Virtual Equine Assisted Therapy

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ABSTRACT

People with a wide spectrum of disabilities, ranging from spinal injuries to autism, have benefited from equine assisted therapy (EAT). Using EAT, therapy patients have improved both physically and psychologically (e.g., demonstrating increased attention, motivation, and communication skills). There are still many open questions regarding this therapy and the reasons for its success. Many of these questions have remained unanswered due in large part to the uncontrolled nature of EAT. The Virtual Equine Assisted Therapy (VEAT) Project integrates a robotic platform with virtual reality technologies to provide a safe, controlled environment through which various aspects of EAT can be isolated and studied. The system incorporates realistic equine motions with visual, auditory, olfactory, and somatosensory stimuli to provide highly immersive experiences to patients.

KEYWORDS: Virtual reality, equine assisted therapy.

INDEX TERMS: H.5.1 [Multimedia Information Systems]: Artificial, augmented, and virtual realities; J.3 [Life and Medical Science]: Health; J.m [Miscellaneous].

1 INTRODUCTION

Over the last 25 years, thousands of patients have benefited from the integration of horses into rehabilitation programs. The use of horses in therapy (Equine Assisted Therapy, or EAT) has benefited children and adults afflicted with language impairments or disorders such as cerebral palsy and autism.

Simple interactions with horses, such as petting or brushing, can reduce anxiety in patients and can also produce other positive emotional outcomes (e.g., increased social functioning) [1]. The psychological benefits of EAT have resulted in it being used in settings ranging from psychotherapy [2] to treatments for autism [3]. In addition to the many psychological benefits that have been reported, the integration of horses into rehabilitation programs have also produced many physical benefits. Patients with cerebral palsy, for example, have experienced improvements in posture, gross motor function, and muscle symmetry [4].

Although EAT has been a beneficial addition to many rehabilitation programs, there are still many unanswered questions pertaining to how and why it works. EAT is difficult to study in its natural setting due to the difficulty of recording data in the outdoor environments (e.g. movement measurement), the limited control over horse movements, and the large number of uncontrollable environmental variables. Using virtual reality (VR), we can simulate EAT in a safe, controlled manner. Our VR system, Virtual Equine Assisted Therapy, or VEAT, (Figure 1a) will allow us to systematically isolate various elements of traditional EAT and quantitatively study their effects on therapeutic outcomes.

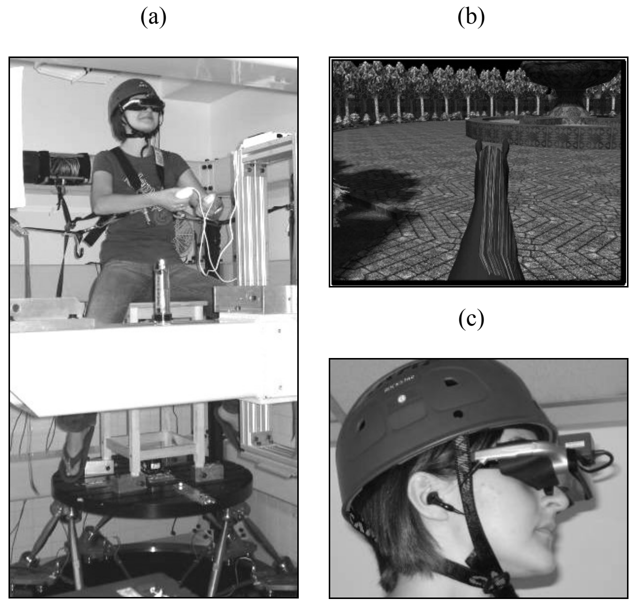

Figure 1. (a) A participant with the VEAT system, (b) Participant view from atop the virtual horse. (c) A HMD and InertiaCube used for virtual environment presentation and head tracking.

2 SYSTEM ARCHITECTURE

We designed the VEAT system to provide a safe, controllable environment through which EAT can be studied. The VEAT system integrates a number of technologies that fall into three main categories: 1) stimuli, 2) behavioural and performance measurement, and 3) participant interaction.

2.1 Stimuli

For Virtual EAT to be effective, it is crucial that patients are able to receive sensory information similar to that experienced during traditional EAT. To achieve this, the VEAT system provides vestibular, visual, auditory, olfactory, and somatosensory feedback.

2.1.1 Vestibular stimuli

To simulate the motion of a horse, we are recording data from a real horse as it moves through traditional EAT scenarios (i.e., walking at various speeds, trotting, etc). We capture the position and orientation of a saddle on the back of the horse using the Visualeyez II system, which uses active wireless markers and is capable of recording over 3000 data points per second. The recorded motion data (i.e., position and orientation) is then mapped to movement commands for a Parallel Robotics R-Series Hexapod robotic platform (Figure 1a).

