A Smartphone-based Virtual Reality Visualization System for Human Activities Classification

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Abstract

This paper focuses on human activities monitoring problem using onboard smartphone sensors as data generator. Monitoring such activities can be very important to detect anomalies and prevent disease from patients. Machine learning (ML) algorithms appear to be ideal approaches to use for processing data from smartphone to get sense of how to classify human activities. ML algorithms depend on quality, the quantity and even more important, the properties or features, that can be learnt from data. This paper proposes a mobile virtual reality visualization system that helps to view data representation in a very immersive way so that its quality and discriminative characteristics may be evaluated and improved. The proposed system comes as well with a handy data collecting application that can be accessed directly by the VR visualization part.

I. INTRODUCTION

In the era of big data and IoT, many researches have exploited the abundance of data to implementation data-driven applications that can help to understand human behavior in the society. Understanding statistical structure of such data is important to optimize accuracy of machine learning (ML) algorithms. One of ways to get such knowledge from data is through visualization software [5]. Moreover, virtual reality (VR) environments [7] bring more immersion factor to such systems. System at [6] proposed a human locomotion classification problem where their main focus was fall detection case that may be important for third age populations in case of medical crisis. Similar systems at [1, 2, 3] proposed a human transportation activities classification problem using a deep neural network as core ML algorithm in case of [3].

The proposed system focusses on showing the advantage of data visualization through a mobile VR system where features extraction quality can be viewed and inspected in order to get a clue of its characteristics. Such visualization can help then to optimize accuracies of ML algorithms.

II. PROPOSED SYSTEM

The proposed system can be divided in two interfaces, the data collection interface and the VR visualization interface. Each of these interfaces will be introduced in the following parts to show advantages of using our system.

II.1. DATA COLLECTION/AUGMENTATION INTERFACE

This part of the proposed system presents a handy way to collect data set directly from sensors (accelerometer and gyroscope). The Android application has three checkboxes representing “stay”, “walk” and “run” activities. After selecting an activity, the user can start/stop collection data from accelerometer and gyroscope sensors using a Bluetooth controller for convenience. Collected data is saved in a file that then will be accessed by the visualization interface.

II.2. THE DATA VISUALIZATION INTERFACE

As shown in Fig.1, this interface reads data collected at the previous interface. To display data in the VR system, first 3 features extractions techniques are used. Features named “data type1”, “data type2” and “data type 3” are respectively those proposed at [3], [6] and both combined. After feature extraction, data dimensionality is reduced to either 3 or 2 dimensions using Principal Component Analysis (PCA) for visualization. For the selected feature extraction method, the data can be trained then using its full dimensionality and can be displayed with the Support Vector Machine (SVM) as shown in Fig.1. Activities accurately classified as “stay”, “walk” and “run” are respectively represented by yellow, red and green colors. Black color samples are those that are misclassified by the SVM algorithm.

III. EXPERIMENTS AND RESULTS

The aim of this part is to show how the visualization may help to take efficient decision on the choice of data features representation. The system was implemented on the Unity3D [4] development tool and run directly on android device through the LG v30 device. Data

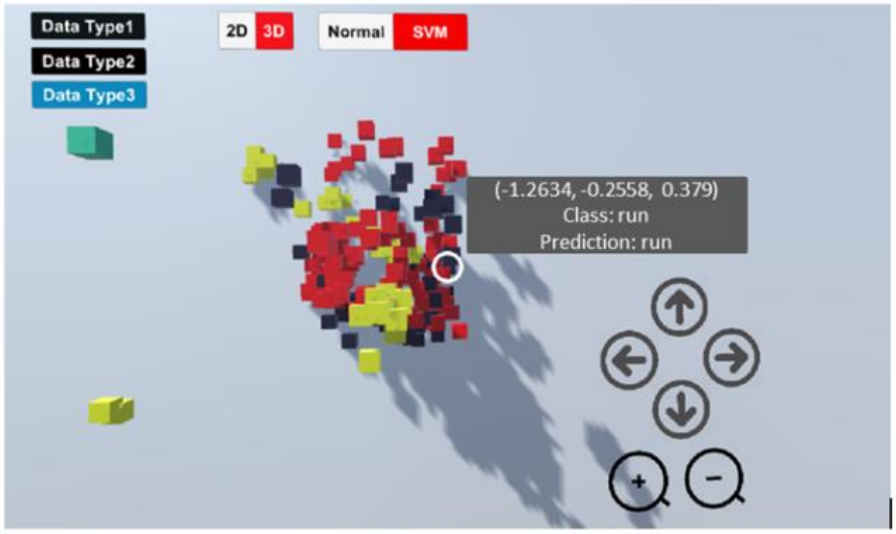

Figure 1. The proposed VR visualization system.

was collected for 10 mins of sensors reading for each of activities and all data types were collected simultaneously. Results show that the third feature extraction, "data type 3", has given better accuracy as shown in the Table 1. This gives a clue that SVM using the data type 3 will more likely outperform the others. And this is the aim of the proposed system to get such clues from visualization.

Table 1. Accuracy of SVM classifier trained with different data types or feature extractions.

With data type 1	With data type 2	With data type 3
69.24266 %	79.13446%	81.60742%

IV. CONCLUSION AND FUTURE STUDIES

This paper proposed an immersive VR visualization system for dataset of human activities generated by inboard smartphone inertial sensors. The proposed system offers a handy way of data collection/augmentation and a good platform to evaluate feature extraction techniques so that ML algorithm, SVM in our case, can be optimized. Future studies will aim to provide more feature extraction techniques and more ML algorithms as well.

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