Action Recognition for Controlling Electronic Appliances

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ABSTRACT--- The objective is to develop a system for controlling electronic appliances by recognizing human action. Generally, sensors are used for tracing the pattern of action recognition. Human action recognition and feature extraction are the main challenges of the system, which can be effectively overcome by using deep learning techniques. This approach uses deep learning technique by combining both RNN and CNN network for action recognition either in the form of images or signals. Combining CNN and RNN will enhance the ability to recognize different actions at varied time span.

Keywords: CNN-Convolution Neural Network, RNN-Recurrent Neural Network.

I. INTRODUCTION

Due to rapid advances in computer vision and machine learning approaches brings an idea of controlling electronic appliances by recognizing human action which can be helpful for physically challenged people and elderly persons to control electronic devices.

Human Activity Recognition (HAR) is considered to be a challenging factor in the computer vision area. Gesture recognition is the process of capturing the movement of human action by computing device. Basically, Gestures include the motion of the hands and face. A gesture can be divided into two categories namely

- Static gesture
- Dynamic gesture.

Static gestures are postures that do not consider movements into account, e.g. thumbs up. Dynamic gestures consider the angles between fingers during certain start and end time, e.g. drawing letters in the air.

Human Activity Recognition (HAR) is the process of predicting the movement of a person based on the data. The data can be in the form of an image or it can be a sensor data. For sensor data, the traditional approach uses deep domain expertise and method from signal processing to extract the feature from the raw data to fit the machine learning model. In the proposed model, as we used the deep learning methods such as convolution neural networks (CNN) and recurrent neural network (RNN) have shown capable results by automatically learning the features from the raw sensor data. The strategy that automatically learning the features is for accurate predictions from the raw data. This method allows new datasets and new sensor data to be adopted quickly and with fewer expenses. In deep learning models, the feature extraction and model building procedures are performed simultaneously. The deep neural network is suitable for complex action recognition problems as it is capable of extracting high-level representation using deep layers. This makes the system, which implements deep learning methods to be more efficient one.

MEMS Accelerometer:

MEMS accelerometer is one of the simplest and widely used micro electromechanical systems. This device is used to measure acceleration and the force producing it. The application of this sensors are in automobile industry, computer and audio-video technology. The MEMS is based on silicon-based micro fabrication. The size of the MEMS accelerometer is small, this reduces its cost compared to existing system.

Figure 1: Mems Accelerometer

II. LITERATURE SURVEY

1. Convolutional and Recurrent Neural Networks for Activity Recognition in Smart Environment by Deepika Singh, Erinc Merdivan, Sten HankeJohannes Kropf, Matthieu Geist, and Andreas Holzinger.

Inference: This paper demonstrates the use of CNN along with RNN, Long short term memory (LSTM) and other machine learning algorithms which includes Naive Bayes, Hidden Markov models and Conditional Random Fields. LSTM proposed, is a recurrent neural network which is capable of learning long term dependencies.

2. Gesture Recognition Based Device Control Using MEMS Accelerometer by Kalyan Kasturi, K.SriMourya, I.Mahendra, and Vikas Maheshwari.

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Inference: This paper capture the user gesture by using MEMS accelerometer, and the PIC microcontroller activates the corresponding relay circuit which in turn operates the specified device. The microcontroller was programmed to transmit the status of the particular device.

3.Human Action Recognition System for Automation Application by Sai Kailash, Purav M Shah, Sai Karthik, B Madhukar, K.Vijaya.

Inference: This paper implements an automated visual recognition system using Matlab and also uses a Kinect camera to capture a video image and a fuzzy inference system for making the decisions.

4. Hand Gesture Based Home Appliances Control System by Jyoti Jadhav, Prashant Avhad.

Inference: This system uses MEMS accelerometer to detect the hand motion and transmitted using Radio Frequency (RF). This paper demonstrates a system with low cost and 3-axis wireless accelerometers to control the electronic devices at homes using ARM7.This system is mainly used for visually challenged persons to operate the electronic devices in homes.

III. EXISTING METHODS

The existing gesture recognition methods are mainly classified into vision-based and other is accelerometer or gyroscope based. Due to some limitations like optical noise, slower dynamic response and relatively large data collection the accelerometer based implementations are consider to be more efficient.

1. **Vision-Based gesture recognition:**

Vision-based gesture recognition is a challenging area that includes computer vision and graphics, machine learning, image processing, bio-informatics and psychology. The requirement of the working system are robustness, computational efficiency, user tolerance, scalability. Most of the system uses a idea of detecting and segmenting the gesture of hand from the motion detection.

2. **Accelerometer based gesture recognition**:

In this type of gesture recognition system, input is collected using one or more sensors. Facial expression and eye motion applications involves a camera or a photo sensitive device. Body, hand and arm movement are measured using accelerometers, surface EMG sensors and bend resistive sensors. Accelerometers are devices that are used to measure acceleration due to force.

IV. PROPOSED SYSTEM

The gesture of a human can be captured in two ways namely image based and sensor based. For image-based gesture recognition, we can use a video camera to capture the image and for sensor-based gesture recognition accelerometer, Arduino type sensors are used. In the proposed work we go with the sensor-based approach. The MEMS accelerometer is a Micro Electromechanical System used to measure accelerations. The system uses MEMS accelerometer to capture the static and dynamic gestures of the users. The aim of the proposed work is to develop an Action Recognition system for controlling electronic appliances. To overcome the challenges and limitations in the existing system and also to enhance the system the proposed work uses a hybrid model which consists of both CNN and RNN network for recognizing action either in the form of images or in the form of signals. Along with CNN and RNN network, a MEMS accelerometer is used for the interaction with the electronic devices using the recognized actions to control the electronic devices.

