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Human Activity Tracking System

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Abstract:

This paper focuses on the sensor-based activity tracking to identify the actions performed by humans using signals collected from the sensors. The raw inputs are the signals acquired from the set of the data from the sensors and the outputs are the pre-defined activities. In human activity recognition the features for identifying the activities are critical and challenging. Most existing methods rely on the heuristic hand-crafted feature design and shallow feature learning architectures which cannot classify different activities accurately. In this paper, human activity tracking system adopts the deep learning convolutional neural networks (CNN) that makes possible to automate the feature learning from raw inputs in a systematic way. Deep learning performs the high-level extraction to represent the low-level raw inputs and widely adopted for the sensor-based activity recognition tasks.

Keywords **—Human Activity Tracking, Deep Learning, Convolutional Neural Networks (CNN), Activity Recognition, Human Activities, CSV Files.**

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I. INTRODUCTION

Human activity tracking is an important yet challenging research area with many applications in smart environments, homeland security and healthcare [1]. Due to technological advances based on sensors the human activity tracking is possible [2]. In the Human activity tracking system model the daily activities of human such as walking, running, sitting, standing, upstairs and downstairs is recognized. The raw data collected by a single tri-axial accelerometer and gyroscope. A Human Activity Tracking System collects the raw data from sensor and the collected data is trained by the machine learning algorithm for the classification of the human activity. The advancement of sensing technologies, embedded systems and wireless communication technologies makes it possible to develop smart systems to monitor activities of human beings continuously [3].

This design is similar to smart watch. Human Activity Tracking System used in the industrial environment to track continuously the company's employee activities such as walking, running, sitting, standing, upstairs and downstairs during the work time. The monitoring employee activities leads us to eliminate the supervising of, whether the employee is executing the allocated task or not. Human Activity Tracking System helps to improve the environment more smart and advance.

II. HARDWARE ACHITECTURE

A. Hardware Block Diagram

The Fig. 1 shows the hardware block diagram of the system. It mainly consists of a Processor, MPU6050 module, Wi-Fi Module, Organic Light Emitting Diode Displaying Unit (OLED Display), SD-card Module, Real time clock and Power supplying unit.

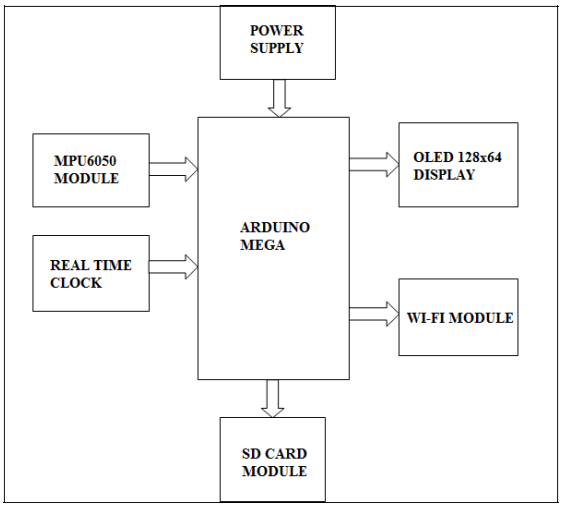

Fig . 1 Hardware block diagram of Human Activity Tracking System.

B. Hardware Block Diagram Description

The human activities such as walking, running, sitting, driving can be sensed using sensors such as accelerometer and gyroscope. There is a I2C protocol based sensor MPU6050 module which will include these two sensor over a single PCB. Also real time clock can be included in the design for time purpose. The SPI/I2C based An Organic Light Emitting Diode screen of size 128 X 64 can be interfaced on top of it. The data will be stored locally over SD card as well as it can be transmitted using Wi-fi over a server. Once sufficient data is collected then the human activity can be recognized using machine learning classification algorithm which will be the most enhancing step for the project. This way we can design wearable system, interface complex sensors with a unique protocol, design hardware and its power supply with space constraint, implement wireless protocol to transmit data, interface small OLED screen, interface SD card and store data from human activity.

