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Performance Evaluation of Support Vector Machine Algorithm for Human Gesture Recognition

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ABSTRACT

Research on human motion gesture recognition has been widely used for several technological devices to support monitoring of human-computer interaction, elderly people and so forth. This research area can be observed by conducting experiments for several body movements, such as hand movements, or body movements as a whole. Many methods have been used for human motion gesture recognition in previous studies. This paper attempted to collect data of performance evaluation of support vector machine algorithms for human motion recognition. We developed research methodology that is adapted PRISMA. This methodology is consisted of four main steps for reviewing scientific articles, including identification, screening, eligibility and inclusion criteria. After we obtained result of systematic literature review. We also conducted pilot study of SVM implementation for human gesture recognition. Based on the previous study result, the accuracy performance of vector machine algorithms for body gesture dataset is between 82.88% - 99.92% and hand gesture dataset 88.24% - 95.42%. Based on our pilot experiment, recognition accuracy with the SVM algorithm for human gesture recognition achieved 94,50% (average) accuracy.

Keywords: Human Gesture, Support Vector Machine, PRISMA

I. INTRODUCTION

The implementation of human motion gesture recognition has been widely used for several technological devices to support monitoring of human-computer interaction, elderly people, sport training movements and so on (Kale & Patil, 2016; Kumari, Mathew, & Syal, 2017; Zhou & Hu, 2008). Applications that utilize human motion gesture recognition have had a positive impact and great business value, such as applications on watches or smart phones as part of a smart home device that can monitor or monitor the activities of people inside (Del Rio, Sovacool, Bergman, & Makuch, 2020; Sovacool &

Del Rio, 2020; Wan, Qi, Xu, Tong, & Gu, 2020). These applications are usually used to monitor the activities of elderly people to avoid events that endanger their safety (Ani, 2020; Bu, 2020; Putra, Hidayat, & Noprisson, 2016).

Research on human motion gesture recognition can be observed by conducting experiments for several body movements, such as hand movements, or body movements as a whole. There are many research challenges related to human motion gesture recognition, such as complex image or video background problems that require appropriate preprocessing in order to get maximum results (Bu, 2020).

Many methods have been used for human motion gesture recognition in previous studies by using support vector machine (Oudah, Al-Naji, & Chahl, 2020; Ramayanti & Salamah, 2018). In 2017, De Smedt et al. conducted research for 3d hand gesture recognition using a depth and skeletal dataset (De Smedt et al., 2017).

In 2015, Chen et al completed research project of the real-time dynamic hand gesture recognition system using Kinect sensor (Chen, Luo, Chen, Liang, & Wu, 2015)

In 2019, Bamwenda & Özerdem completed the study of recognition of static hand gesture with using Artificial neural networks (ANNs) and support vector machine (SVM) (Bamwenda & Özerdem, 2019). In 2020, Quaid and Jalal proposed the wearable sensors based human behavioral pattern recognition using statistical features and reweighted genetic algorithm (Quaid & Jalal, 2020).

In 2019, Zhang, et al conducted research of human motion recognition based on support vector machine (SVM) in virtual reality (VR) art media interaction environment (Zhang, Wu, Pan, Ding, & Li, 2019). In 2012, Pei et al., using LS-SVM based motion recognition for smartphone indoor wireless positioning (Pei et al., 2012).

Based background above, this paper attempted to collect data of performance evaluation of support vector machine algorithms for human motion recognition from previous studies. We also conducted pilot experiment to prove the accuracy of SVM for human recognition is similar to result from previous studies.

II. METHODS AND MATERIAL

We developed research methodology that is adapted PRISMA. This methodology is consisted of four main steps for reviewing scientific articles (Liberati et al., 2009; Mohamed, Ghazali, & Samsudin, 2020; Moher, Liberati, Tetzlaff, & Altman, 2009). The four steps of phases of this research can be seen in Figure below.

