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Robot Interaction Analysis Based on Support Vector Machine

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Abstract: With the rapid improvement of technologies such as machine learning, artificial intelligence and new applications, robots have gradually evolved from tools that can only complete simple repetitive tasks to applications that serve very efficient and intelligent services, and can be customized according to customer needs. Robot interaction is an important part of robotics as the needs of users and the improvement of ever-changing practical applications. The purpose of this paper is to analyze the robot interaction based on support vector machine. In the experiment, a database is established, and the robot interaction is investigated and analyzed from the quantitative evaluation results and the analysis and discussion of the experimental results by using the curve of recognition rate and recall rate.

1. Introduction

High-tech technologies such as Internet technology, robotics and virtual reality technology are improveing rapidly with the continuous progress of human technology. Disaster relief, industrial production and other fields play an important role [1]. However, there are many problems in the actual application of current robots in various scenarios, such as low robot control efficiency and low operator immersion. These problems not only affect the user experience in human-computer interaction, but also restrict the efficiency of task completion.

Robotics is one of the most promising areas of scientific research at present. Kim S G proposed an autonomous feeding robot and its obstacle classification system using ultrasonic sensors to ensure safe driving of the robot and efficient feeding operations. The feeding robot that has been developed was verified in a test at the shrine. In the proposed classification algorithm, not the maximum amplitude of the ultrasonic echo signal, but the two gradients and the amplitude changes of the signal are taken as the characteristic parameters of the target classification. Experimental results show the effectiveness of the SVM-based classification method, which is able to distinguish

objects or obstacles such as people, cows, walls, and fences [2]. Park K M robots operating near people need to detect attacks quickly and reliably, ranging from violent attacks (hard attacks) to push-pull movements (soft attacks). Because net torque sensors can be expensive, the external net torque due to a crash is often estimated from motor current measurements in net actuators. However, for a reliable detection, these methods typically require complex collision models. In this letter, we design two learning-based detection methods—support vector machines and neural networks—that require current measurements and a robot force model and force observer; no conflict model is required, and manual correction of the collision detection ground. for each joint can be avoided. Extensive experiments on 6DOF industrial robots built using summaries of 4D and 6D real-time data validate our algorithm for a variety of hard and soft collisions [3].Convolutional neural network-based methods show better performance if more training data is available, while support vector machine-based methods perform better with less data.

According to the research background, this paper analyzes the support vector machine and robot human-computer interaction technology. The research on human-computer interaction is mainly divided into three types: data interaction, image interaction, and behavior interaction. In the experiment, a database is established, and the robot interaction is investigated and analyzed from the quantitative evaluation results and the analysis and discussion of the experimental results by using the curve of recognition rate and recall rate.

2. Research on Robot Interaction Analysis Based on Support Vector Machine

2.1. Research Background

Robotics is one of the most promising scientific research directions. To make robots better adapted to human life, their appearance is usually designed to resemble humans [4-5]. The appearance of the humanoid makes the service robot have good compatibility, which can quickly attract users' attention and gain a good impression; but at the same time, people's requirements for its services are still very high. People are expected to be like real people, able to pay attention to words and words, express their feelings, and have a good relationship with people. In order to achieve this goal, it is necessary to study reliable and perfect human-computer interaction concepts and algorithms, and find more accurate, efficient and intelligent solutions in many fields such as human motion capture, behavior recognition, and interactive response. After reading and reading related research results, we found that there are many areas for further research. With the continuous improvement of algorithms such as image processing and pattern recognition, there are more and more technologies for HRI recognition through non-contact audio information, and its accuracy and reliability have been sufficiently guaranteed [6-7]. In recent years, the research on stereo vision in the field of artificial intelligence has become more and more popular. People are no longer satisfied with flight information, but expect to obtain detailed stereo information. Currently, most human motion capture devices on the market use multiple camera systems to capture 3D data of human motion [8-9].

