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Research Article

Gesture Recognition Based Smart Home Control System

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Abstract: This paper is based on gesture recognition. It aims to transform gesture signal into electronic communication with home facilities. The main procedure consists of following steps: First, Curie chip collects the command gesture. Then, the gesture will be translating into accelerometer and gyroscope information. The Curie chip will integrate them into a motion vector and transport them to the k-means neural network as training. After training, each gesture represents a command attached to a facility control, and gesture control is revealed for smart home. Additionally, the whole system can be integrated as a wearable device, which relives complex button controller and improve portability. In brief, the research aims to replace remote controller and create a more convenient and pleasant living environment for users.

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1 Introduction

The concept of smart home first appeared in the 1980s. It is based on the platform of home residence, which uses advanced computer technology, network communication technology, security technology, integrated wiring technology, automatic control technology to effectively and efficiently supervise and control the household facilities and household appliances related to life. It aims to create a convenient, safe and comfortable living environment for users.

With the gradual maturity and diffusion of the Internet of Things technology, the intention to apply the Internet of Things and smart home is more popular. As its name implies, the Internet of Things links real objects with the Internet. Through the combination of local sensor networks and the Internet, it can realize the monitoring and control of the perceived objects. The rise of the Internet of Things brings better solutions for the development of smart home.

In the present living environment, remote control is a necessary event. However, for each device, it has its own remote control, which leads to the complexity and decentralization of the central control. If the remote control set for every item can also generate a complex and inconvenient control system, it may have dozens of press. The key remote control is neither convenient to control nor portable.

So we propose that gesture can be used as a control signal to fuse the difficult-to-integrate commands of control keys into a wearable device, and realize the control of home by recognizing gesture signals that are easy to learn and understand.

2 Methods

2.1 Procedure

Step 1: gesture design

In smart house, devices, such as air conditioner, television, stereo, projector, lights, curtain, window and door could be controlled by this gesture recognition based smart home control system is capable to send commands to them through WiFi.

Figure 2 illustrates the gesture for each device, and to improve the performance of recognition system, we increase the difference between gestures.

Step 2: training

As for training this gesture recognition model, we set the training time to be 4 in consideration of both the limited Arduino capacity and the acceptable accuracy. Every time, first draw a specific trace in the air while

holding the button, afterwards, we release the button to enter the next round. The data of accelerator and gyro during this motion is sampled by microcontroller at 200Hz, and then is filtered by using simple "moving average" filter. For every gesture, we repeat this process 10 times.

The classification method is K-nearest neighbour algorithm. The input in the classification process is the feature vector of the instance, and the output is the category of the instance. In the classification, the K-nearest neighbor algorithm predicts by means of majority voting according to the training instance category of its nearest neighbor. The K-nearest neighbor algorithm does not have an explicit learning process. In fact, the training vector data is used to divide the feature vector space. On the basis of the category of the sample, the system would switch the correct device.

Step 3: testing

In this part, we test every gestures for a hundred times, and get an accuracy of approximately 75%.

In order to get optimization, we adjust training time to several values and make the gestures with significant difference to each other. Eventually, under the condition of Arduino storage, we increase time to 10 and repeat testing. The optimal recognition accuracy become 84%.

Step 4: Sending commands

After training, now the system could identify every almost gestures, by classify the gesture we perform, it could send corresponding command to control the behavior of smart devices.

3 Results

In order to enable users to use fingers to express their interact intent naturally and enhance the accuracy, directivity and arbitrary in most recognition circumstance, we decide to apply a specific gesture recognition method for daily-used gesture based on machine learning to achieve this goal and minimize the potential shortcomings of this technology.

Arduino 101 is used for the hardware device, which is a low power consumption microcontroller based on the Inter CurieTM module. The Curie chip itself is specially designed for smart wearables, which comes with an accelerometer gyroscope (IMU) and a pattern recognition engine (PME), also known as hardware neural network. It provides varieties of benefits such as better performance and efficiency, wireless connectivity and motion sensing. It is possible to acquire accelerometer data from CurieIMU, preprocess the data and throw it into the pattern recognition engine(PME) to learn the gestures. The trained pattern recognition engine can classify the gestures and feedback a corresponding instruction.

For the data training, K-NN(K-Nearest neighborhood) algorithm is utilized to recognize and classify the data sample. For a sample data set(training data set), there is a label for each data in the sample set that we could get access to the relationship between every single data and the corresponding data category. Then input data without label, compare each feature in the new data with the feature corresponding to the data in the sample set and extract the classification label of the most similar data (nearest neighbor) of the feature in the sample set.

The distance can be derived as the square root of the difference in each dimension of the sample feature.

In general, we only select the top k most similar data in the sample data set. Setting the k value to a smaller value means that we expect a more complex and accurate model and it is easier to overfit. On the contrary, if the K value is larger, the model opportunity is simple, which could lead to underfitting. Finally, majority voting rule is used to select the most frequently occurring classification among the k most similar data as the classification of the new data.

4 Conclusions

(1) Our invention replaces traditional remote-control unit with buttons by gesture recognition based smart home control system, which achieves the goal that control various electric appliances by one small and portable equipment, bringing considerable convenience.

(2) Owing to the use of gesture recognition, users can design their own action to control their furniture, as long as the gestures are short and significantly different enough to be input the database and classified. To illustrate, the gesture to turn on a television could be different for each user, which increases the level of privacy.

(3) Our invention increase the training times for each symbol to improve the accuracy of classification.