User Model for Determining User's Motor Skills

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1 Motivation

Most users are, naturally, healthy, so it is not common for applications to deal with users outside this group. We are presenting a possibility for an application to recognize different motor skills among its users.

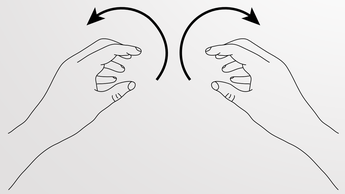
Determining the users' skills from human-computer interaction can be challenging even if it is the only goal of an application. Users with motor skills and coordination disorders are usually not very alike in their movements, not even when the motor impairments are the same. This problem introduces many difficulties in designing a user model for determining user's motor skills.

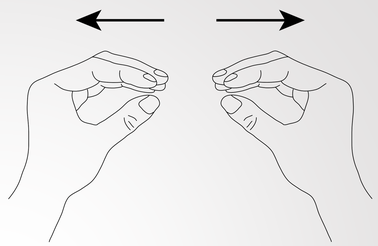
2 Categories and Gestures

Motor Skills Categories

- motor skills of healthy users
- motor skills of users with dyspraxia
- motor skills of users with cerebral palsy

These three can be also categorized as *regular category*, *discoordination category* and *movement-constrained category*, respectively, because the categorization is based on those principles.





Gestures

- rotate gesture
- scale gesture
- carry gesture

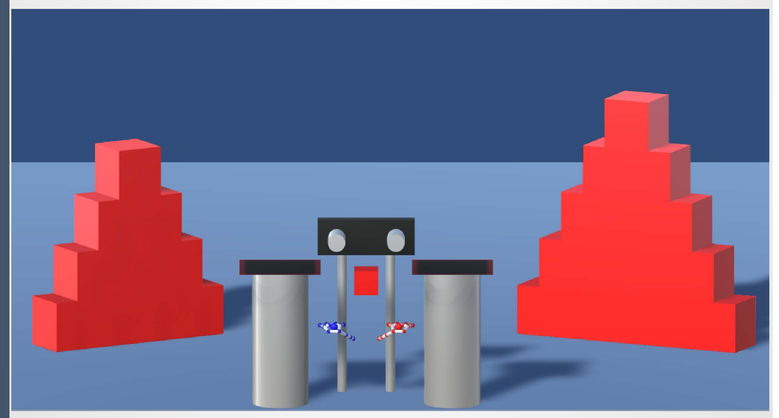
Focus on short and well-defined actions – gestures – of both hands. All the gestures are based on a coordination and are inspired by everyday gestures, such as screwing a lightbulb, opening a cabinet door or carrying a tray.

3 Experiments

We designed and performed two experiments:

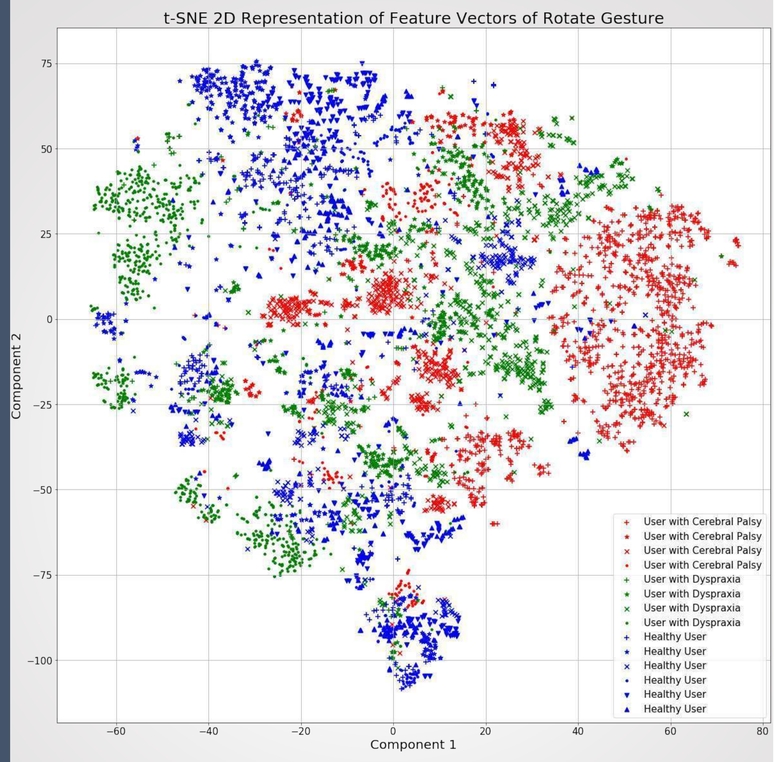
- obtaining data from users for choosing the best classifier for our problem and analyze the success rate of the proposed method
- evaluating obtained results and observe the ability of the system to adapt to the user

The gestures are processed from hand movements obtained from the Leap Motion sensor. We are able to extract behavioral biometric characteristics (e.g. average palm velocity) from the sensor data, classify them and adapt the gestures in real time.



We incorporated all the gestures in a simple pyramid-building game, making users focus on the game goal rather than carefully performing the gestures. The gamification of experiments motivates users to perform the same gestures over and over, making their progress visible directly by their actions. The participants of both experiments were chosen by a specialist from the Research Institute for Child Psychology and Pathopsychology in Bratislava.

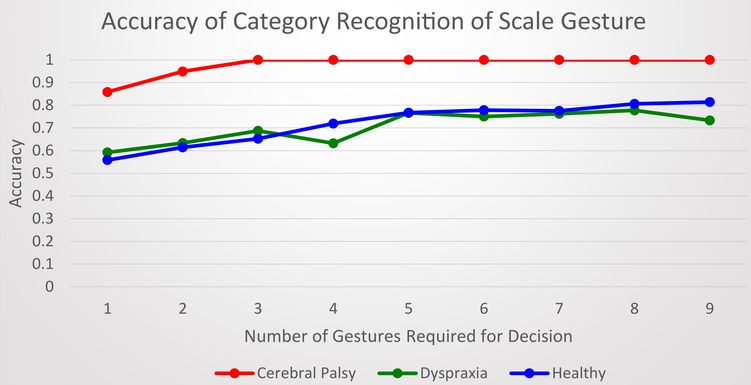
4 Similarity of Categories



Interesting patterns in confusion matrices of our training models were discovered among the gestures during the process of training classifiers. There is a much greater confusion between healthy users and users with dyspraxia, than between healthy users and users with cerebral palsy. This can also be observed on the two-dimensional representation of our dataset for the rotate gesture.

5 Results

The results show that for motor skills category determination were suitable two out of three proposed gestures, and both gestures performed very well in the adaptation context. The results of scale gesture recognition of motor skills categories for 3 gestures in row were better than our expectations. The best classifier which was able to obtain such good results is SVM with Gaussian Radial Basis Function kernel. It was used for classification of categories of all the gestures.



6 Conclusion

Recognition of motor skills categories and gesture adaptations to users were put into test in two experiments. The results of the experiments are very favorable and encourage further work in this domain.

Our solution was built to decide whether it is possible for system to recognize a motor skill category of a user and adapt to the user based on this category. Now, when these hypotheses are confirmed, we see a large potential in developing this idea further and create similar systems with a different goal – to create gestures and techniques able to adapt to user more conveniently.