III. SYSTEM ARCHITECTURE

Fig. 2 System Architecture of the Human Activity Tracking System. The system architecture shows every method that is used for the collection of activities from sensor and the recognizing of the activities using the deep learning convolutional neural networks (CNN).

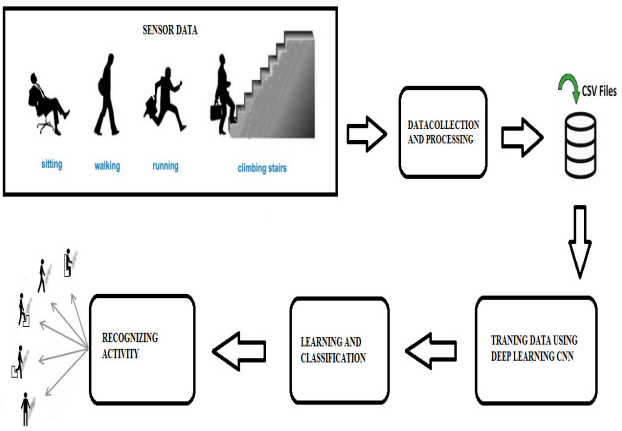

Fig . 2 System architecture of Human Activity Tracking System.

IV. SYSTEM DESCRIPTION

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The description of the different module and the functions with their result in Human Activity Tracking System are as follows.

C. Data Collection And Processing

The dataset contains six daily activities collected from the sensors. The activities include sitting, standing, walking, jogging, upstairs and downstairs. The data is collected from the 20 users with the 20 values per seconds rate. The collected data is then converted into Comma-Separated Values (CSV) file given in Fig. 3 Dataset in CSV file format.

User	Activity	Date	Timestamp	x	y	z	x	y	z
1	Sitting	14/2/2020	15:02:23	-1408	-699	110	-93	185	144
1	Sitting	14/2/2020	15:02:34	-1370	-798	20	-495	61	-110
1	Sitting	14/2/2020	15:02:44	-1460	-566	208	876	134	-113
1	Sitting	14/2/2020	15:02:50	-1462	-537	113	-608	172	-111
1	Sitting	14/2/2020	15:02:59	-1473	-439	250	-745	68	24
1	Sitting	14/2/2020	15:03:07	-1477	-550	312	2960	-3312	1152

Fig. 3 Dataset in CSV file format.

D. Deep Learning Neural Network

The Deep Neural Network (DNN) is developed from Artificial Intelligence Network (ANN) [7]. The existing ANN often contains very few hidden layers and deep neural network contains more. DNN is capable of learning from large raw data. The feature extraction and the model building procedure are performed simultaneously in deep learning methods [7]. In the deep learning, when the human activity data is multi-dimensional and complex then the more hidden layers can help to train the model to identify the human activities accurately.

1. Convolutional Neural Networks (CNN)

Convolution Neural Network (CNN) is Deep Neural Network (DNN) with the interconnected layers [6]. CNN has the huge potential to identify the various human activities performed. The input to the neural network is original dataset and applying the feature extraction from the original dataset it improves the performance. The CNN model contains the convolutional layer and max-pooling layer.

The input of each layer is output of the previous layer [5]. The have fully connected layer and its output is given to the softmax layer. These layers are layered together to form deep architecture for feature extraction from raw sensor data. CNN used to automatically learn features from the original dataset. In CNN the learning feature is considerd to be high-level representation of the low-level raw dataset input.

The Fig. 4 shows the CNN model.

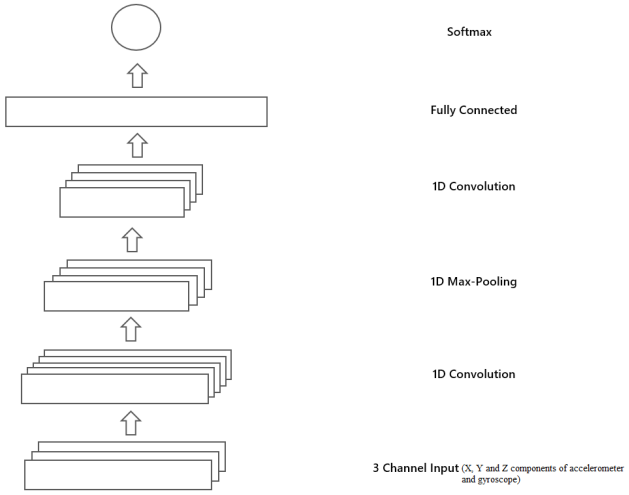

Fig . 4 The CNN model.

