Introduction

Project based models of teaching and the use of maker spaces is becoming a strong trend in modern education. But how to assess how well is a student doing on these activities? One hypothesis is that the set of gestures and time a student applies in solving tasks is a predictive of how much expertise he acquired. In this project, I apply machine learning to evaluate participants in a workshop organized in the Stanford's fablab, by comparing them with graduate engineering students (experts) using data from a Kinect sensor.

Experiement:

20 senior high-schoolers participated in a workshop that took place in GSE's Fablab. They performed a set of six tasks that require problem-solving skills, three before and the remaining after the intervention. As a control group, 18 graduate Mechanical Engineering students (experts) performed the same tasks. Three participants dropped the program before completing the workshop. Video and body position were recorded during the task execution.


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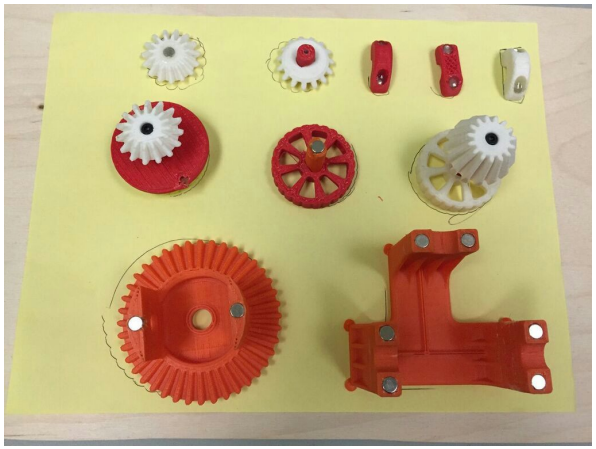
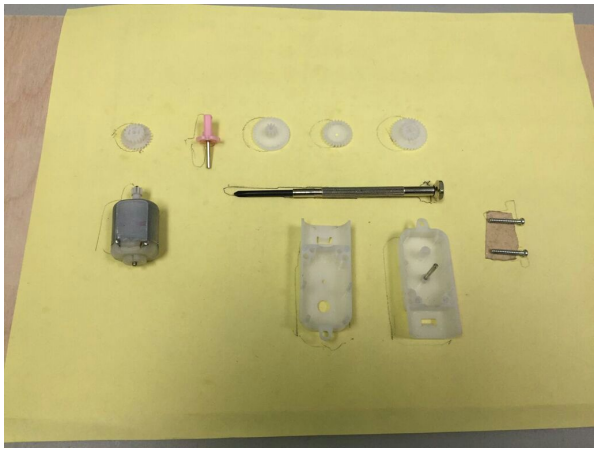
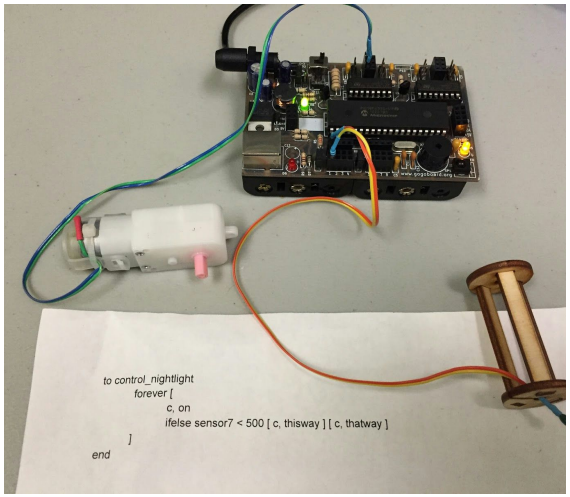





to control_nightlight
forever [
c, on
ifelse sensor7 < 500 [c, thisway] [c, thatway]
]
end


to control_nightlight
forever [
c, on
ifelse sensor7 < 500 [c, thisway] [c, thatway]
]
end

