Neck gesture recognition by using constancy of head turning

Hiroki Taguchi
ShiraiLab, KAIT
1030 Shimo-ogino
243-0292 Atsugi, Japan
+8146-291-3201
taguchi@shirai.la

Hisataka Suzuki
ShiraiLab, KAIT
1030 Shimo-ogino
243-0292 Atsugi, Japan
+8146-291-3201
hisataka@shirai.la

Yannick Littfass
ShiraiLab, KAIT
1030 Shimo-ogino
243-0292 Atsugi, Japan
+8146-291-3201
yannicklittfass@yahoo.com

Akihiko Shirai
ShiraiLab, KAIT
1030 Shimo-ogino
243-0292 Atsugi, Japan
+8146-291-3201
shirai@mail.com

ABSTRACT

This article proposes a motion recognition method for Oculus Rift, which is currently the most popular head mounted display available, by using neck motion as non-verbal interaction. The method can define three gestures, namely, "agree," "disagree," and "make a question," by determining the constancy of the head turning angle.

Categories and Subject Descriptors

D.4.4 [Software]: Communications Management - Input/output, D.4.7 [Software]: Organization and Design - Interactive systems, H.5.2 [Information Systems]: User Interfaces- Input device and strategies

General Terms

Algorithms, Measurement, Neck, Interaction.

Keywords

Oculus Rift, head tracking, natural user interface, virtual reality.

1. INTRODUCTION

Content production nowadays has become easier compared with recent years because of the construction of content creation platform software such as Unity3D. Oculus Rift (hereinafter Rift) has appeared in the video game industry in 2012 as a prototype and has been rapidly funded at the crowd funding KickStarter. The construction of Rift became a tailwind not only for video games but also for the virtual reality industry. The highly immersive sense of Rift has an increasing effect on the game system. However, Rift has limited ability to add interactions between user and virtual character in the virtual environment. Rift cannot see the user's hands if the users try to use a classic device, such as a mouse or a keyboard. Developers may recognize the swinging and nodding head movements to realize the "Yes" or "No" commands. The sensor fusion of Rift obtains neck movement through integrated natural user interactions. However, a specialized implementation by a developer may not fit all users. Therefore, we proposed an absolute angular movement to configure simple neck command recognition through psychophysical experiments. This proposed approach could solve issues in the precision accuracy of the yaw axis. This approach can also define a guideline in human computer interaction by using human properties based on gesture recognition.

2. Related Work

Hyun proposed external gesture recognition software by using the upper-body kinematics information of game players [1]. However, given the occlusion of the head-mounted display (HMD) user, the accuracy of the detected neck angle differs between two Kinect devices. In addition, this accuracy is not enough to separate the detected motion from natural gesture motions.

Sakai proposed the AccuMotion method, which can separate natural movements by using the kinematics of the accumulated motion of a user by utilizing the inner product of vectors [2]. However, utilizing the neck movement to define accumulated motion, such as leg or arm movements, in natural user interaction is difficult.

Oculogyric recognition and gaze recognition are suitable methods to integrate the interaction of HMD users. However, these special devices are not suitable for Rift because the market price of Rift is targeted at 300 USD for end users. In addition, users should not need to calibrate their max–min oculogyric range and neck movement.

3. Constancy of neck and head movement

The neck is a complex structure comprising seven bones, which are difficult to define as matrices. However neck gestures are often used to tell "Yes," "No," and to ask questions in the major linguistic area. The neck and head movement range has constancy between each user [3]. A value is used to obtain the constant property of neck movable angle when users equip Rift in several subjects.

3.1 Environment

We used Rift and its sensor fusion, which contains magnetometers, gyroscopes, and accelerometers. By combining the values obtained by the sensor fusion, we can determine the rotation angle of the user's head in three dimensions in accordance with the right-handed coordinate system. The rotation for each axis is given in the form of pitch–yaw–roll (see Figure 1). In the X axis, the rotation of the upper direction is positive pitch. In the Y axis, the rotation of the left direction is positive yaw. The rotation of the Z axis is positive and tilts to the left in the XY plane roll. These values are obtained from **OVRDevice.GetPredictedOrientation** in Oculus SDK as rotation of yaw–pitch–roll. We converted the values from Quaternion type to Vector3 type.

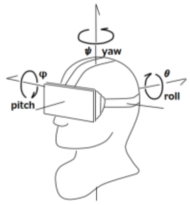

Figure 1: Coordinates in this experiment.

3.2 Experiment protocol

Subjects (four male Asian) wore Rift and recorded six operations. They watched “center-bottom,” “top-center,” “left-center,” “center-right,” “tilted left,” and “tilted right” scebes for 10 times each. The scene contained spherical textures, which are taken in an actual room and one computer-generated cube. The graphics are generated by Unity3D. Subjects must imagine the center and ground plane from visual feedback and somatesthesia.