V. RESULTS & DISCUSSIONS

The block diagram representing the working model of the system is shown below. The system uses MEMS accelerometer sensors to recognize the gesture from the users. Initially, a user performs the action and the MEMS accelerometers will capture and recognize the gesture and this sensor data is now provided to the hybrid model which consists of the combination of CNN and RNN networks as input. This model will automatically extract the features from the given sensor data. The recognition procedure involves of acceleration acquisition, signal preprocessing, feature selection and feature extraction. Based on the feature knowledge provided on training the system performs the necessary action on the devices.

The dataset should be collected for the system. This involves collection of public dataset or self-collection of data. From those data features are extracted by applying preprocessing.

Methodology for building a hybrid model:

1. Dataset preparation:

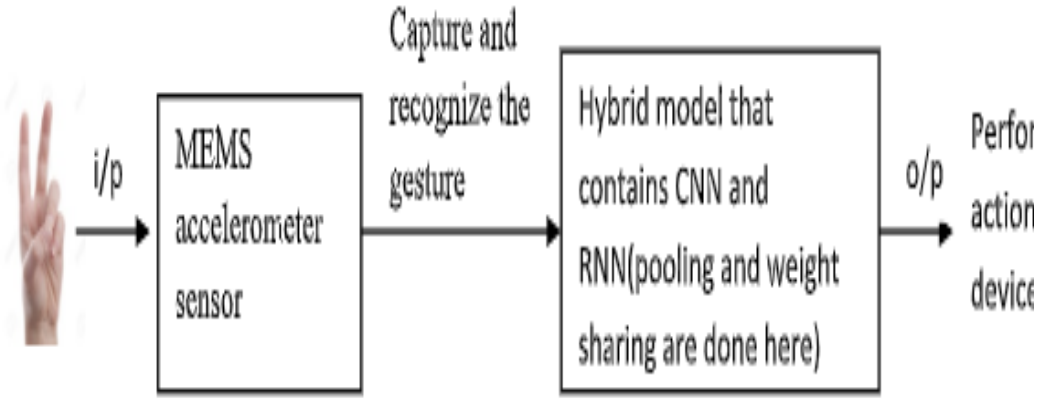

Figure 2: Working Model

From those data features are extracted by applying preprocessing.

1. Developing a hybrid model:

The hybrid model is a network containing both CNN and RNN along with mems accelerometer. Here the weights sharing, pooling and input adaptations are applied.

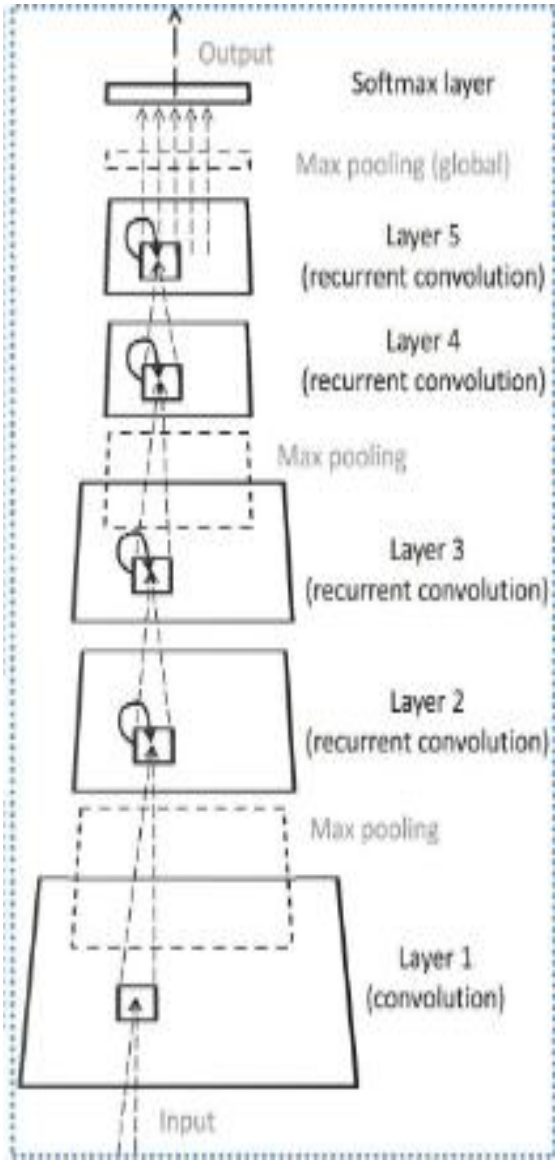

Figure 3: RCNN Model

The combination of CNN and RNN network is known as the RCNN and the representation of the RCNN is shown above. The raw sensor data is the input to the hybrid model. But this input data is transformed to spectrogram before it is fed to the network. A spectrogramis a visual representation of the spectrum of frequencies of a signal. These data are passes through the RCNN with number of hidden layers and by using softmax layer a single output is obtained. This output specifies the action to be performed on the device.

VI. CONCLUSION

This paper proposed a system for controlling electronic devices by recognizing the human action. The system uses Mems accelerometer to recognize the gesture or human action and the CNN and RNN networks are used to perform the necessary function for each valid gesture. Combining both RNN and CNN networks will automatically extract the features from the raw data this results in accurate predictions. This system is very much useful for the blind persons and also for aged persons.

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