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Activity Recognition in MATLAB Using KNN

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ABSTRACT

Activity recognition is a crucial task in machine learning, widely used in healthcare, sports analytics, and human-computer interaction. This study explores the implementation of K-Nearest Neighbors (KNN), a simple yet effective machine learning algorithm, to classify different human activities based on sensor data. The classification is performed using features extracted from accelerometer and gyroscope readings, which capture motion patterns associated with various activities. MATLAB is utilized as the development platform due to its powerful built-in functions for data preprocessing, feature extraction, model training, and evaluation. The workflow includes data normalization, feature selection, and applying the KNN algorithm to recognize activities such as walking, running, sitting, and standing. Performance evaluation is conducted using accuracy metrics and confusion matrices to assess the effectiveness of the model. The results demonstrate that KNN provides reliable classification performance with minimal computational complexity, making it suitable for real-time applications. Furthermore, tuning KNN parameters such as the number of neighbors and distance metrics enhances classification accuracy.

Keywords: Artificial Intelligence, Deep Learning, Monitoring system, Action recognition

INTRODUCTION

Activity Recognition is a fundamental problem in machine learning and signal processing, where the goal is to classify human activities (such as walking, running, sitting, or standing) based on sensor data. This data is typically collected from accelerometers, gyroscopes, or wearable devices. Accurate activity recognition has applications in healthcare, sports analytics, smart homes, and human-computer interaction.

K-Nearest Neighbors (KNN), a simple yet effective machine learning algorithm, to classify different activities based on sensor data. MATLAB provides built-in functions for data preprocessing, feature extraction, and classification, making it an excellent tool for

implementing activity recognition systems. The population of elderly persons is one of the foremost significant trends of the 21st century. United Nations Population Fund says that one in eight people in the world is aged 60 or over. Therefore, to enhance the standard of lifestyle for elderly persons, various efforts were made. Associated with this problem, Ambient Assisted Living (AAL) technology aims at ensuring security and health quality for elder people who live independently and alone at home. AAL systems monitor the elder person from the information through different sensors. The data is processed through the Web of Things and the Internet of Healthcare Things (IoHT) is used for monitoring purposes. In today's age of artificial intelligence computers, vision-based systems implementation for various applications, recognition and detection, and control have become a common aspect in our day-to-day life and are used in various fields however, the systems and methods that are used to interact with computers are costly, increases electricity consumption, also requires additional supportive gadgets which increase system cost although technology is very useful but becomes out of reach for common man due to its higher cost and maintenance. So, the design of a cost-effective system becomes necessary to reach technology to middle-class people. AI-based automation can be utilized for industrial applications, the residential sector, physically challenged people, traffic control, health monitoring, etc. The proposed paper implements activity recognition of humans based on their pose and

movements for detection person's health and abnormal activities if found then calls for help for elder people living alone. The proposed system uses images as objects where the images are broken into 2.5D coordinate axes and detection is based on the learning of the axes frames.

There are three steps for deep learning: first is to understand the problem and check the feasibility of deep learning, second is to identify relevant data to prepare and the last is to choose a Deep Learning algorithm, training algorithm, and test. Deep Learning has different applications, like health care and automatic text generation image recognition, etc. Deep is defined as hidden processing layers. There are two types of Deep Learning convolutional neural and recurrent neural. Convolutional neural nets consist of image recognition. Deep Learning is needed because a recent data science method has a more extended performance. Deep Learning has different hardware and software tools.

The tensor flow consists of Google's open-source machine library, and multidimensional arrays are used here. There are also challenges with Deep Learning working better with a large amount of data. Convolution Neural Network performance and convolution operation as shown in Figure 1 Convolution Neural Network is the best-researched deep learning, used in mobile based on recognition. Deep Learning network has a variety of Multilayer Perceptron and Autoencoders. Deep Learning has different applications such as virtual assistance, vision for driverless cars, and face recognition.

LITERATURE SURVEY

Rodriguez-Moreno and Martinez-Otzeta have designed well-known deep-learning methods and tested results on Global Visual Descriptors. A pipeline for action recognition uses two different tasks: sign recognition and action recognition [1]. Recognition of human activity in densely populated areas is an important field. The sector has recently received official attention number of educational researchers. The results indicate that proposal architecture exceeds the pre-constructed architecture predicting human actions [2]. Deep Learning methods are categorized into Boltzmann machine convolution and recurrent neural networks. They have designed a modular system to detect and recognize pedestrians' actions. [3]. Hyunchoon Lee and Young-Seok Kim first developed several 3D-CNN architectures at the run time. 3D convolution neural networks solve action recognition issues [4]. Cecil C Nachiar et al. designed wearable technology with smartphones and proposed a system for processing, analyzing, and displaying patient-collected data using a default alarm [5].

