

# Gesture Recognition Using the Leap Motion Controller

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The purpose of this study is to show that the Leap Motion Controller is able to recognize not only basic gesture but also complex gesture using neural network and Principal Component Analysis (PCA). The Leap Motion Controller is a small USB peripheral that can, using 2 cameras and 3 infrared LEDs, track fingers and similar tools with a spatial precision of 0.01 mm. It can natively detect simple gesture like sweep or rotation but we will show that it can detect more complex gesture by coupling it with a neuronal network and analyzing the data with PCA. The aspects explored are the data gathering done with the LEAP, the type of data used, the PCA analysis done on the data using R, the training on the network and finally the means of integrating this development in the ordinary life.

For that we choose 7 gestures for the Leap to recognize : Swipe right, swipe left, swipe up, swipe down, rock, paper, scissors (of the Rock-Paper-Scissors game). Then we created an interface in C# to facilitate the data gathering and some Perl scripts to validate the format of the data. This interface was made so that, by pushing a button, it would record all the data of the Leap Motion for a certain number of frame, here 5 frames. It also created info files to keep certain data like the number of data per gesture or the description of the gesture on the hard drive. These data were mostly data on a detected hand like its roll, yaw and pitch value but also the position of the hand or the number of fingers detected. To have a more robust detection system, we decided to not use position data but its derivatives and so we made the interface calculate the velocity, the acceleration, the jerk and finally the jounce of the hand. In the end, we ended with 7000 sets of data with each set, 85 arguments.

The next phase was to train our neural network and test the data. For the implementation of neural network, we worked with the Fast Artificial Neural Network (FANN) library that gave us a robust but easy to use neural network. After it's done, we had to create a tool to test our data. For this purpose, we created a program in C# that gives us the confusion Matrix of our data. This matrix contains in percentage the results of all the tests realized and so we had 43.3% of precision, a very low value.

To optimize our network and validate the data, we decided to make a Principal Component Analysis (PCA) on the data with the language R. This mathematical procedure permits in fact to analyze a set of data and give us the most significant arguments of the data set. And so the PCA showed us that theses most significant arguments were not this significant, a proof that the data was invalid. After some research on the Leap Controller itself, we found

that it is very lacking in term of stability and zone of detection and so many gesture like Rock, Paper, and Scissors is not detectable.

In conclusion, we decided to specialize the type of gesture that we wanted the Leap to detect and will concentrate in detecting all the gesture of the hand and particularly, those of the 5 fingers, in order to create a new type of interface.