the robotic hand and prostatic hand. Some of the researchers are studying recognizing the poses of the hand in dynamic movement. Dynamic hand gesture prediction from the movement of the hand before completed. This system is introduced by Chen et al. (Chen, 2015). They enabled to identify of 36 patterns which comprise 26 letters and ten numbers. For this task, the SVM algorithm and a leap motion sensor are used. The others application is to identify the movement of the user's hand to translate to the text line. The Hidden Markov Model (HMM) is used by this system to identify the gestures of the hand.

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Moreover, a leap motion is also used to sense the poses of the hand (Agarwal, 2015).

Several researchers have done studies about the identification of Sign Language. The American Sign Language recognition using HMM is done by Fok et al. (Fok, 2015). In comparison, the Arabic Sign Languages is studied by Mohandes et al. (Mohandes, 2014). They used a Multi-layer perceptron Neural Network (MLP). The Euclidean distance and Cosine similarity are used for Indian Sign Language (Mapari, 2015).

The robot hand is controlled using the user's palm, which has been researched by Bassily et al. (Bassily, 2014). This system uses leap motion to obtain the position of the palm of the user.

For this study, the Naïve Bayes algorithm is used for identifying the gestures of the hand. Naive Bayes is a simple probabilistic classifier that calculates a set of probabilities by adding up the frequencies and combinations of values from a given dataset. To explain the Naive Bayes method, please note that the classification process requires a number of instructions to determine what class is suitable for the analyzed sample. Therefore, the Naive Bayes method above is adjusted as follows:

$$\left(\frac{P(X|C)P(c)}{P(x)}\right) \quad (1)$$

$$P(c\,|\,X) = P(x_1|c)\,\mathrm{x}\,..\,P(x_n|c)\,\mathrm{x}\,P(c) \quad (2)$$

Where:

P(c|x) is the probability of posterior class c with attribute x

P(x|c) is the likelihood which the probability of the predictor given class

P(x) is the probability of class x

P(c) is the probability of class a

$X = (x_1, x_2 \ldots, x_n)$

In this classification, all features/values are assumed to be independent of each other in each class. Because of this, even if a value is dependent on one another, this classification will consider all data to be independent thus giving a probability effect. One of the advantages of Naive Bayes is that only the mean and standard deviation values of the variables are needed to estimate the parameters of the classification:

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i \quad (3)$$

$$\sigma = \left|\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \mu)^2\right|^{\frac{1}{2}} \quad (4)$$

Where:

μ is the mean of the attribute in a class

σ is the variance of the feature in a class

The decision-making rule for classification is to choose one more possibility based on the results of the density of probability values, such as the Gauss Density equation.

$$f(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \quad (5)$$

3 METHODS

To examine the system's effectiveness in identifying the hand's gesture, a system comprised of a hand tracking sensor and connected to a computer. This computer is to process the recognize algorithm also to run the game to test the results. The block diagram of the system is shown in figure 1.

The hand poses used by this study are the gestures. The gestures are the hand that rolls to the left, roll to the right, and hand that face downward. Figure 2 shows the motions of the hand that were used in this experiment.

Figure 3 shows the flow chart of the system. In the Naïve Bayes classification algorithm, the process is divided into two phases, namely the training and test phase. In the training phase, the algorithm is given the parameters of the movements. For this experiment, yaws, pitch, and roll of the palm of the hand for each pose are supplied to the algorithm.

After the training phase is finish, the algorithm will provide the values that used in the test phase. In this phase, each gesture will determine the success rate.

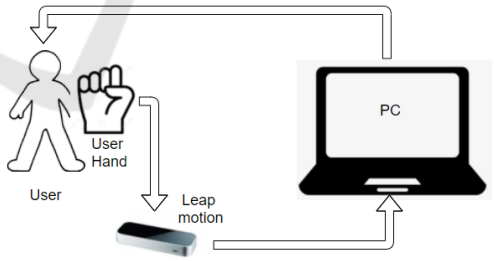


Figure 1: Block Diagram of the proposed system.

Figure 2: (a) Roll to the left (b) face downward (c) roll to the right.

