Title:
Simulating a Virtual Journey on Italian Alps through a Multisensory Mixed Reality Environment

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Introduction:

The aim of this research work is to develop a multisensory application for the tourism sector by using visual, audio, tactile and olfactory stimuli, and offer to the user the possibility to enjoy the experience of a walk on Italian Alps. The simulation environment is specifically designed for the tourism sector, especially for travel agencies: the customers have the possibility to virtually test different holiday destinations before booking one of them.

Virtual Reality (VR) offers tourism many useful applications that deserve greater attention from tourism researchers and professionals [2]. Planning and management, marketing, entertainment, education, accessibility, and heritage preservation are six areas of tourism in which VR may prove particularly valuable [2].

Creating a realistic virtual simulation might take time and be time consuming. Thus, in this research we used a mixed approach. We captured real movies and integrated them into an interactive virtual simulation.

The overall multisensory experience is based on a video projection, recorded in the real environment, synchronously matched with a tactile interface. The haptic interface is made up of a pair of slippers provided with actuators, and an actuator applied on the trunk, which reproduces a snowball hit. Moreover, a fan combined with a scent delivery system is used as olfactory display and provides pine smell. Furthermore, the user sits on a yoga ball, whose inclination allows him/her to start and stop the virtual and haptic experience. The simulation also includes sounds.

The goal of this research is thus the use of the sense of smell and touch, combined with vision and hearing, to improve the user's experience of a VR application related to a virtual journey. We focused on marketing tourism sector, particularly on the case of a travel agency [1]. The result is a experience able to provide a virtual preview of the desired holiday destination, resulting attractive for the customer but especially effective in increasing sales for the tourism provider.

Main Idea:

The concept at the basis of this research relies on the "sense of embodiment" [4] and immersiveness in the virtual experience. A video and an audio, recorded in the real environment, are shown to the user

and the same tactile and olfactory sensations felt during the recording by the operator are synchronously reproduced by the device as output. In order to make the experience more interactive, the user has the possibility to control the simulation with his/her own movement.

Because the application has been designed for the promotion and selling in tourism, one of the first design decisions has been the selection of a case study, thus the experience and the location. In order to meet the needs of the tourism sector related to people interesting in both winter sports and nature, we decided to focus on mountain tourism related to nature exploration. So, we selected the Italian Alps environment and, specifically, the little town of Foppolo, which is a known skiing destination. Three main steps have been carried out to develop the experience:

- video recording and data acquisition;
- data analysis and design of the circuit;
- design and development of the physical prototype and synchronization.

The basic idea was recording a video of a walk in the snow along a mountain path surrounded by nature and, at the same time, collecting data related to tactile sensations perceived at the feet level by the walker. In addition, we integrated the experience with the smell of pines of the location and include an effect unexpected by the user: the tactile feedback of a snowball hitting the body.

About the video creation, we chose an area close to a creek and characterized by the presence of a small path coming out from a wood and completely covered with high fresh snow. Furthermore, it was also possible to have an overview of the city from that site.

As previously said, we designed the experience for an ideal travel agency who wants to give to its customers the chance to have a virtual preview of a journey before booking it [1]. In this case a simulator is effective if a customer could make better-informed decisions and have more realistic expectations, which may lead to a more satisfactory vacation [2]. According to these assumptions, an "active experience", in which the user can move freely in a limited environment and obtain stimuli by sensory activation, has been considered not suitable for this application. That is because it could happen that he/she focalizes his/her attention only on some aspects of the simulator, not considering all the attractions of the destination. Much worse, the user could feel inside a playful application instead of a marketing one and use it like a game, with the result of a loss of time and money for the travel agency. These are the reasons that brought us to design a "passive experience", namely an experience in which the user feels like being inside the body of who physically recorded the video and undergoes the sensations related to the actions shown in the video. This type of approach allows creating a guided tour of all the main beauties of the location, in a short time and in an effective way.

