Training for Safe Tree Felling in the Forest with Symmetrical Collaborative Virtual Reality

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Abstract : One of the most common pieces of equipment still used today for pruning, felling, and processing trees is the chainsaw in forestry. However, chainsaw use highlights dangers and one of the highest rates of accidents in both professional and non-professional work. Felling is proportionally the most dangerous phase, both in severity and frequency, because of the risk of being hit by the plant the operator wants to cut down. To avoid this, a correct sequence of chainsaw cuts must be taught concerning the different conditions of the tree. Virtual reality (VR) makes it possible to virtually simulate chainsaw use without danger of injury. The limitations of the existing applications are as follow. The existing platforms are not symmetrical collaborative because the trainee is only in virtual reality, and the trainer can only see the virtual environment on a laptop or PC, and this results in an inefficient teacher-learner relationship. Therefore, most applications only involve the use of a virtual chainsaw, and the trainee thus cannot feel the real weight and inertia of a real chainsaw. Finally, existing applications simulate only a few cases of tree felling. The objectives of this research were to implement and test a symmetrical collaborative training application based on VR and mixed reality (MR) with the overlap between real and virtual chainsaws in MR. The research and training platform was developed for the Meta quest 2 head-mounted display. The research and training platform application is based on the Unity 3D engine, and Present Platform Interaction SDK (PPI-SDK) developed by Meta. PPI-SDK avoids the use of controllers and enables hand tracking and MR. With the combination of these two technologies, it was possible to overlay a virtual chainsaw with a real chainsaw in MR and synchronize their movements in VR. This ensures that the user feels the weight of the actual chainsaw, tightens the muscles, and performs the appropriate movements during the test allowing the user to learn the correct body posture. The chainsaw works only if the right sequence of cuts is made to felling the tree. Contact detection is done by Unity's physics system, which allows the interaction of objects that simulate real-world behavior. Each cut of the chainsaw is defined by a so-called collider, and the felling of the tree can only occur if the colliders are activated in the right order simulating a safe technique felling. In this way, the user can learn how to use the chainsaw safely. The system is also multiplayer, so the student and the instructor can experience VR together in a symmetrical and collaborative way. The platform simulates the following tree-felling situations with safe techniques: cutting the tree tilted forward, cutting the medium-sized tree tilted backward, cutting the large tree tilted backward, sectioning the trunk on the ground, and cutting branches. The application is being evaluated on a sample of university students through a special questionnaire. The results are expected to test both the increase in learning compared to a theoretical lecture and the immersive and telepresence of the platform.