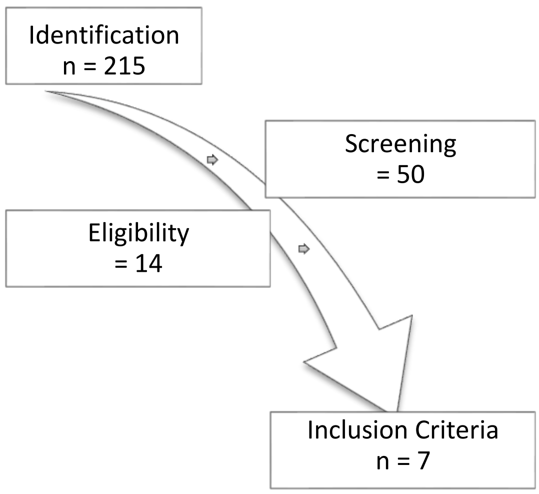


Figure 1: Research steps of this systematic literature review

We explored research databases, such as Google Scholar, IEEEXplore and Wiley Online Library, Science Direct and ProQuest to obtained relevance articles by using keyword “human gesture recognition” OR “human motion recognition” && “SVM”. The research question as guidance for systematic literature review as follows:

- What is dataset used for human motion recognition research?
- How result of algorithm performance for recognizing human motion?

After we obtained result of systematic literature review. We also conducted pilot study of SVM implementation for human gesture recognition. The dataset was obtained using the Microsoft Kinect Sensor (Biswas & Basu, 2011; Ghotkar, Vidap, & Deo, 2016). The dataset consists of 594 movement sequences obtained from 30 people performing 12 gestures. The 12 gestures consist of basic movements, namely lift arm, duck, push right, goggles, wind up, shoot, bow, throw, had enough, change weapon, beat both and kick. In this dataset, one person performs a movement 9-10 times. In each frame there are 20 3D joints which are estimated using the Kinect Pose Estimation pipeline.

III.RESULTS AND DISCUSSION

A. Data Collection

By using systematic literature review, we successfully collected seven data (n=7) of international articles from research databases that presented in Table 1 below.

TABLE I
DATA COLLECTION N=7

Year	Authors
2017	(De Smedt et al., 2017)
2015	(Chen et al., 2015)
2019	(Bamwenda & Özerdem, 2019)
2020	(Quaid & Jalal, 2020)
2019	(Zhang et al., 2019)
2004	(Schuldt, Laptev, & Caputo, 2004)
2012	(Pei et al., 2012)

B. Human Motion Recognition Dataset

One of the research problem or aim in this research is dataset identification of human motion recognition using support vector machine (SVM). In general, we found two types of dataset, including hand gesture and body gesture dataset.

The research by using hand gesture dataset is conducted by (De Smedt et al., 2017) (Chen et al., 2015) (Bamwenda & Özerdem, 2019). De Smedt et al. (2017) used hand skeletal dataset from intel real sense depth camera (SHREC 2017 track 3D) with image size 640×480 pixels (De Smedt et al., 2017). Chen, et al. (2015) employed dynamic hand gesture dataset from Kinect v2 camera sensor with image size 512 × 424 pixels (Chen et al., 2015). The last, Bamwenda & Özerdem (2019) used hand gesture dataset of American Sign Language (24 alphabets) from Kinect V2 with image size depth 512 × 42 pixels (Bamwenda & Özerdem, 2019).

The research by using body gesture dataset is proposed by (Quaid & Jalal, 2020) (Zhang et al., 2019) (Schuldt et al., 2004) (Pei et al., 2012). Quaid & Jalal (2020) utilized Intelligent Media Sporting Behaviours (IMSB), Wireless Sensor Data Mining (WISDM) and Human Motion Primitives (HMP) for the research (Quaid & Jalal, 2020).

Zhang et al (2019) used private dataset from VR human–computer interaction application contains 10 types of actions, including Plie, Battement Tendu, Rond De Jambe A Terre, Battement Frappe, Battement Fondu, Rond De Jambe En Lair, Battement Releve Lent, Battement Retire, Port De Bras, Devant (Zhang et al., 2019). The process of dataset collection using VR human–computer interaction application is presented below.

Figure 2: The process of private dataset collection
Source: (Zhang et al., 2019)

Schuldt et al (2004) used private dataset of human actions including walking, jogging, running, boxing, hand waving and hand clapping (Schuldt et al., 2004). The example of dataset is presented in Figure below.