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The movement data gathered from the saddle can be played back as raw data or can be isolated to replay specific segments of movement. The isolated movement segments will be used to examine the effects of various motion components (e.g., particular axes, or the amplitude and rate of motion). Alternatively, the platform can also be moved in novel, artificial patterns. This flexibility could enable the VEAT system to produce outcomes that are better than those found with traditional EAT.

2.1.2 Visual Stimuli (Virtual Environment)

We have created a virtual environment using 3D models created with Maya 8.5 and the Virtools 4.1 software. The virtual environment is currently one square kilometre and contains a number of different regions: a mountainous area, a foot hilled-section, a river region, a number of riding trails, an open, grassy area, and a training facility. The participant takes the viewpoint of a rider sitting on the back of a horse (Figure 1b).

The interactive virtual world is displayed via a stereo-enabled head mounted display (HMD) (Figure 1c). We use the light-weight, i-Glasses 920HR HMD for viewing the virtual environment. Our display weighs only 68g and can display stereoscopic images with a resolution of 640x480 pixels. In addition, the HMD has built-in earphones, thus eliminating the need for additional audio cables, and ensures that participants can hear auditory stimuli while wearing our required safety helmet.

2.1.3 Olfactory and Somatosensory Stimuli

In the first prototype, an assistant manually disperses scents to participants using atomizers. Different areas in the virtual world trigger different scents. In the heavily wooded areas, for example, a pine scent is dispersed, but when near the river area, a ‘wet and musky’ scent is dispersed. Horse specific smells such as sweat and manure can also be presented. By integrating diverse olfactory stimuli into the virtual environment, we hope to provide participants with an immersive, realistic experience.

To further enhance a participant’s experience with the VEAT system, we have included somatosensory stimuli in the form of wind. Virtual wind is achieved by placing four electric fans around the hexapod robot and controlling them with a Phidget Relay Interface kit. This kit enables the VEAT system to vary the wind speed as well as wind directions that are experienced as a participant moves through the virtual environment.

2.2 Participant Interaction

It has been suggested that the feelings of dominance that are experienced when controlling an animal (such as a horse) are direct contributors to many of the psychological benefits of EAT that have been experienced [3]. To induce these feelings in the VEAT system, participants are able to manipulate the speed of their virtual horse using Wii Nunchucks (which are normally used with the Nintendo Wii Console). In the VEAT system, participants hold one Wii Nunchuk in each hand. By moving the reins in a quick, up-and-down ‘giddy-up’ motion, participants can increase the speed of their virtual horse. This change in motion causes the robotic platform to speed up the playback of a pre-recorded walk or trot. Slowly moving the reins upwards, for example, signals a ‘whoa’ movement and will cause the robotic platform to slow down the movements of the robotic platform.

Participants can move their head freely to get a different view of the environment. By default, the user’s viewpoint coincides with the virtual rider’s head and follows the path of the horse. We use an InertiaCube orientation sensor mounted on top of the HMD to detect the orientation of the participant’s head and map this to the virtual camera orientation.

2.3 Behavior and Performance Measurement

To answer many of the difficult questions surrounding the success of EAT, it is imperative that we are able to quantitatively measure participant performance and behaviour.

The use of an electro-myogram (EMG) enables the VEAT system to record specific muscle activity during VEAT sessions. By replaying isolated motions of the horse and recording the associated muscle activity, it is possible to discover which segments of a horse’s motions correspond to physical improvements.

To accurately assess the emotional aspects of EAT, we are planning to use a number of physiological measurements that are known to vary with emotional changes, including heart rate, galvanic skin response, blood pressure, and respiration rate. The integration of these sensors will allow for the continuous monitoring and recording of data from the participant during experimental trials.

The motion capture system used to capture the horse’s movements will also be used to capture a participant’s behaviour and movements as they use the VEAT system. By tracking the position and orientation of a participant’s back, shoulders, head, and neck, we can monitor changes in posture, physical responsiveness, and body movement as participants undergo therapy using the VEAT system.

3 Conclusion

Equine Assisted Therapy has been beneficial for a wide range of patients. Improvements in emotional attitude, gross motor function, and muscle symmetry are just some of the many benefits that EAT has provided. The reasons for the success of EAT are still largely unknown, mostly due to the difficulties inherent in studying EAT in its natural, outdoor setting. We have developed a Virtual Reality system (VEAT) that resolves many of the difficulties associated with performing such studies and will allow us to perform controlled, realistic experiments to help discover why EAT has been a successful therapeutic methodology.

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