METHODOLOGY

1. Deep Learning Methods

The generative Deep Learning method is classified into restricted Boltzmann machine, deep autoencoder, sparse coding, and stacked deep Gaussian model. Figure 2 shows the Recognition Deep Learning Method. The deep-restricted Boltzmann machine method was started by Hammerla. Deep Belief Network (DBN) is used to extract hierarchical features form. The proposed work was extended using the mobile spark platform. Zhang et al. proposed unsupervised feature extraction, which is used to recognize the heartbeat during exercise using a generative Deep Learning method. The deep Boltzmann machine method is used in action recognition because this method has the advantage of reducing data sensitivity.

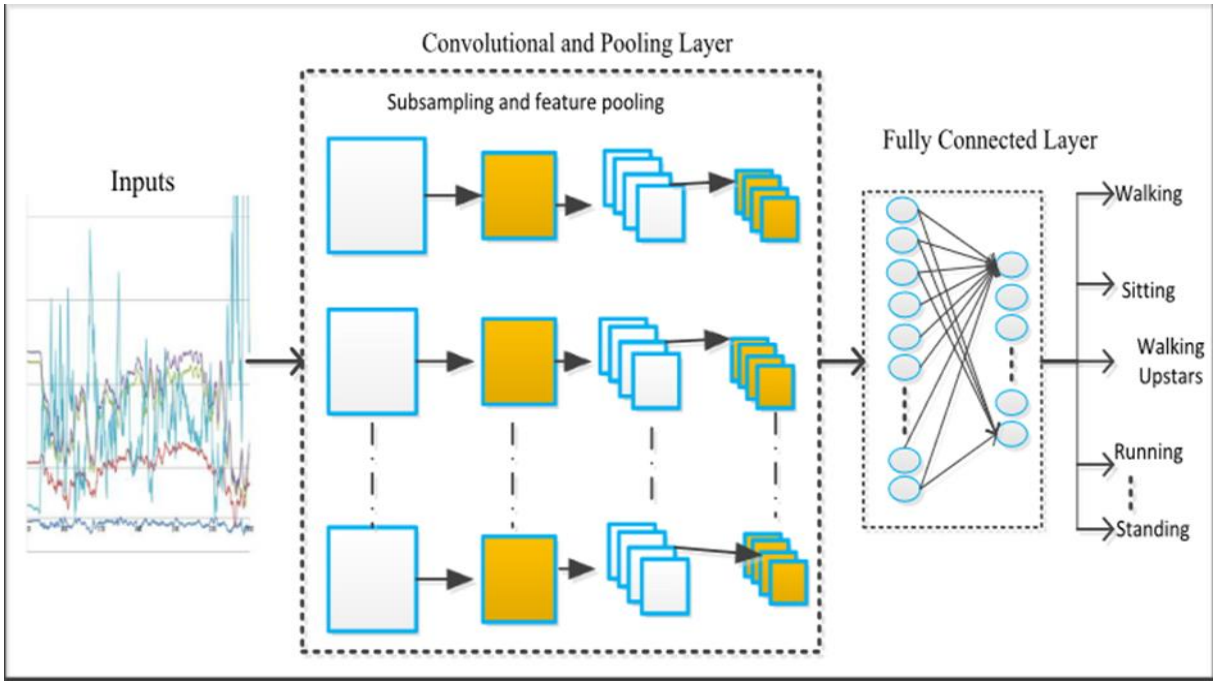

Fig. 1. Deep Convolution Neural Network

Table1. Deep Learning Method

Deep Learning Methods	Weaknesses	Application
Contractive autoencoder	Difficult to optimize	ADL, user location
Convolution neural network	Require large data set	In Sports Activities, Automatic Pain Recognition
Deep Belief Network	Extensive parameter Process, Complex onboard training	ADL localization
Deep Boltzmann machine	A Practically complicated process is DBM Joint Optimization	Detection of irregular heartbeats
Denoising auto encoder	High computational time and high parameter tuning	ADL
Sparse autoencoder	High computational time	Health rate analysis
Sparse coding	Difficult to develop sparse coding	Smart homes monitoring and health recognition
Recurrent neural network	Challenging Large Parameter Activity Prediction	Daily activities

Table1 summarizes the different Deep Learning Methods with their weaknesses and application for human activity recognition. For ADL application contractive autoencoder, Deep Belief Network, Denoising auto encoder methods are used. Convolution neural network are mostly used because it is applicable in Sports Activities, Automatic Pain Recognition. Denoising auto encoder and Sparse autoencoder require high computational time. Recurrent neural network is mostly used in daily activities recognition.