2.2. Support Vector Machines

The most prominent feature of statistical learning theory is the introduction of the concept of VC dimension, which is an indicator to measure many performances, such as the complexity of the function set and the learning ability of the machine [10]. On the basis of this concept, many conclusions about the ability of discriminative learning have been obtained, such as generalization performance, convergence speed, etc. Statistical learning theory has a relatively complete set of theories as the basis, and has its unique advantages in solving small sample problems. The theory

has strong absorptive capacity, and can learn from the advantages of other methods for its own use, and its theoretical foundation is relatively rich and solid, which can solve a single problem that cannot be solved; and can learn from each other in the process of fusion of various methods. Method, Support Vector Machine (SVM) is an example. It was also proposed by former Soviet mathematicians and their collaborators. It took advantage of the advantages of many previous learning methods and improved its shortcomings. The performance of other methods has been proved in practice. At present, this method has become a research hotspot and is expected to make a big breakthrough in machine learning theory [11]. The support vector machine is developed on the basis of the small sample statistical theory. The purpose is to introduce the VC dimension theory when the calculation speed is required to be fast in the case of using a small sample. Risk, these two points have become the theoretical basis of this method.

2.3. Analysis of Robot Human-Computer Interaction Technology

Human-computer interaction technology (Human-ComputerInteractionTechniques) usually means that with the help of various command input devices such as mouse and keyboard, and various data output devices such as display screens, data exchange and mutual exchange between the operator and the machine can be realized under the condition that both parties can receive it. The technology of dialogue [12-13]. From the operator's point of view, human-computer interaction technology is that the operator inputs various types of information such as language and text to the machine, and the machine converts and processes the information and responds to the operator's instructions, and responds through the display screen or other output devices. According to the different forms of interaction, the research on human-computer interaction in this paper is mainly divided into three types: data interaction, image interaction, and behavioral interaction [14-15].

(1) Data interaction

In the VR remote control robot system, the interaction between the operator and the robot can actually be regarded as the interaction between the human and the computer, and the data interaction is an important means of "communication" between the human and the computer [16-17]. Data interaction is actually the process in which the operator inputs data into the computer, and the computer outputs the data after judging the correctness of the data, executing the encoding, etc. These data not only refer to the visible information such as numbers and codes entered through the keyboard, but also include the mouse photoelectric information, sensor acceleration information, etc.

(2) Image interaction

The so-called image interaction refers to the data interaction between the operator and the computer, one or both parties in the image format, including the operator to retrieve pictures, the computer to do threshold segmentation of the input image and other operations [18]. In the process of image interaction, we can divide it into three levels: image perception, image recognition and image processing according to the depth of application of image information. The top of these three levels is image perception, while image recognition and image processing The hierarchical level of processing is decremented once, forming an image interaction pyramid.

(3) Behavioral interaction

In the VR-based remote control robot, in order to improve the efficiency of human-computer interaction, there will be a way for the operator to input control instructions through body movements, that is, to convert the operator's body movements into computer-readable motions through wearable accelerometers and other methods. Read digital signals and respond accordingly to those messages. Usually, what we mean by behavior and action are two different definitions. The physiological structure of the human body and the behavior pattern of the human body determine

that behavior is actually composed of a series of continuous actions. Therefore, in behavioral interaction, computer processing In fact, it is some data such as continuously changing arrays.

3. Investigation and Research on Robot Interaction Based on Support Vector Machine

3.1. Database

(1) MSRC-12 database

A total of 20 participants in the MSRC-12 database exhibited 10 behaviors. In order to detect the recognition effect of the algorithm on daily interaction behaviors, a set of daily interaction behaviors was designed, and 2 participants were arranged to perform and use Kinect to record their movement data, forming a set of daily interaction behavior database.

(2) Multimodal Action Database (MAD) database

Established by the Robotics Institute at Carnegie Mellon University. The database was designed with 10 behaviors, and eight participants performed each behavior twice. Kinec was used to collect movement data.

(3) CR-UESTC database

The CR-UESTC database is an interactive behavior database created by the Institute of Machine Intelligence, University of Electronic Science and Technology of China. The database uses Kinect 2.0 to record 5 interaction behaviors performed by 10 pairs of participants.

