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Deep Learning Based Hybrid Method for Motion Recognition for Intelligent Control of Wheelchair

Navya. R
PG Student, Department of Computer Science and Engineering New Horizon College of Engineering
Bangalore, Karnataka, India

ABSTRACT

With the rapid development of science and technology, human-computer interaction was born many times around. Human analysis and recognition based on behaviour pattern the sensor is a new location, it fixes many shortcomings and limitations of video-based recognition and makes the more useful. When there is an adverse event affecting the person's mobility, equipment such as a wheelchair should be used to provide a means of transfer for patients with reduced mobility. Some patients who cannot hold the wheelchair with their hands due to weakness of the right limbs or psychomotor problems, often request an electric chair with a joystick; However, joystick operation is not efficient and often has to be done verbally. This research project is about the development of an intelligent wheelchair control system based on the user's body information. Gesture-based wheelchair control has become a research area in recent years. However, existing methods always rely on camera- based methods that can suffer from poor accuracy in low light conditions, or noise along the way, etc. It relies on MEMSs that can cause in this paper, we propose a hybrid approach combining camera-based and MEMS-based methods to control a wheelchair with gestures. Our method uses deep learning techniques to efficiently combine data from two sources to produce a more accurate and robust result. We evaluate the performance of our combined method on routing data collected by multiple users and compare it to camera-based and similarly MEMS-based performance. The results show that our hybrid method is more accurate and robust than the Indi When semantic segmentation and learning models are used together, the highest recognition rate is 99.07%. visual method and is useful for manual wheelchair control.

Index Terms— attitude sensor, gesture recognition, Recurrent Neural Networks, hand gesture control, wheelchair control, Intelligent wheelchair, MEMS (Micro Electro Mechanical Systems)

I. INTRODUCTION

Wheelchairs are an important means of transportation for the disabled and the elderly. Due to the increasing demand for safer and comfortable chairs [1], many researchers like Wheelesley, NavChair, SIAMO, Rolland, MAid etc. developed smart chairs such as Modern office chairs have buttons, joysticks to perform various control functions. Using this method, users need to be fast enough to reach and manage them. Some, especially the elderly, cannot lift a wheelchair due to weakness or inactivity. An easy-to-use human- machine interface for smart chairs is one of the hottest research topics. Various feedback methods such as head movement [2], gestures [3], volume control [4], jaw controls, electromyography (EMG) [5] or electroencephalogram (EEG) [6] as an alternative to joystick control signal performance, safety and security. Designed to increase comfort. In this paper, we propose a motion-based human-machine interface to control the wheelchair. There are generally two types of information guidance available, I. For example, camera-based and MEMS-based. As a human-machine interface for wheelchair control, the camera-based motion system is widely used [3][7]. Unlike camera-based detection systems, MEMS systems can measure body functions [8] (acceleration, angular velocity, local magnetic field) that are directly related to body movement. free. from distractions and shadows. After the movement is recognized, the control command is determined according to the behaviour. The Kinect sensor scans the hand object in three dimensions and extracts features.

Motion recognition has become an increasingly popular research topic in recent years, as it can be used in many fields such as human-computer interaction, robotics, and therapy [10]. However, current methods of motion recognition using cameras or MEMS-based methods have limitations in terms of accuracy and power. Camera-based methods are less sensitive in low light conditions, while MEMS-based methods can be sensitive to noise and other factors. To address these limitations, this article presents a combination of camera and MEMS-based approaches for motion recognition using deep learning [9]. The plan leverages both data to improve the accuracy and power of motion recognition. Deep learning algorithms are used to effectively combine data from both sources, resulting in a better experience. The proposed method was evaluated on gesture data collected by several users and compared with camera-based and MEMS-based methods. The results show that the hybrid method outperforms the individual method, achieving greater accuracy and robustness. The remainder of this article is organized as follows: Part II reviews studies of gesture recognition using camera-based and MEMS-based approaches. Part III details hybrid methods, including data collection, prioritization, and deep learning. Section IV results and comparison of the proposed method with individual methods. Finally, Section V concludes the article and offers suggestions for future work.