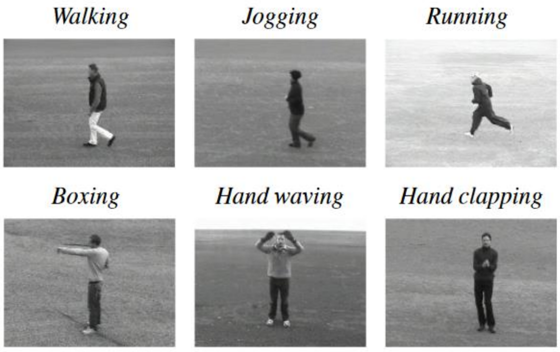


Figure 3: The example of human body gesture
Source: (Schuldt et al., 2004).

Pei et al. (2012) used dataset of human actions including standing with hand swinging, normal walking while holding the phone in hand, normal walking with hand swinging, fast walking, U-turning, going up stairs, and going down stairs. (Pei et al., 2012).

TABLE II
DATASET OF GESTURE RECOGNITION

Authors	Dataset
(De Smedt et al., 2017)	Hand Skeletal Dataset from Intel Real Sense depth camera (SHREC 2017 track "3D) with image size 640 × 480 pixels
(Chen et al., 2015)	Dynamic hand gesture dataset from Kinect v2 camera sensor with image size 512 × 424 pixels
(Bamwenda & Özerdem, 2019)	Hand gesture dataset of American Sign Language (24 alphabets) from Kinect V2 with image size depth - 512 × 42 pixels
(Quaid & Jalal, 2020)	Intelligent Media Sporting Behaviors (IMSB), Wireless Sensor Data Mining (WISDM) and Human Motion Primitives (HMP)
(Zhang et al., 2019)	Private dataset from VR human–computer interaction application contains 10 types of actions, including Plie, Battement Tendu, Rond De Jambe A Terre, Battement Frappe, Battement Fondu, Rond De Jambe En Lair, Battement Releve Lent, Battement Retire, Port De Bras, Devant
(Schuldt et al., 2004)	Private dataset of human actions including walking, jogging, running, boxing, hand waving and hand clapping.
(Pei et al., 2012)	Private dataset of human actions including standing with hand swinging, normal walking while holding the phone in hand, normal walking with hand swinging, fast walking, U-turning, going up stairs, and going down stairs.

C. Performance Evaluation

We divided performance evaluation into two types of result, including result from hand gesture and body gesture dataset. The performance evaluation of support vector machine algorithms for hand gesture recognition is presented below.

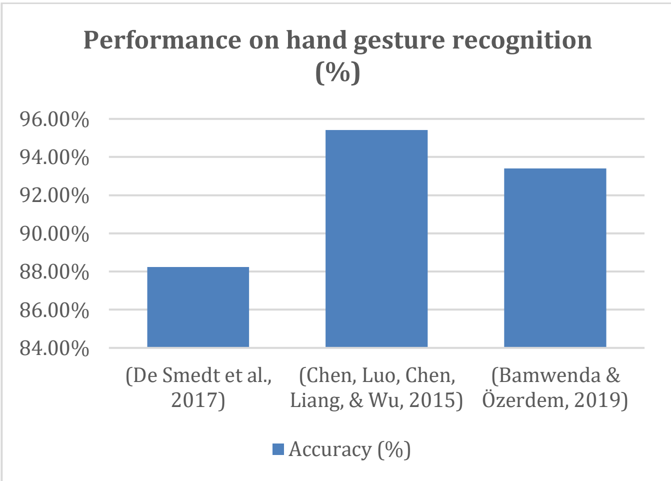


Figure 4 : The performance on hand gesture recognition

Based on Figure above, the accuracy performance of vector machine algorithms for hand gesture dataset is between 88.24% - 95.42%. The highest accuracy is obtained by (Chen et al., 2015). Moreover, the performance result of support vector machine algorithms for body gesture recognition is presented below.

