

# CirculaFloor

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## Abstract

CirculaFloor is a locomotion interface using a group of movable floors. The movable floors employ a holonomic mechanism that achieves omni-directional motion. Circulation of the floors enables the user to walk in a virtual environment while his/her position is maintained. The user can walk in arbitrary directions in a virtual environment.

Keywords: locomotion, walking, movable floors

## 1 Introduction

In most applications of virtual environments, such as training or visual simulations, users need a good sensation of locomotion. We have developed several prototypes of interface devices for walking since 1989. From the results of this research, we determined that an infinite surface is an ideal device for creating a sense of walking. We employ a group of omni-directional movable floors to realize the locomotion interface. Each floor is equipped with a holonomic mechanism that achieves omni-directional motion. An infinite surface is simulated by circulation of the movable floors. The position of each floor is detected by ultra-sound sensors. The motion of the feet is measured by magnetic sensors. The floor moves opposite to the measured direction of the walker, so that motion of the step is canceled. The position of the walker is fixed in the real world by this computer-controlled motion of the floors. The circulation of the floors has an ability to cancel the displacement of the walker in arbitrary direction. Thus, the walker can freely change direction while walking.

## 2 Technical Innovation of the Project

The major innovation of this work is a new method of creation of an infinite floor. The easiest way to realize an infinite floor is the use of a treadmill. However, a treadmill has difficulty in realizing omni-directional walking. A motion foot-pad for each foot is an alternative. It has the ability to simulate omni-directional walking as well as walking on an uneven surface. The major limitation of this method is that severe accuracy is required for the foot-pad to trace the walker. Actually, the walker has to be careful about miss tracing of the foot-pad. The CirculaFloor is a new method that takes advantages of both the treadmill and foot-pad. It creates an omni-directional infinite surface by the use of a group of movable floors. Combination of the floors provides sufficient area for walking, thus precision tracing of the foot position is not required. Locomotion interfaces often require bulky hardware because they have to carry the whole body of the user. Also, the hardware is not easy to reconfigure to improve its performance or add new functions. In consideration of these issues, the CirculaFloor has scalable hardware. It is easy to install and its performance can be improved by upgrading the actuators

of each floor. Moreover, it has the potential to create an uneven surface by mounting an up-and-down mechanism on each floor.

## 3 Larger implications of the project beyond this demonstration phase

It has often been suggested that the best locomotion mechanism for virtual worlds would be walking. It is well known that the sense of distance or orientation while walking is much better than that while riding in a vehicle. However, the proprioceptive feedback of walking is not provided in most applications of virtual environments. The CirculaFloor is a new locomotion device which provides such a sense of walking. It will revolutionize entertainment and training simulators. One of the serious applications will be an "evacuation simulator." Analysis of evacuation of people in disasters is important in social safety. However, it is impossible to carry out experiments with human subjects during an actual disaster. A virtual environment is inevitable for such experiments. Since evacuation is done by walking or running, the CirculaFloor will be an indispensable interface device for the experiments. The combination of the CirculaFloor and an immersive projection display may provide the ultimate sense of presence. The integrated system can greatly contribute to tele-operation or virtual travel.



Figure 1. Overall view of the CirculaFloor

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