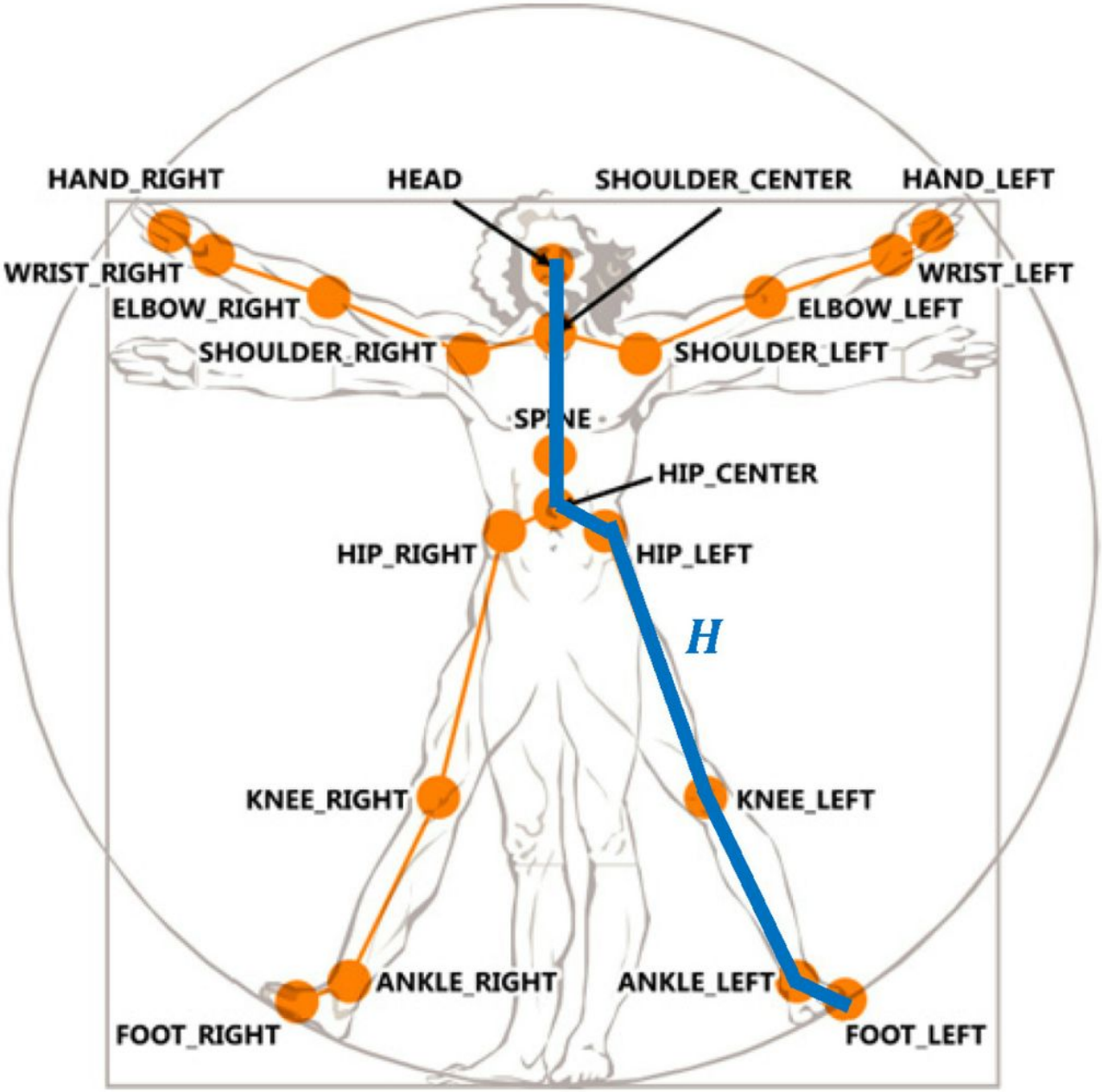
Data and Features:

The kinect sensor gives the position of 30 points per each 0.02 seconds.

The following features were extracted:

- Average speed for each kinect point
- Minimum speed for each kinect point
- Maximum speed for each kinect point
- Range of motion for each kinect point
- Average joint angles for hands, tips, thumbs, wrists, elbows, shoulders and spine

There were 183 training data, being one for each of the 6 tasks each participant or expert realized


HAND_RIGHT
HEAD
SHOULDER_CENTER
HAND_LEFT
WRIST_RIGHT
WRIST_LEFT
ELBOW_RIGHT
ELBOW_LEFT
SHOULDER_RIGHT
SHOULDER_LEFT
SPINE
HIP_CENTER
HIP_RIGHT
HIP_LEFT
H
KNEE_RIGHT
KNEE_LEFT
ANKLE_RIGHT
ANKLE_LEFT
FOOT_RIGHT
FOOT_LEFT

Results

Algorithm	Without FS	With FS
Logistic Regression	65.03%	66.5%
SVM Linear Kernel	54.10%	68.13%
SVM Polynomial Kernel	65.38%	65.38%
SVM - Gaussian Kernel	70.88%	80.22%
PCA + SVM		54.40%

Data Analysis

Given the small size of the data set, it was used Leave-one-cross-out validation for testing.

I first used Logistic Regression in the data, achieving poor results even for the training accuracy. I then tested SVM algorithms using linear, polynomial and Gaussian kernels. I used grid-search for the C and gamma parameters. The best results were achieved with a Gaussian Kernel, C = 3, gamma = 0.02, but of only 70.88% of test accuracy.

After performing feature selection, I tested the algorithms again, getting 80.22% of accuracy on the LOOC for SVM with a Gaussian Kernel, C = 3 and gamma = 0.125

Feature selection with Forward-search, gaussian SVM and 5-fold cross validation.

8 features were selected:

1. Average distance moved by left hand
2. Maximum speed of Spine Mid
3. Maximum speed of head
4. Maximum speed of left Wrist
5. Maximum speed of Right elbow
6. Range of movement of head
7. Range of movement of left thumb
8. Left elbow-shoulder-spine angle

Identifying Expertise Using Kinect Data