During the video acquisition, we synchronously acquired data useful to reconstruct the walking cycle, namely the temporal history of the steps and the feet position during motion. The walking cycle can be schematized in 3 parts:

- stance (60% of the total cycle), corresponding to the time period in which the foot is in contact with the ground;
- swing (30% of the total cycle), corresponding to the time period in which the foot is lifted from the ground;
- double support (10% of the total cycle), corresponding to the time period in which both feet are in contact with the ground.

Relying on these assumptions, we decided to use a 3-axis accelerometer and gyroscope to acquire data related to the position of one foot during the walking.

Regarding the tactile interface, the most important point was modelling the tactile sensations felt by the person during the walk. Considering that the person walking in the snow is wearing a pair of boots (thus the movement of the foot is constrained), we schematized the stresses on the feet as concentrated in 3 main areas (see Fig.1):

- under the heel (rear support area of the foot);
- under the forefoot (frontal support area of the foot);
- above the forefoot, just before the toes (where the boot bends during walking).

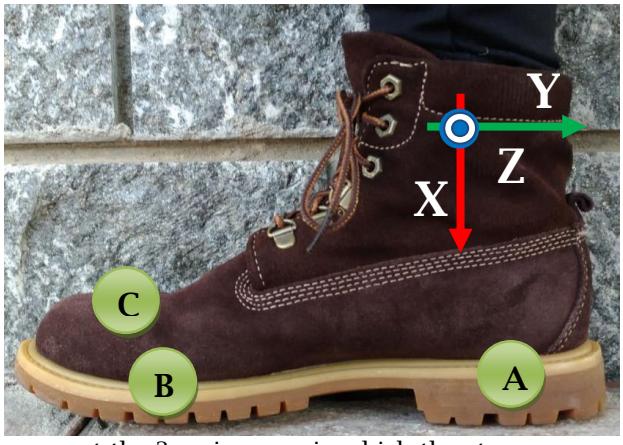

Fig. 1: The green circles represent the 3 main areas in which the stresses are concentrated according to the model. The reference system refers to MPU-6050 device orientation respect to the ankle.

We reproduced the stresses by using a single actuator in the middle of each area, so we acquired data from three different points of the foot. We performed three acquisitions for each foot area, one area per time, then choosing the less noisy one. Also, we acquired the data regarding the snowball hit in the same way.

The collected data have been analysed and used for defining the tactile sensations to be reproduced. About tactile sensations reproduction, we used three actuators for each foot, so totally six, and another one for the snowball hit simulation. The vibrating motors have been embedded in a pair of slippers (see Fig.2). In order to make the simulation being experienced interactively, we added the possibility to start and stop the video according to the will of the user. For this aim we used a tilt sensor that can pass from "OFF" to "ON" state and vice versa, according to the inclination. By using a yoga ball as a chair, the user can spin of the ball to activate and deactivate the tilt sensor. Moreover, the ball could be fit to the height of the user by inflating or deflating it and forced the user to maintain a defined position: at the start, the person is sit like on a rigid chair, with the weight concentrated at the bottom part of the vertical column and the legs downloaded; to activate the simulation, the person is asked to slightly tilt forward, moving partially the weight on the legs, reaching thus the equilibrium state of the ball. In addition, the ball is elastic so in the activation position the user feels like "going to stand up and start walking".

Fig. 2: On the left: slipper with vibrating motors embedded. On the right: slippers running during the simulation

Finally, concerning the olfactory simulation, we decided to simulate the pines scent carried by the breeze passing through the tree branches. Therefore, we used a 5V fan, and we covered it with a piece of fine fabric soaked with a mix of drops of pine essential oil and water [3].

The overall experience the user can perceive is of a walk into the specific location, combining information of four sensory modalities.

Conclusions:

In this paper, we described the design and the implementation of an interactive multisensory virtual journey, specifically designed to help travel agencies to improve their selling activity. By means of this simulation, the potential customer can select the journey by experiencing part of the journey itself and can make a better choice.
The simulation involves four senses and is a combination of real (visual and hearing) and virtual information (olfactory and tactile). The motivations behind the design choices are described in the paper.

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