2. Deep Learning Methods for Recognition

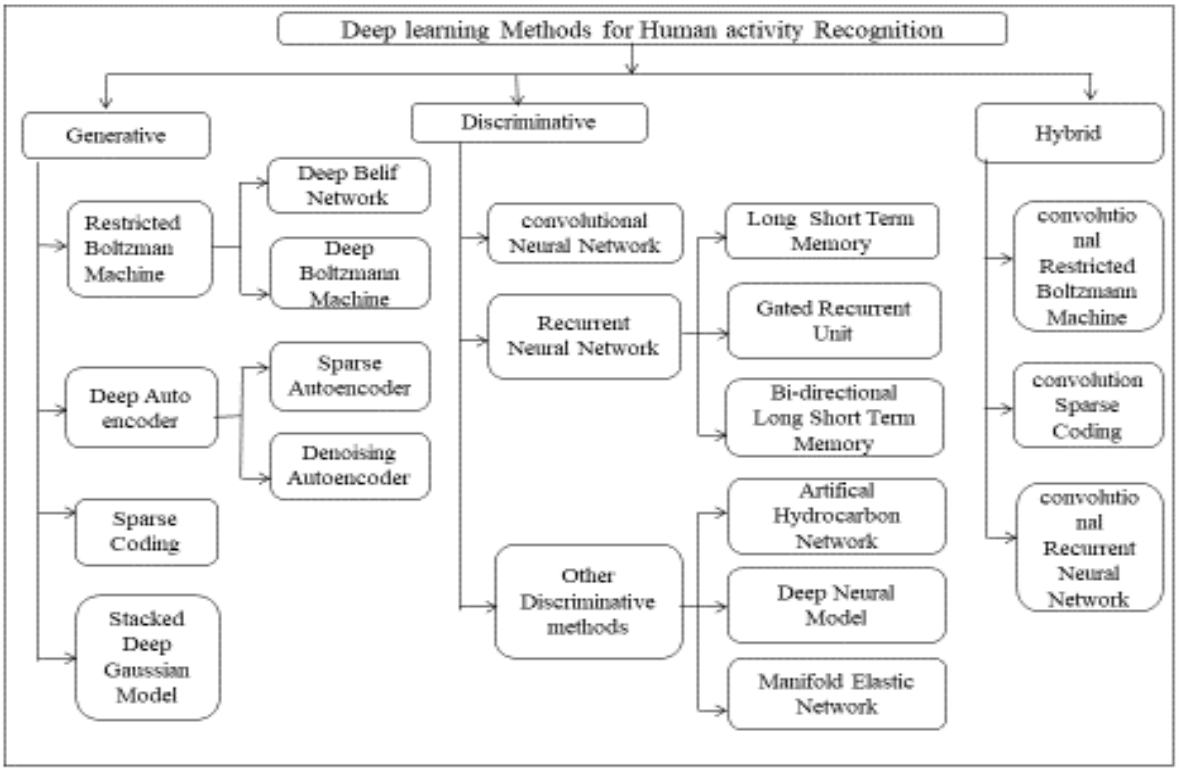

Fig. 2. Recognition Deep Learning Method

Table 2. Deep Learning method for recognition.

References	Deep Learning Methods	Description of Methods	Advantages of Methods
Bhattacharya and lane et al.	Deep Boltzmann machine	Generative undirected bipartite graphs of stochastic visible	To reduce data sensitivity
Bhattacharya et al.	Sparse coding	To extract salient feature	Reduce computational complexity
Feng et al.	Stacked deep Gaussian model	probabilistic models for nonlinear transformation	model complexity
Hasan et al.	Sparse autoencoder	Introduce sparsity penalty	Introduce a sparsity penalty. Extract high-level features.
Munoz-organero and ruiz-blazquez et al.	Deep autoencoder	Correlation Unsupervised feature algorithm	Reduce feature dimensionality
Sheng and Zhao et al.	Denoising autoencoder	Partial Reconstruction of corrupted raw input	The compressed features representation of raw sensory data

Yalcm et al.	Deep Belief Network	Greedy Layer-wise generative model	Reduction of high sensor data dimensional
Zhang and Wu et al.	Convolutional neural network	polling operations to extract translation-invariant	Extract hierarchical and translational invariant features.

