6DMG: A New 6D Motion Gesture Database

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Abstract

Motion-based control is gaining popularity, and motion gestures form a complementary modality in human-computer interactions. To achieve more robust user-independent motion gesture recognition in a manner analogous to automatic speech recognition, we need a much better understanding of the motions in gesture, which arouses the need for a 6D motion gesture database. In this work, we present a database that contains comprehensive motion data, including the position, orientation, acceleration, and angular speed, for a set of common motion gestures performed by different users. We hope this motion gesture database can be a useful platform for researchers and developers to build their recognition algorithms as well as a common test bench for performance comparisons.

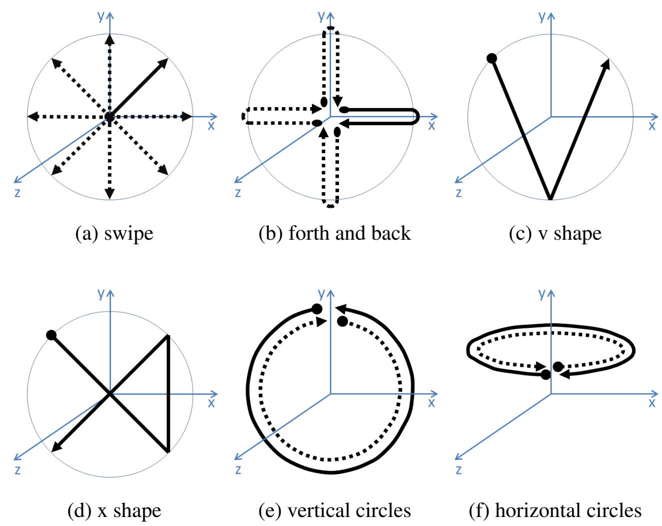

Figure 1: Selected set of gestures in our database

1. Why 6D Motion Gesture?

In this work, the motion gestures are composed by the location and orientation of the hand or the handheld device, i.e., 6D motion gestures. Common motion gestures are mostly defined with 2D movements on a plan. Even though we intend to perform planar motions, it is natural that human motions are still in 3D. Therefore, information other than 2D trajectory, such as depth and orientation, may give more insight into the motion gesture and improve the accuracy and robustness of recognition. Moreover, we are no longer limited to planar motion gestures if full spatial tracking results are available. Any type of motion can be considered as gesture as long as it can be differentiated from others, and it is thus possible for designers and/or users to define their own motion gestures.

Similar to the case of speech recognition, it is desirable that the recognition system accommodates user-specific adaptation or customization, but it is also very important to achieve robust user-independent recognition. If we find a way to represent a motion gesture as a string of motion "alphabets", the recognition problem can be restated and solved in a manner analogous to automatic speech recognition. Therefore, we need a much better understanding of the motions in gestures, which arouses the need for a motion gesture database.

Our contribution in this work includes the rationale and analysis of a number of factors that may prove imperative in ensuring the sustainable usefulness of the database. We consider swiping motions as the basic elements to form other complex gestures and hence include the group of swiping motions in eight directions into the gesture set. We also define a group of gestures that swipe rapidly forth and back in four directions. Other widely used motion gestures such as circle, cross, v-shape, roll, etc, are included. Figure 1 illustrates selected gestures from the gesture set used in our database.

For every user, the gripping posture and the way he or she performs a given gesture can be different from one another. Variations of the same gesture between individuals are expected, and recording motion gestures from different users ensures inclusion of the in-class variability. These variations are considered inherent in natural gesture rendering and need to be properly accounted for in the database, which is key to modeling and testing a user-independent motion gesture recognition task. We also would like to explore the differences between motion gestures performed by right-handed and left-handed users. In order to have sufficient data, we are targeting at least a set of 20 motion gesture performed by both 20 right-handers and 20 left-handers. More participants or new motion gestures may be added if needed in the future.

2. Motion Tracking

A hybrid framework of optical sensing and inertial sensing is used for 6-DOF motion tracking. We use WorldViz PPT-X4 as the optical tracking system, which tracks infrared dots at 60 Hz and transmits the tracking results with Virtual Reality Peripheral Network (VRPN) through Ethernet. It claims to have sub-millimeter precision and sub-centimeter accuracy with minimum 18 ms latency. As for the inertial sensors, we use the MEMS accelerometers and gyroscope embedded in Wii Remote Plus (Wiimote), which samples and reports at about 100 Hz. WiiYourself! library is used to communicate with Wiimote through Bluetooth. In addition to the 6 DOF of position and orientation, we actually have six extra dimensions from accelerations and angular speeds, which also infer the kinematic properties of the motion gestures.

3. 6D Motion Gesture Database

We present a motion gesture database of comprehensive motion data, including the position, orientation, accelerations, and angular speeds, which is named "6DMG". In our implementation, a formal database structure is used to store the recorded motion gestures, which makes the management between gestures, testers, and trials very handy. The database structure can also be convenient for further development on motion gesture recognition. We use SQLite, a self-contained and serverless SQL database engine for this purpose. 6DMG is in a single file, and the user can easily access it without installing any database server. To make the database portable and to keep the flexibility, we store the raw binary data and are not limited to any specific file format of motion gestures, such as AMC, BVH, C3D, or CSV. In case a user wants to recover the raw angular speeds or derive the orientation measurement with different algorithms, we also include the calibration information of the bias and noise levels in the gesture structure.

In the first release of 6DMG, it contains 20 motion gestures and involves 28 participants (21 right-handed and 7 left-handed, 22 male and 6 female, and ranging in the age of 15 to 33). We will continue update the database for more left-handed testers. Together with the release of the database, we also provide sample programs, i.e., 6DMG loader and 6DMG viewer, to acces and visualize the motion gestures. Figure 2 shows the screenshot of 6DMG viewer. Please refer to the 6DMG site for more details.

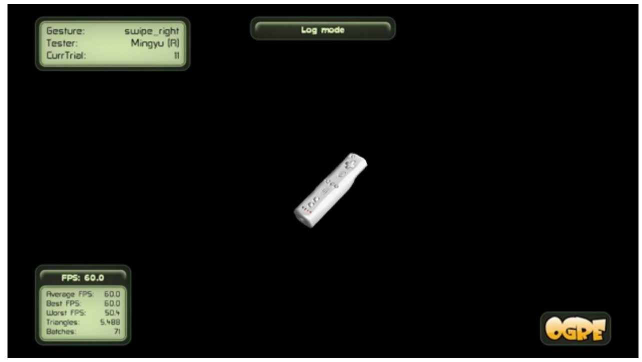

Figure 2: The screenshot of 6DMG viewer

With this motion gesture database, we plan to investigate motion gesture recognition using a hierarchical approach. It is no longer a symbolic classification problem, and we want to have a deeper understanding of motion gestures. As in speech recognition, we are interested in robust user-independent gesture recognition based on our 6D motion gesture database, which can improve the accuracy and the design space for motion gestures. Theoretically, both the position and orientation can be inferred from the accelerations and angular speeds. Hence, it is very likely that the features of motion gestures can be extracted from either the explicit 6D (position and orientation) or the implicit 6D (accelerations and angular speeds), and our motion gesture database provides both. It is also an interesting signal processing problem to make direct use of raw data with the drifting issue.

We hope 6DMG can be a handy platform for researchers and developers to build their recognition algorithms and a common test bench for performance comparison. Moreover, a subset of information in our database, *e.g.*, only the accelerations, can be used.

The most recent release of the 6D motion gesture database, the accompanying sample programs (6DMG loader and 6DMG viewer), and implementation details are available at: http://www.ece.gatech.edu/6DMG/