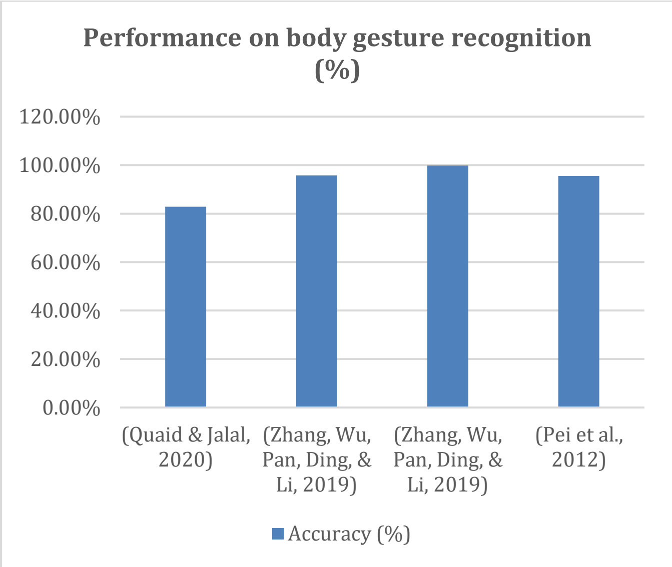


Figure 5: The performance on body gesture recognition

Based on Figure above, the accuracy performance of vector machine algorithms for body gesture dataset is between 82.88% - 99.92%. The highest accuracy is obtained by (Zhang et al., 2019) that combining LDA-GA-SVM algorithm. The complete result of performance evaluation can be seen in Figure below.

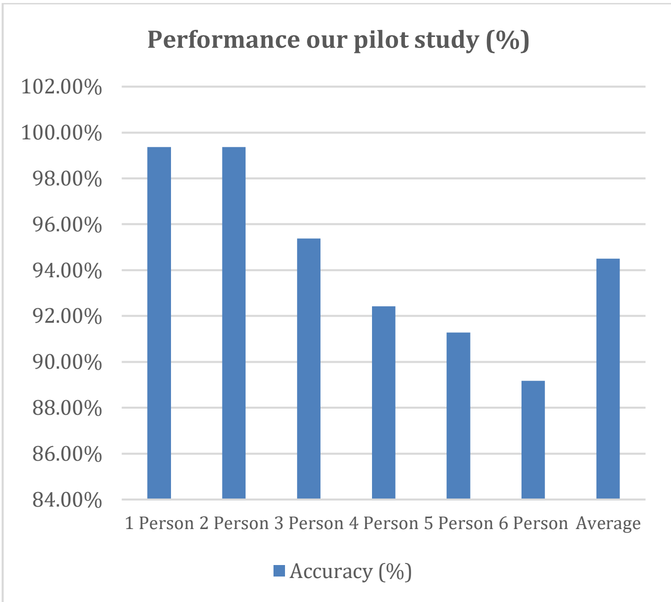
TABLE III

RESULT OF PERFORMANCE EVALUATION IN PREVIOUS STUDIES

Authors	Type	Method	Accuracy
(De Smedt et al., 2017)	Hand gesture	SVM	88.24%
(Chen et al., 2015)	Hand gesture	SVM	95.42%
(Bamwenda & Özerdem, 2019)	Hand gesture	SVM	93.4%
(Quaid & Jalal, 2020)	Body gesture	LSVM	82.88%
(Zhang et al., 2019)	Body gesture	K-means-SVM	95.83%
(Zhang et al., 2019)	Body gesture	LDA-GA-SVM	99.92%
(Pei et al., 2012)	Body gesture	LS-SVM	95.53%

D. Pilot Study

In this experiment, a comparison of SVM performance was carried out on MRSC-12 data. Experiments were carried out by cross-validation, where 2/3 of the data were treated as training data, and the rest as testing data. Experiments were carried out using MRSC-12 data consisting of 12 gestures performed 5 times by 1 to 6 people. Figure below shows the recognition accuracy with the SVM algorithm.



IV. CONCLUSION

Based on the previous study result, the accuracy performance of vector machine algorithms for body gesture dataset is between 82.88% - 99.92% and hand gesture dataset 88.24% - 95.42%. The highest accuracy for body gesture is obtained by (Zhang et al., 2019) that combining LDA-GA-SVM algorithm. Moreover, based on our pilot experiment for body gesture, recognition accuracy with the SVM algorithm for human gesture recognition achieved 94,50% (average) accuracy.

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