INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Design and Evaluation of User-Centric Gesture-based Selection Techniques for Small Objects of Varying Distances in Dense Virtual Environments of HMD-VR Applications

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SHORT ABSTRACT

Virtual reality (VR) is a computer-generated simulation of a three-dimensional environment that can be interacted with in a seemingly real or physical way through the use of electronic devices, such as head-mounted displays. In VR, users have various options for interacting with the virtual world, such as controllers, gloves, bare-hand gestures, haptic devices, and bodysuits. VR has a multitude of applications, ranging from gaming to healthcare, education and training, and tourism and travels to name a few. Object selection is an essential and crucial task in any of the VR applications because it allows users to identify, interact with and manipulate virtual objects in the virtual environment (VE). In VR, VEs contain objects of varying densities, sizes, and distances from the user. However, selecting small objects placed at varying distances in a dense VE can be challenging, and can lead to inaccurate selection, increased task completion times, and higher levels of fatigue and frustration. Therefore, it is necessary to develop effective object selection techniques that enable accurate and quick selection, particularly for small objects placed at varying distances within dense VE. Our thesis is focused on controller-less object selection techniques. The thesis is based on five primary experiments, with the first two studies being gesture elicitation studies. The initial study focuses on investigating user-centric gestures for selecting small objects within arm's reach and at a distance in a dense VE. The second study concentrates on evaluating user-elicitated gestures for selecting an individual gesture for each VE condition. The gestures were evaluated based on their ease of use, appropriateness, suitability for the gesture's function, preferences, and effort. Thereafter three studies were conducted to evaluate the techniques with existing techniques in the literature. The third study aimed to design and evaluate gesture-based object selection techniques for dense VE where targets are small and placed within arm's reach. We designed a technique called Locked Dwell Time based Point and Tap (LDTPT) and compared it with existing techniques from the literature. The results showed that LDTPT was the most natural and efficient technique for selecting small targets at arm's reach. However, participants found it difficult to use and learn. To address the limitations, in the fourth study, we designed and evaluated a new

technique called Tiny hands, which scales down the size of virtual hands to select small targets. Results showed that Tiny hands technique was significantly faster, more accurate, and easy to use, learn, and preferred over other techniques. In the fifth study, we designed and evaluated AMAZE and AMAZE-X techniques (A Multi-finger Approach to Zoom in dense Environments) for the selection of small targets placed at a distance in dense VE. This technique offers zoom using multiple fingers in VR. Results show that these techniques outperform existing techniques in task completion time, accuracy, easy to use, ease of learning, naturalness, preference and effort. Lastly, we are able to present a set of design recommendations that can be used by designers and developers to design efficient and effective gesture-based object selection techniques for small object selection in dense VE where targets are placed within arm's reach and at a distance.