3.2. Recognition Rate and Recall Rate Curve

The recognition rate curve refers to the curve formed by the corresponding recognition rate and the average detection time when different recognition thresholds are selected. The recognition rate (Accuracy) is the percentage of correctly recognized behaviors in the total test samples, where TP, FP, TN, FN correspond to the number of different recognition results of positive and negative samples: TP is the number of positive samples that are correctly recognized as positive samples; FP is the number of negative samples that are wrongly identified as positive samples; TN is the number of negative samples that are correctly identified as negative samples; FN is the number of positive samples that are wrongly identified as negative samples. Its definition is:

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \tag{1}$$

Recall is the percentage of positive samples that are correctly identified, and is defined as:

$$Recall = \frac{TP}{TP + FN} \tag{2}$$

The recall rate curve refers to the curve formed by the corresponding recall rate and the average detection time when different recognition thresholds are selected.

4. Analysis and Research of Robot Interaction Based on Support Vector Machine

4.1. Quantitative Evaluation Results

In terms of spatial similarity, the optimization results of RVM and RRBR are both better than the original data, while CIC fails to optimize, so the average spatial similarity of its right arm is lower than the original data. In terms of temporal similarity, the optimization results of CIC are improved by about 5% compared with the original data, and the optimization results of RVM and RRBR are

improved by about 10%. In terms of smoothness, the optimization results of CIC and RRBR are greatly improved compared with the original data, while RVM has an improvement of nearly 10% compared with the optimization results of these two algorithms, and even the average smoothness of the right arm exceeds the true value of Vicon. Quantitative analysis of the above multiple angle trajectories, the evaluation index used is the spatial similarity index, and the results are shown in Table 1 and Figure 1:

Table 1. Data table of different perception algorithms

Free degree	Initial data	RVM	CIC	RRBR
Left arm average	0.0089	0.0043	0.0058	0.0063
The right arm is averaged	0.0421	0.0214	0.0615	0.0274