Table 2 summarizes the different Deep Learning Methods for human activity recognition. Another generative feature learning technique is a deep autoencoder, a sparse coding method for reducing sensor data and preprocessing and learning an essential function that captures high representation in sensor data. Discriminative Deep Learning is used for activity classification and recognition. Ranao and Cho proposed a CNN for human activity recognition.

IMPLEMENTATION

Figure 3 shows the Human Activity Recognition Flowchart. The implementation Flowchart consists of different steps. Action recognition algorithms were, different activities were used, like standing, walking, sitting, raising hands, hands down, bending down, touching, bending over, and standing with both hands up, to be detected and recognized. Normalization is utilized to solve the model learning challenge. It is a preprocessing tool that brings numerical data to a standard scale without distorting its shape. The DFT is described as the below equation,

$$x(f)=\sum_{i=O}^{N-1}(\mathrm{Xi}\frac{e^{-j2f\pi t}}{N}) \sum_{i=0}^{N-1}\left(x_i\frac{e^{-j2fnt}}{N}\right) \quad (1)$$

x= Frequency Spectrum,

f= Fourier Coefficient

N= Sliding Window

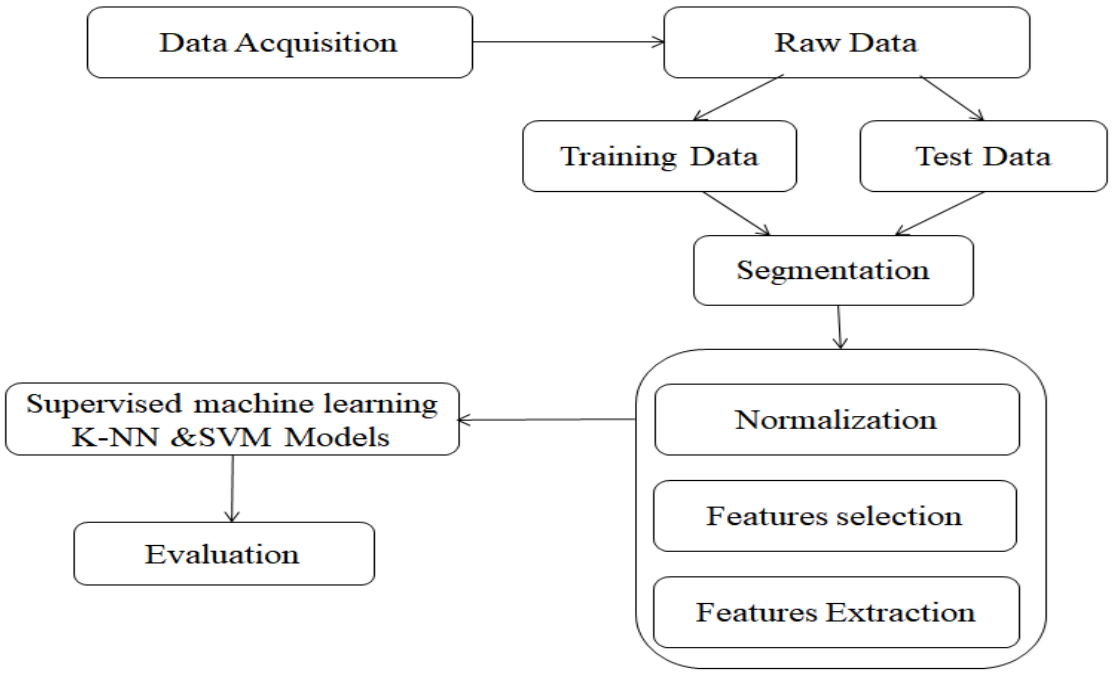

Fig. 3. Human Activity Recognition Flowchart

RESULTS AND ANALYSIS

For action recognition, the performance of feature representation is calculated by evaluation techniques. Their different parameters are used to evaluate the performance, like as accuracy computation time, data size, type of sensors, and storage requirement. Accuracy, precision, recall, and confusion matrices are calculated for the performance metrics and the Receiver Operating Characteristics curve. When an activity is correctly recognized, and when an activity is not correctly recognized, the activity can be classified as FP and FN.