E. Dataset And Preprocessing

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The Dataset used in this work which may have some noisy raw dataset. To remove those inconsistencies data pre-processing is done. The dataset contains six daily activities collected from the sensors. The activities include sitting, standing, walking, jogging, upstairs and downstairs. The data is collected from 20 users. The data distribution with respect to the activities is shown in the Fig. 5.

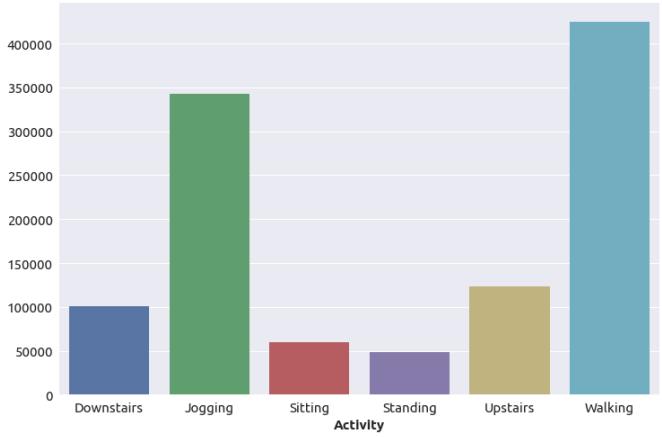

Fig . 5 Dataset distribution with repective to acivities.

1) Source of the dataset: The raw data collected from the sensors.

2) About the dataset: The collected raw data from the sensor is converted into the CSV file format.

3) Attributes: 6

a) Sitting
b) Standing
c) Walking
d) Jogging
e) Upstairs
f) Downstairs

F. Results

The result contains the probability for each possible activity, according to human activity tracking model. The dataset is preprocessed by the deep learning convolutional neural networks. After preprocessing the data is layered for accurate identification. The layered data is then classified to predict the respective human activities. Finally, the output of the last layer is passed to a soft-max layer that computes probability distribution over the predicted classes. Confusion matrix for the model prediction is given in Fig. 6.

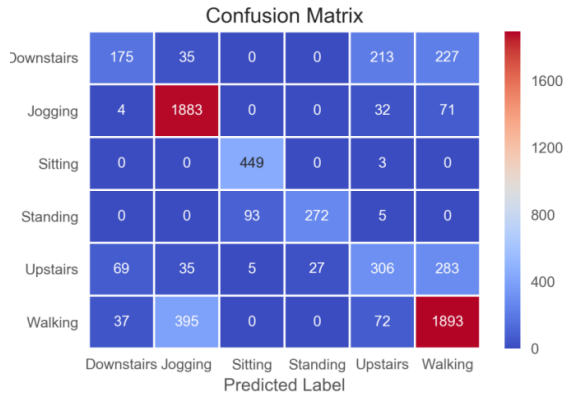

Fig . 6 Confusion Matrix for model prediction

V. CONCLUSIONS

This paper concludes that advance deep learning framework approaches for tracking human activity using tri-axial accelerometer and tri-axial gyroscope. The evaluation of different pre-processing steps, training of raw data and comparative analysis with conventional methods demonstrated that:

1) CNN has great potential in handling the feature learning from raw input dataset.
2) Produces high accuracy if input datasets are define in an efficient way.
3) Able to classify daily living activities in real-time and practical scenarios.

Overall, this paper contributed towards proposing a generalized and low-computational cost sensor based model for tracking human activities using deep learning convolutional neural networks (CNN). This proposed work can be further extended towards evaluating more number of subjects and also towards health care monitoring and security surveillance.

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