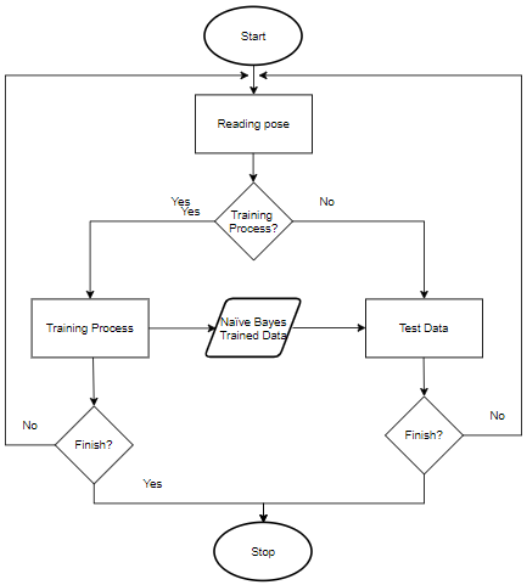


Figure 3: Flowchart of the system.

4 RESULTS

A male 24years old subject is done the experiments. He never used the leap motion before. He uses the dominant hand to do the experiments. Figure 4 shows the right hand of the subject maneuverings his hand above the leap motion sensor. He performed the training phase. For each pose, he has done it five times. To examine the algorithm, the subject has performed the tests. He was moving his hand five times for each gesture. Table 1 shows the results of the test in the confusion matrix. From this table, the percentage of the successful classification is about 93%.

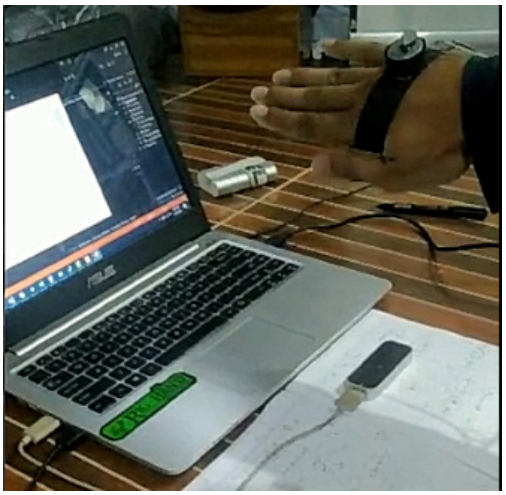
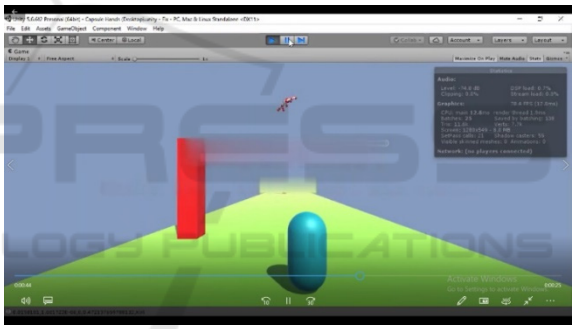


Figure 4: Subject hand above the sensor.

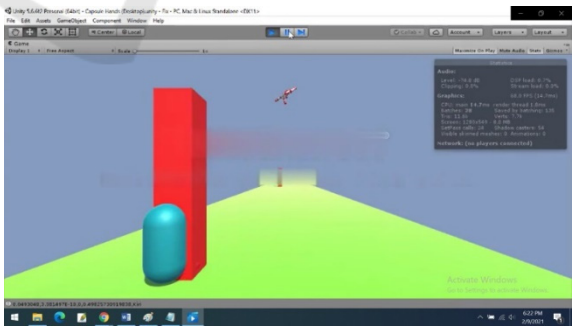
Table 1: The Confusion matrix.

		Predicted		
		Left	Middle	Right
Actual	Left	5	0	0
	middle	0	5	0
	Right	0	1	4

To demonstrate the effectiveness and the reaction of the system, a costumed game is designed. In this game, the classification system is included. This game is to control a cylinder to avoid the obstacle. This cylinder is controlled by the gesture of the hand. To move to the left, the user has to roll their hand to the left. Also, to go to the right, the user has to roll their hand to the right. The subject never plays the game before. The subject feels that the system is responsive. The system enables to identification of the movement of the hand fast. He is able to control the movement of the cylinder easily.



(a)



(b)

Figure 5: The screen shoot of the game (a) success to avoid the obstacle (b) bump the obstacle.

4 CONCLUSIONS

This article shows how the Naïve Bayes theorem to be applied to identify the hand gestures. The poses of the hand is sense using a stereo infrared camera. The experiments show that the system enables to recognize the movement of user hand. The successful rate of identify the poses is around 93%. Moreover, the proposed system is responsive to read the hand poses. It shows in the application in the game. In the future this system will be used to be applied in the advanced games. This system will be combining with the tactile actuators, to make user more immersive with the game.

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