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# Gesture detection using wearable based accelerometer

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## Motivation

Gesture recognition, in simple terms, is the ability of a computer or machine to interpret human gestures. These could include a wide array of motions such as hand movements, facial expressions, voice commands and the like. Devices such as cameras, microphones or accelerometers are used to detect and capture human gestures and machine learning / AI algorithms are then applied to interpret the data and recognize the gesture.

Interpreting human gestures is an important problem and has many applications. For example, researchers at Ben Gurion University have developed a hand-gesture recognition system that enables doctors to manipulate digital images during surgeries using hand gestures instead of touch screens or computer keyboards.

Solving this problem not only requires appropriate hardware but also proper lighting conditions, and suitable approaches for image capture.

Our client required us to assist with recognizing human gestures using accelerometer measurements available in smart watches. Accelerometer sensors read the acceleration over a body or an object in its instantaneous rest frame taking into account the acceleration due to gravity [4].

### Problem

GITAA had to develop a POC to detect a set of pre-defined gestures performed by a human wearing the smart watch at any given point in time.

### Solution

The data [3] used for this study is accelerometer data of a set of pre-defined gestures as shown in Figure-1.

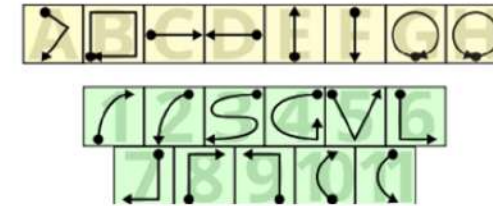


Figure-1

At GITAA, we addressed the problem in two ways. The first approach was a two step process, in lines with the research done in GestureKeeper [1]. The first step involved Gesture Identification, which is identifying the gestures from non-gestures from a streaming accelerometer data by posing the problem as a binary classification problem. In this step, Recurrent Quantification Analysis (RQA) is performed and two features namely recurrence rate (RR) and transitivity (T) are extracted on accelerometer y-axis data over which Support Vector Machine(SVM) is used as binary class detection method. The second step (Gesture Recognition) is to recognize the gesture from a set of pre-defined gestures on 3-axis accelerometer data along with statistical parameters - mean, median, root mean square (RMS), standard deviation, variance, skewness, and kurtosis over which SVM is modeled by defining it as a multi-class classification problem.

The second method adopted was to classify the gestures in the dictionary using a state of the art neural network method based on restricted column energy (RCE) [2] which is a 3 layer network (an input, a hidden and an output layer). In this method, the Euclidean Distance (ED) metric is replaced with Dynamic Time Warping (DTW) distance in each neuron in the hidden layer in order to activate the neuron. DTW distance is used to measure the distance between two time dependent data sequences that involves alignment of two time sequences before measuring the distance.

Based on the availability of the low cost smart devices with low frequency accelerometer data, the problem of detecting gestures using accelerometer data acquired at a frequency of about 10 Hz was addressed with much accuracy using the first method identified above. The application of gesture recognition using wearable devices was realized by implementing the mouse pointer control based on the literature [5] on a simple web application. This led to the development of a low-cost sensor based gesture recognition model to achieve simple daily tasks using electronic and electrical devices at home. Further recommendations were provided for building a generic hardware setup more suitable for real time learning using the second method.

## References

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