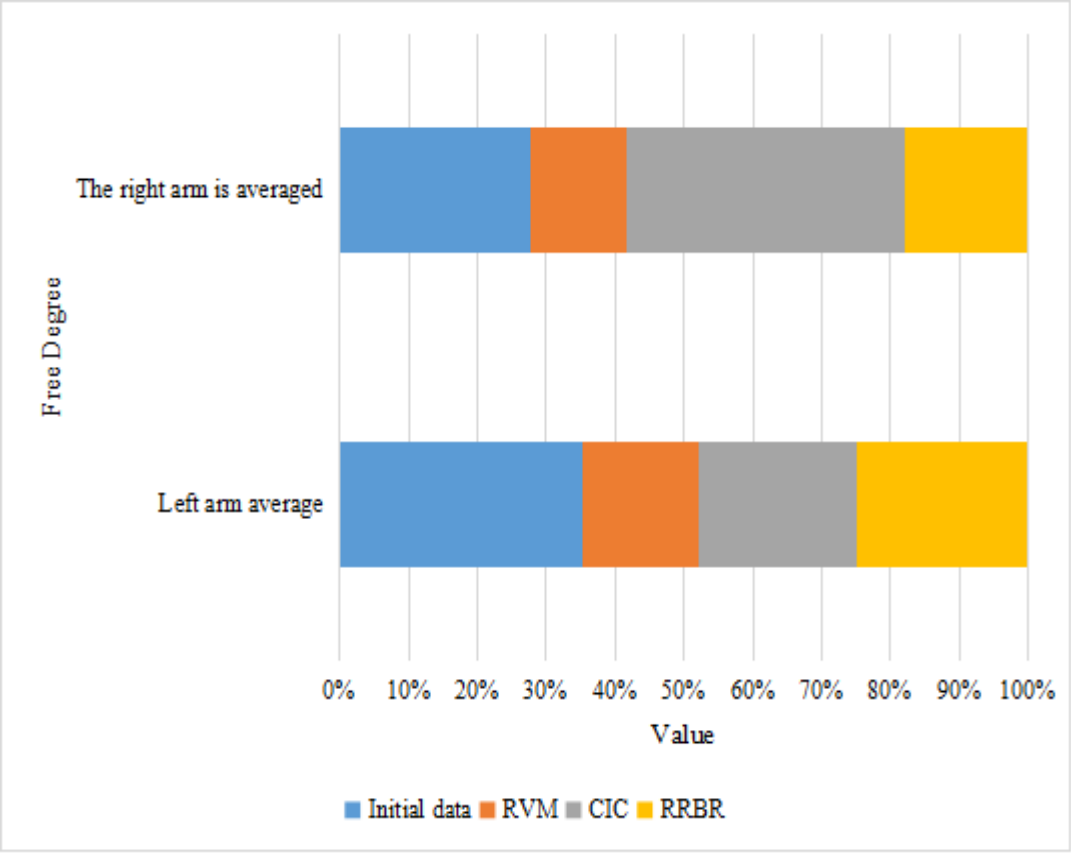

Figure 1. Spatial similarity comparison of the different perception algorithms

4.2. Analysis and Discussion of Experimental Results

At the same time, we also compare an early recognition algorithm based on Self-Organizing Feature Map Network and Locality Sensitive Hashing (SOM+LSH). Since there are no adjustable thresholds in this algorithm to obtain the recognition rate and recall rate curves, we give the overall recognition accuracy and timeliness. The accuracy of PFR using different spatial information in the four databases is summarized in Table 2 and Figure 2, and the accuracy of different algorithms in the four databases is summarized in Table 3 and Figure 3:

Table 2. Precision data tables of the PFR on the four databases (Unit: %)

Information	MAD	MSRC-12	DIA-9	CR-UESTC
Position	87.6	85.4	81.3	78.7
In-frame-inter-frame distance	88.9	92.3	85.1	75.4
Angle + distance	99.4	98.7	80.8	87.3