In this section, the k-NN model is introduced. Using MATLAB, the human action recognition algorithm works with the input video. The evaluation result is shown in following figure 4. In the experiment, the result shows there are different action recognition frames present. There is a total of 50 frames generated. A total of 12 activities are detected standing, walking, sitting, raising hands, hands down, bending down, touching, bending over, standing with both hands up, standing with arms outstretched, changing in the face, and walking with bending down to be detected and recognized. Standing activity is presented from frames no 25 to 50. The walking activity is presented in frames no 6 to 25. Sitting activity is presented in frames no 1 to 5. Raising hands is presented from frames no 31 to 50. Hands down are presented from frames 1 to 20, and bending down is presented from frames 1 to 25.

Touching is presented from frames no 11 to 25, bending over is presented from frames no 6 to 25, standing with both hands up is presented from frames no 31 to 50, standing with arms outstretched is presented from frames no 26 to 28, changing in the face is presented from frame no 1 to 50, and walking with bending down is presented from frame no 6 to 25.

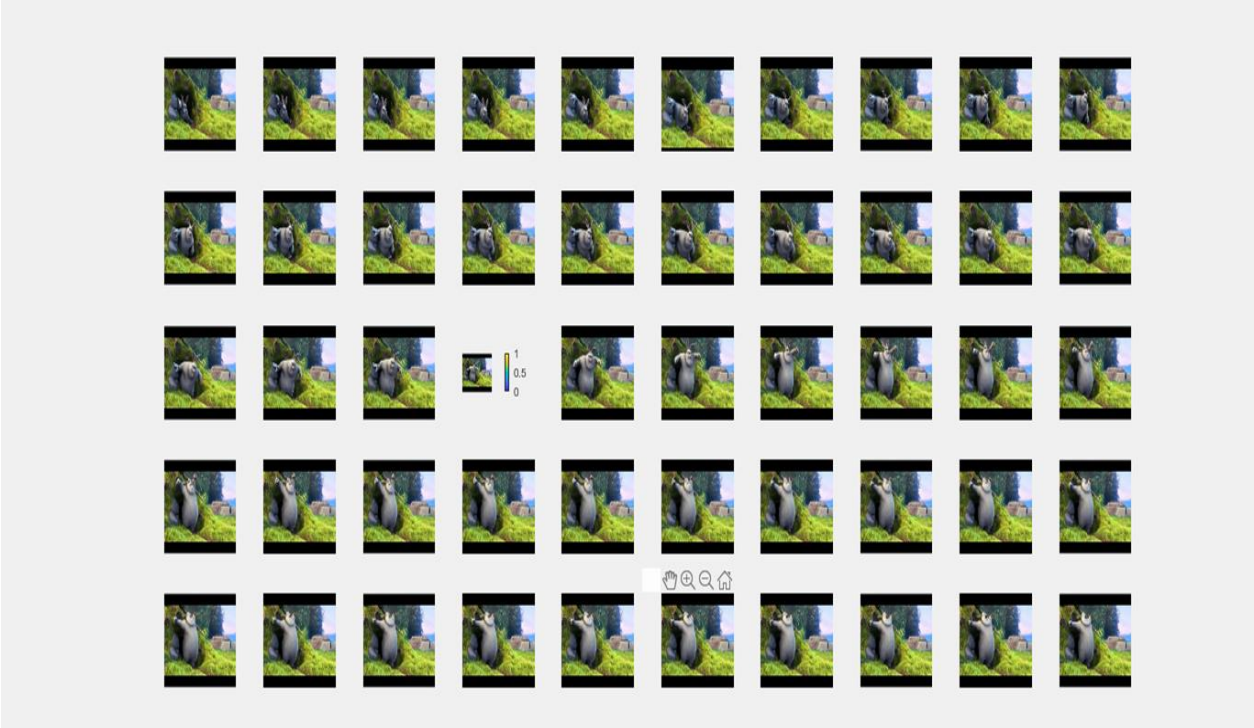

Fig. 4. Human Activity Recognition in MATLAB

CONCLUSION

Deep Learning supports action recognition mechanisms. This paper explained different Deep Learning methods which are used in human action recognition. The Deep Learning method is designed by software framework and computing GPU. Action recognition algorithm shows higher accuracy than other recognition networks. Using k-NN Different activities are recognized. The maximum accuracy of 98% is achieved which proved our deployment to be precise and accurate.

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