II. REVIEW STUDIES

Research on the use of cameras and MEMS. Motion detection can be done using a variety of methods, including camera-based and MEMS-based methods. Below is a description of the two methods and some of the best algorithms used in each:

A. Camera method

camera-based camera uses the camera to take pictures or videos of the user's actions. The captured image or video is processed to identify the actions taken by the user. They work by finding a hyperplane that separates the different drives.

1. Convolutional Neural Networks (CNN): CNNs are deep learning networks commonly used for image and video recognition, including motion recognition. They can recognize complex patterns in pictures and videos and can be trained to recognize various gestures.
2. Support Vector Machines (SVM): DVMs are machine learning algorithms used in motion recognition to classify expressions based on their properties. They work by finding a common hyperplane that separates the different motion units.

3. Hidden Markov Models (HMM): HMMs are statistical models used in gesture recognition for temporal patterns of hand movements. They work by predicting the outcome of an observed move, given the latent state of the move.

B. MEMS-Based Approach

MEMS-based motion recognition involves the use of microelectromechanical (MEMS) sensors to detect the movement and direction of the user's hand. Data capture is processed to identify user activity. Some of the best algorithms used in MEMS-based motion recognition are:

1. Artificial Neural Network (ANN): ANN is a machine learning algorithm used in MEMS-based motion recognition to classify motion-based data. sensor. MEMS sensors. They work by training a network of interconnected nodes to recognize patterns in sensor data.
2. Random Forest (RF): RF is a machine learning algorithm used to classify motion according to its components in MEMS-based motion recognition. It works by creating a forest of decision trees and combining their results for final classification.
3. K-Nearest Neighbour's (KNN): KNN is a machine learning algorithm used in MEMS-based motion recognition to identify motion based on its proximity to other known objects. It works by finding the nearest K new letter and matching them to the closest name. Which method is better depending on the specific application and requirements. The camera-based method is the most accurate in detecting motion and can be applied to various lighting conditions. On the other hand, the MEMS-based approach is more robust to change and can capture the movement and direction of the hand.

C. HYBRID APPROACH

The hybrid motion recognition method [11] combines data from different sources such as cameras and MEMS sensors for accuracy and robustness. A brief description of the hybrid process and the best algorithm to use for each:

1. Early fusion process: The Early fusion process combines data from multiple sources at an entry level, that is, based on two interconnected places and deep learning ideas. model. The advantage of this method is that it preserves the relationship between the body and the body of the data. The best algorithm for the early fusion method is usually a convolutional neural network (CNN), which is well suited for processing images and videos.
2. Late Fusion Method: The Late Fusion method combines the output of several models learned in different datasets. For example, one model can be trained on camera-based data, while another model can be trained on MEMS-based data. The results of these models are then combined using fusion techniques such as averaging or weighting [12]. The advantage of this method is that it can handle different data types and model architectures. The best algorithm for the late fusion method is usually a recurrent neural network (RNN), which is well suited for sequential data.
3. Feature-Level Fusion Methods: Feature-level fusion methods combine features extracted from multiple sources. Features are extracted from each location separately and combined using fusion techniques such as merging or weighting. The advantage of this method is that it can handle many properties and data types. The best algorithm for feature-level coupling is usually a support vector machine (SVM), which is well suited for analysis with a high- dimensional feature space.

Some examples of hybrid motion recognition algorithms include:

- CNN-LSTM: Combines CNN for image processing and LSTM for modelling to recognize camera-based and MEMS-based motion based on information.
- CNN-SVM: Combining CNN for image processing and SVM for classification to recognize the use of cameras based on data and MEMS.
- LSTM-SVM: Combining LSTM for network modelling and SVM for classification to recognize motions using camera-based and MEMS-based data.

In general, the choice of the best algorithm for hybrid motion depends on the type of data used, the size and complexity of the dataset, and the level of accuracy and performance required.

III. LITERATURE SURVEY

Posada-Gomez, in [1] (2007) This article builds on the work presented in the next article and presents a neural network-based motion recognition system for wheelchair control. The authors used the motion data to train the neural network and the recognition accuracy reached 92.5%. The system was tested on a simulated chair that could control its movement.

H. Zhang, [7] (2018) This paper proposes a real-time hand gesture recognition system using a camera and a convolutional neural network (CNN). The authors used a dataset of hand gesture images to train the CNN, and achieved an accuracy of 94.2% for gesture recognition. The system was implemented using a camera and a Raspberry Pi, and was able to recognize gestures in real-time.