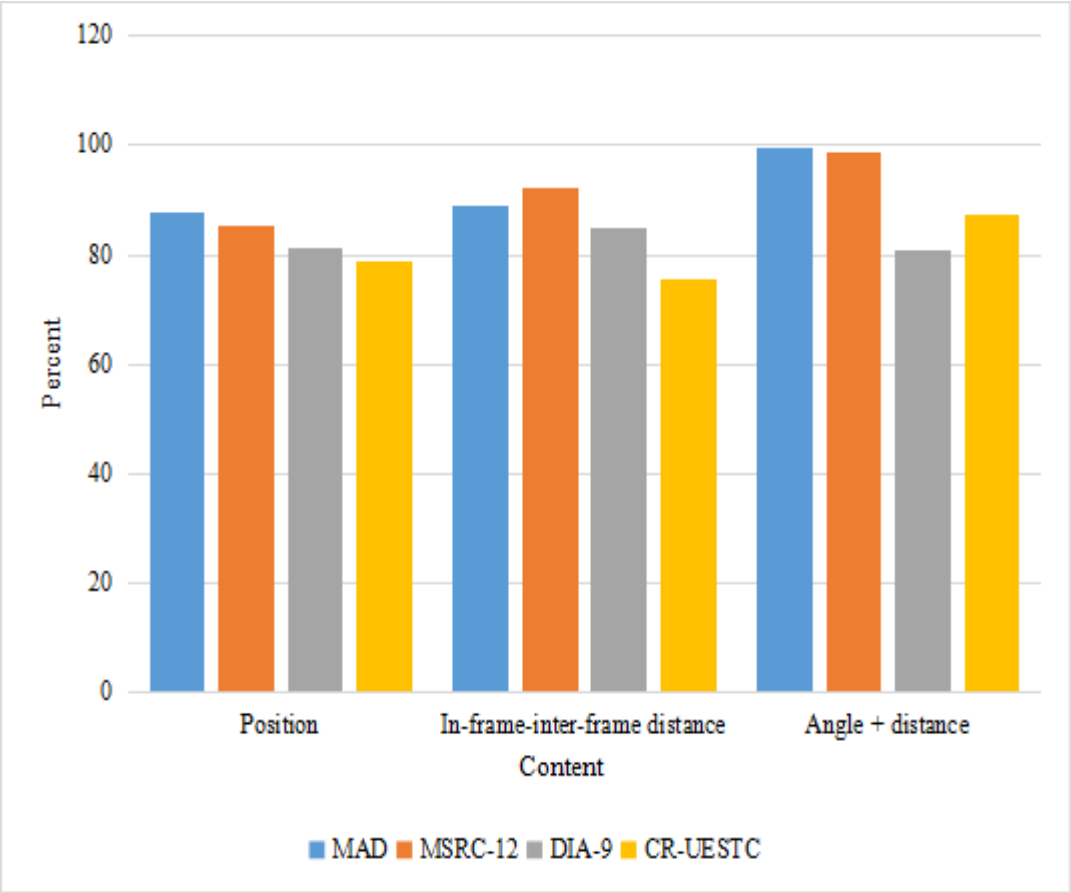

Figure 2. Precision of the PFR using different spatial information on the four databases

Table 3. The Recognition Accuracies of the various algorithms

Algorithm	MAD	MSRC-12	DIA-9	CR-UESTC
OE-DTW	91.25	89.47	63.54	58.47
SOM+LSH	93.24	87.69	69.71	59.17
I STM	91.47	89.67	79.14	69.32
PFR	93.29	93.71	78.36	73.14

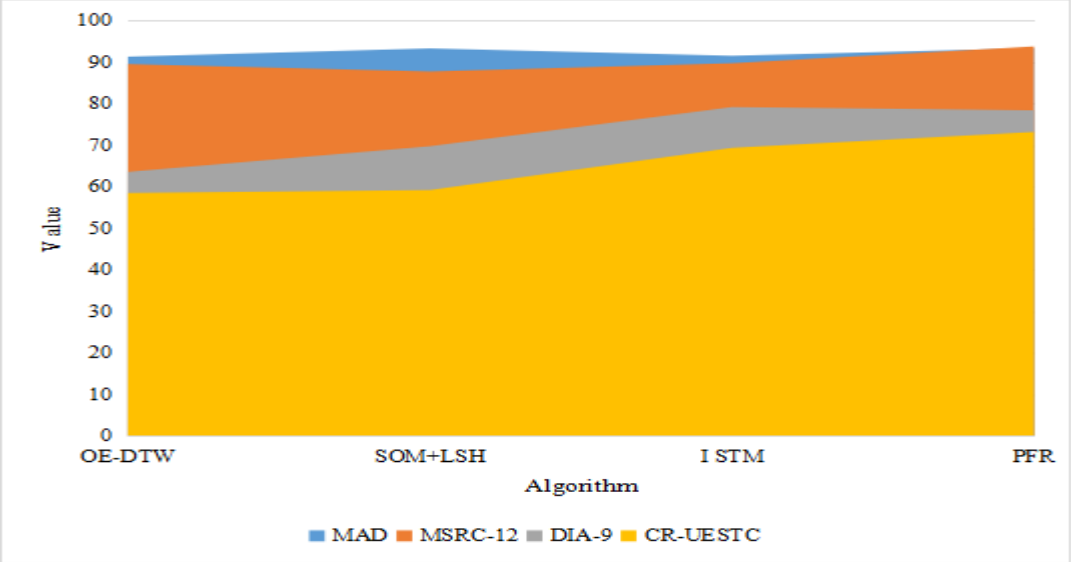

Figure 3. Accuracies and timelinesses of different algorithms on four datasets

In summary, progressive PFR can more accurately identify human behaviors in multiple databases, and can predict stable and reliable results earlier before the behavior is completed. Considering the performance, flexibility, adaptability and other aspects, PFR has certain advantages compared with other algorithms.

5. Conclusion

SVM is a learning system that transforms from low-dimensional space to high-dimensional space and uses linear function hypothesis space. It relies on optimization theory to complete the training of learning algorithms. The essence of the algorithm is the learning paranoia derived from statistical learning theory. In specific practical applications, the superiority of the algorithm is reflected, and it is stronger than some other learning systems in many aspects. The learning modes of support vector machines are roughly divided into supervised learning, semi-supervised learning and unsupervised learning, while the more commonly used modes of SVM in practical applications are supervised learning and semi-supervised learning. SVMs have immeasurable operational difficulty during training, so they are not commonly used. Supervised learning has the advantages of simple operation, time saving, and accurate classification effect, and is favored by more and more people.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Tsai C C, Chang C W, Tao C W. Vision-Based Obstacle Detection for Mobile Robot in Outdoor Environment. Journal of Information Science and Engineering. (2018) 34(1):21-34.

