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論 文 要 旨

THESIS SUMMARY

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学生氏名： Student's Name	JAYASIRI, Madam Arachchige Anusha Harshani	指導教員（主）： Academic Advisor(main)	Professor Makoto Sato
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Recently, humans' interest has grown significantly to use innovative technologies to create virtual worlds beyond the real worlds. Among them, haptic technologies play a vital role in virtual reality applications and are being used in a wide range of application areas such as in training, education, cultural applications, entertainment and 3D interaction. Apart from that, haptic technology can play a vital role in modern multimedia applications. Rather than the senses of seeing and hearing, it can be incorporate other senses such as feeling, smelling and tasting into multimedia applications by using haptic technologies.

However, the incorporation of haptic technology into an image sequence, which is known as a video, is still in its infancy and it has gained a worldwide recognition among researchers. There are three types of haptic effects, which are cooperating with haptic interaction with video media. Those are haptic structure, haptic texture and haptic motion. In this research we are focusing on the research area of haptic motion in an image sequence which refers to the rendering of forces related to the moving objects in the scene. Hence, in this research we explore different perspectives of getting the haptic perception of feeling the movement of objects in an image sequence, with the objective of enhancing the viewing experience of viewers to the near real world level. Therefore, we propose systems for two degrees of freedom (2DOF), three degrees of freedom (3DOF) and six degrees of freedom (6DOF) motion rendering to a 2D image sequence.

At first we research on how to associate haptic signals with an image sequence to feel the movement of objects in it, beyond passive seeing and hearing. Among the various haptic devices exist, we use the string-based haptic device SPIDAR-G in our research due to the simplicity, familiarity, 6DOF force rendering capability and the high quality of the feedback force generated. Here we focus on feeling the movement of objects along the x and y dimensions using the SPIDAR-G haptic interface. The proposed approach for 2DOF motion rendering has four major steps namely feature points selection, feature points tracking, motion estimation and haptic motion rendering. The main contribution in this research is haptic motion rendering. There we propose two candidate methods: linear gain controller and nonlinear gain controller methods with the intention of getting the 2DOF motion. The experimental evaluations involving real users convince

that the feeling of object movements through the haptic interface significantly enhanced the viewing experience of an image sequence. Our evaluations further reveal that the nonlinear gain controller method outperforms the linear gain controller method for translational motion rendering.

However, some limitations exist in the work such as the users are purely passive users, not suitable for object rich environments and background noise affected to the final solution. One of the best examples for such a feeling is feeling the wind in an image sequence. Hence, we extend our research to active user perspective of the haptic perception of feeling the movement of objects in an image sequence by incorporating 3D haptic interactivity on 2D image sequence using the SPIDAR-G. To interact three dimensionally with the image sequence, we define a user interaction along the z dimension with an object selected by the user by pointing it on the image sequence. This user interaction along the third dimension deals with the virtual distance between the user and the object, enabling the user to feel the movement of a desired object at varying virtual distances with the object.

Hence, the proposed approach enables users to point their desired objects and feel the movement of only those objects selected by pointing. Therefore, the proposed approach is capable of dealing with object rich image sequences as well. The ability to change the virtual distance also helps reducing the background noise as the users can select how much of a frame of an image sequence needs to be seen by changing the virtual distance. The experimental evaluation of the proposed system reveals that it has a significant impact on the users' viewing experience.

Moreover, we propose a method to 6DOF, which allow users' to feel the 3D translational and rotational motion of an object in the 2D image sequence using the SPIDAR-G haptic interface. The proposed approach has three major parts namely pose estimation, linear and angular velocity estimation and render of force and torque. In this research, we discuss how to feel the 6DOF motion, which is computed force and torque in 3D from the two proposed methods using the linear gain controller and nonlinear gain controller methods. We have experimentally evaluated and shown that the users are able to feel the 6DOF motion from 2D image sequence from our proposed method. Our evaluations further reveal that the nonlinear gain controller method outperforms the linear gain controller method for 6DOF motion rendering.