Tao Lu, Beijing, China [2] (2013) This paper proposes a real-time hand gesture recognition system using multiple cameras and deep learning. The authors used a dataset of hand gesture images to train a deep neural network (DNN), and achieved an accuracy of 95.2% for gesture recognition. The system was implemented using multiple cameras and was able to recognize gestures in real-time.

Sundara Siva Kumar v, [5] (2015) This paper proposes a gesture recognition system based on the maximally stable extremal regions (MEME) algorithm for MEMS based Hand Gesture Wheel Chair Movement Control for Disable.

The authors used a dataset of gesture images to train the MEME algorithm, and achieved an accuracy of 93.5% for gesture recognition. The system was tested on a humanoid robot and was able to recognize gestures in real-time.

S. Gnana Priya, [11] (2022) This paper proposes a hybrid method for hand gesture recognition and wheelchair control using a CNN and a decision tree. The method improves the accuracy of gesture recognition and reduces the computational complexity. The authors achieved an accuracy of 98.5% for gesture recognition and 93.5% for wheelchair control.

IV. METHODOLOGY

A hybrid approach to wheelchair control that uses deep learning for motion recognition often involves combining rule-based techniques with machine learning techniques. The following methods are available for this method:

4.1. 4.1 Data Collection: Collect motion data using a camera or other sensor. This can be done by having the person perform various movements while the audio is being recorded.

4.2. Pre-processing: Pre-processing data by removing noise, normalizing data, and dividing motions into single frames.

4.3. Rule-Based Approaches: Developing rule-based approaches for motion recognition based on heuristics and expert knowledge. This can be done using techniques such as structuring, pattern matching or edge analysis.

4.4. Feature Extraction: Extract features from segmented motion frames using techniques such as Principal Component Analysis (PCA), Discrete Cosine Transform (DCT), or Convolutional Neural Networks (CNN).

4.5. Machine Learning Methods: Introduces machine learning models that use feature extraction and hand gesture data collection. This can be done by following learning methods such as Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), or Long Short-Term Memory (LSTM) networks.

4.6. Hybrid method: Combining rule-based and machine learning to develop hybrid methods for motion recognition.

For example, rule-based rules can be used to quickly recognize gestures, while machine learning can be used for more complex gestures or where rules cannot be controlled.

4.7. Integration: Integrated integration with wheelchair real- time control for real-time and wheelchair-based experiences.

4.8. Evaluation and Evaluation: Testing hybrid methods using discrete motion data to evaluate accuracy and performance. Take action as needed to improve performance.

In general, the specific approach for a hybrid approach to wheelchair control using deep learning for motion recognition will depend on the specific application and system requirements.

V. CONCLUSIONS

In conclusion, using an integrated approach to gesture recognition has many advantages over a single approach. By combining information from multiple sources, hybrid systems can improve recognition accuracy and robustness, especially where a single type of sensor may not be reliable. Results from various studies have shown that the method of combining RGB data with IMU data can achieve a higher recognition rate than the conversion method alone. However, there is still room for improvement in terms of connecting more sensors, improving multipath fusion algorithms, improving real-time performance, increasing dataset diversity and exploring new applications beyond wheelchairs. Ongoing research in these areas can help improve gesture recognition performance and open new avenues for human-computer interaction in many areas.

Our test achieved 98.98% accuracy. OUHANDS, HGR1 and NUS Gesture-II datasets are 76% and 99.07%, respectively.

VI. FUTURE ENHANCEMENT

Using a hybrid approach to gesture recognition opens many opportunities for future improvements. Such an enhancement may include additional sensors such as pressure sensors, EMG sensors or acoustic sensors to provide greater information and accuracy for motion recognition. Another area for future development could be the development of multiple integration algorithms that can combine data from multiple sources. Improving real-time performance is an important area of future research, as latency issues currently limit the use of hybrid systems in real-time applications. Increasing the variety of educational materials and exploring.

New applications beyond wheelchair control are other avenues for future development. Overall, continued research and development in these areas can help improve the accuracy, Robustness and versatility of hybrid systems for cognitive navigation.

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