[2] Kim S G, Lee Y C, Ahn S S, et al. Autonomous Feeding Robot and its Ultrasonic Obstacle Classification System. Transactions of the Korean Institute of Electrical Engineers. (2018) 67(8):1089-1098.

[3] Park K M, Kim J, Park J, et al. Learning-Based Real-Time Detection of Robot Collisions without Joint Torque Sensors. IEEE Robotics and Automation Letters. (2021) 6(1):103-110.

[4] Bousseta R, Ouakouak I E, Gharbi M, et al. EEG Based Brain Computer Interface for Controlling a Robot Arm Movement through thought. Innovation & Research in Biomedical En. (2018) 39(2):129-135.

[5] Deuerlein C, Langer M, Sener J, et al. Human-Robot-Interaction Using Cloud-Based Speech Recognition Systems. Procedia CIRP. (2021) 97(2):130-135.

[6] Badr A A, Karim A. A Review on Voice-based Interface for Human-Robot Interaction. Iraqi Journal for Electrical and Electronic Engineering. (2020) 16(2):91-102.

[7] Park D, Kang K M, Bae J W, et al. Robot Vision to Audio Description Based on Deep Learning for Effective Human-Robot Interaction. The Journal of Korea Robotics Society. (2019) 14(1):22-30.

[8] Geweid G, Abdallah M A. A New Automatic Identification Method of Heart Failure Using Improved Support Vector Machine Based on Duality Optimization Technique. IEEE Access. (2019) 7(99):149595-149611.

[9] Yeh W C, Jiang Y, Tan S Y, et al. A New Support Vector Machine Based on Convolution Product. Complexity. (2021) (2021) (4):1-19.

[10] Samsudin E. Modeling Student's Academic Performance during Covid-19 Based on Classification in Support Vector Machine. Turkish Journal of Computer and Mathematics Education (TURCOMAT) (2021) 12(5):1798-1804.

[11] Ma H, Honig W, Cohen L, et al. Overview: A Hierarchical Framework for Plan Generation and Execution in Multi-Robot Systems. IEEE Intelligent Systems. (2018) 32(6):6-12.

[12] Sampedro C, Rodriguez-Ramos A, Bavle H, et al. A Fully-Autonomous Aerial Robot for Search and Rescue Applications in Indoor Environments using Learning-Based Techniques. Journal of Intelligent & Robotic Systems. (2019) 95(2):601-627.

[13] Orquin J L, Chrobot N, Grunert K G. Guiding Decision Makers' Eye Movements with (Un)Predictable Object Locations. Journal of Behavioral Decision Making. (2018) 31(3):341-354.

[14] Arvin F, Watson S, Turgut A E, et al. Perpetual Robot Swarm: Long-Term Autonomy of Mobile Robots Using On-the-fly Inductive Charging. Journal of Intelligent & Robotic Systems. (2018) 92(4):1-18.

[15] Schlotfeldt B, Thakur D, Atanasov N, et al. Anytime Planning for Decentralized Multirobot Active Information Gathering. IEEE Robotics and Automation Letters. (2018) 3(2):1025-1032.

[16] Matsuda M, Mataki Y, Mutsuzaki H, et al. Immediate Effects of A Single Session of Robot-Assisted Gait Training Using Hybrid Assistive Limb (HAL) For Cerebral Palsy. Journal of Physical Therapy Science. (2018) 30(2):207-212.

[17] Santos M, Diaz-Mercado Y, Egerstedt M. Coverage Control for Multi-Robot Teams with Heterogeneous Sensing Capabilities. IEEE Robotics & Automation Letters. (2018) 3(2):919-925.

[18] Tsang-Kai, Chang, Ankur, et al. Optimal Scheduling for Resource-Constrained Multirobot Cooperative Localization. IEEE Robotics and Automation Letters. (2018) 3(3):1552-1559.