4. Results

Figure 2 shows the average and deviation of the pitch–yaw–roll angle when four subjects watch the center. Roll is stable between subjects, but pitch and yaw are spread within +/−10° between subjects. Pitch can be explained as the difference of the center of gravity of a fixed position or the head. Yaw is the summation of the errors of the magnetometers.

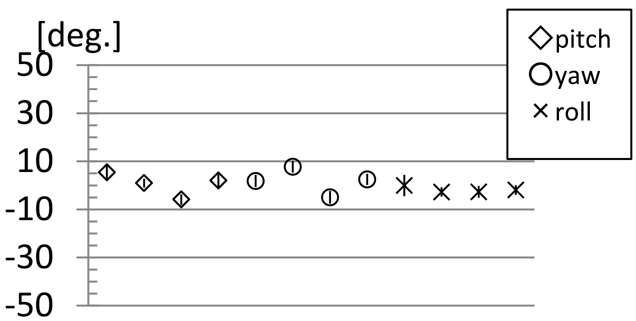

Figure 2: Average and deviation of the center position.

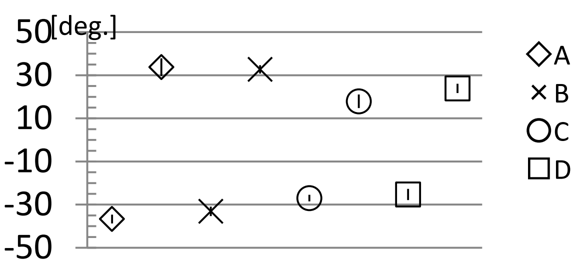

Figure 3: Average and deviation of roll when subject is tilting.

Figure 3 shows the average and deviation of the roll angle of the neck when four subjects tilt their necks. Deviations are small. The range is placed within +/−20° to 30° with symmetry for all subjects. This result indicates that 30° ± 7° is appropriate for the detection of the action “question.”

Figure 4 shows the average and deviation of yaw angles when four subjects swing their heads from side to side. Similar to Figure 2, unsymmetrical variation occurred in Figure 4. This variation is caused by the drift error of the magnetometer or the contact condition of Rift for each subject. Results show that the range 40° +/− 9° is appropriate to detect the “No” action. However, the problem of setting the center value remains.

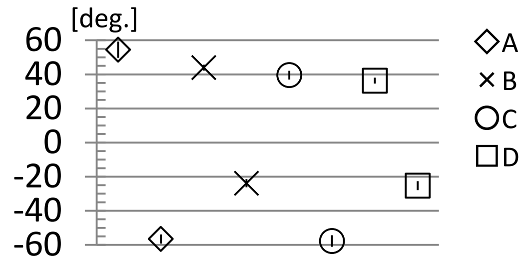

Figure 4: Average and deviation of yaw when a subject swings his or her head.

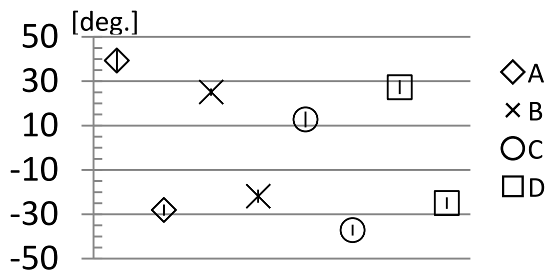

Figure 5: Average and deviation of pitch when a subject is nodding.

In the pitch for nodding, two subjects showed symmetry of +/−30°. However, half of the subjects showed an asymmetrical range (i.e., +40° to −30° and +10° to −35°). For the pitch direction of the jaws, around 18° of inter-subject variability (30%) exists. For the parietal direction, 27° of inter-subject variability (45%) exists. Therefore, inter-subject variability cannot be ignored. The physical limitations of the jaws, which have movable angles, are different. The range 30° ± 5° is appropriate to define “agree” or “back-channel feedback” detections. However, the motion contexts and frequency of nodding should still be considered.

5. CONCLUSION

We obtained experimental values from four subjects to define the “question,” “no,” and “nodding” actions.Constancy of head turning can be useful for neck gesture recognition to detect the “question” and “no” actions. Acceleration should be obtained to separate "agree" or “back-channel feedback” actions from other actions.

REFERENCES

[1] Hyun Kanga, Chang Woo Leea, Keechul Jung, “Recognition-based gesture spotting in video games", Pattern Recognition Letters, Volume 25, Issue 15, November 2004, Pages 1701–1714.

[2] Takuya SAKAI, Wataru FUJIMURA, etal, "AccuMotion: intuitive recognition algorithm for new interactions and experiences for the post-PC era", VRIC 2012 proceedings, Laval Virtual 2012 France, 2012

[3] Miyaoka, Satomi, et al. "Constancy of Head Turning Recorded in Healthy Young Humans." Annals of biomedical engineering 37.2 (2009): 428-436.