

Advantages of the MPI Motion Simulator

- Large, 6 degrees of freedom motion space (larger than the conventional Stewart platform)
- Infinite person-oriented roll ability
- 12ms resolution on kinematic control
- Low system latency (approx. 42ms)
- Robot position feedback with a latency of less than 1ms. This can be used, for example, to synchronize the robot movements with simulated visual/auditory stimuli
- Infinite centrifugal rotations (to be implemented soon)
- No coupling of degrees of freedom, such that, when fully extended, rotations are still possible
- Maintains the highest German safety standards (TÜV approved)

Future Outlook

Future Modifications

- Additional visualization systems are currently being developed. For instance, a curved screen, facing the participants, will be mounted on the seat, thus offering a wider field of view than that provided by a conventional HMD.
- The hardware end stops will be optimized to enlarge the motion range
- The head position tracking system will be upgraded

Future Projects/Uses

- Driving simulation
- Treatment of the vestibular disorders such as BPPV (Benign Paroxysmal Positional Vertigo)

The MPI Motion Simulator is continuously undergoing modifications and improvements (both hardware and software). Therefore, some of the information provided here may change at any time.

References

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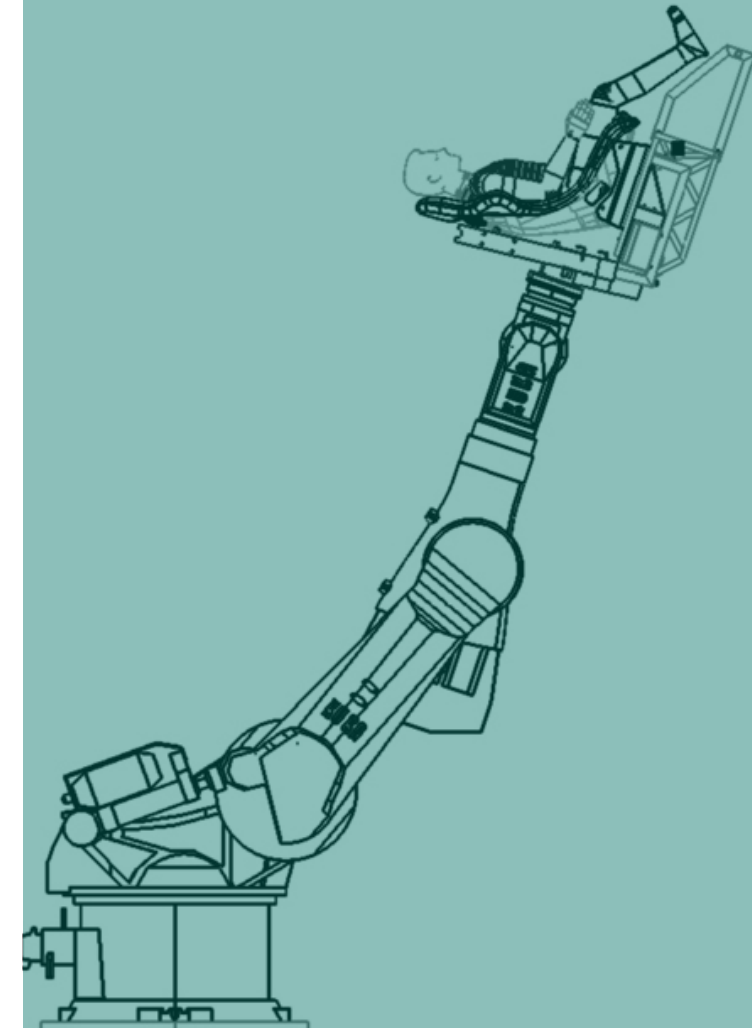
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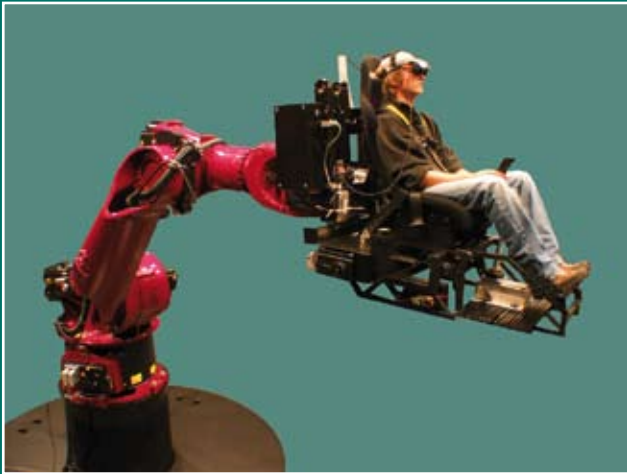
The MPI Motion Simulator



Overview

The MPI Motion Simulator was developed as a novel alternative to traditional motion platforms (e.g. Stewart motion platform) and allows for movement trajectories not previously possible. The MPI Motion Simulator is based on the commercial Robocoaster (a modified KR-500 industrial robot with a 500kg payload), manufactured by KUKA Roboter GmbH. The KR-500 was originally developed for use in industries such as automobile assembly. It was also recently modified for use as an amusement park ride, renamed the Robocoaster, and sold to parks such as Legoland.

At the MPI the robot has been customized for use in basic science research by outfitting it with a racing car seat equipped with a six point safety belt system. The MPI Motion Simulator can be programmed to move participants passively along pre-defined trajectories (open loop) and can allow participants to have complete active control over their movements (closed loop) through the use of various control devices (e.g., joystick, helicopter cyclic stick or steering wheel). Participants can move themselves over the full range of motion, or stop points can be included to restrict particular movements.



For a video of an example movement profile see:
www.cyberneum.de/RoboLab_en.html

Experimental Setup

Sensory Stimulation

Depending on the particular experimental objectives, different types of sensory information can systematically be made available or eliminated.

HMD/Visualization

Movement trajectories can be paired with natural visual information provided by the real environment, or with simulated visual information presented via a head-mounted display (HMD).

Headphones/two-way communication

An active noise cancelling aviation headset can present auditory signals to subjects. A microphone allows the participant to communicate with the experimenter at any time.

This system can also be used to present auditory masking stimuli to eliminate any sound localization cues or auditory movement cues produced by the robot.

Fan

A fan can be mounted in order to mask wind cues that could potentially provide somatosensory information about self-motion.

Vibrational noise mask

Through software, a slight vibration (along any axis) can be added to the translational and/or rotational movements in order to mask the vibration of the gear box and motors.

Measurement Devices

Response system

Several different input systems can be adapted for use with the MPI Motion Simulator. The simplest device is a four button response box. Other possible devices include various potentiometers (e.g., when measuring continuous, online responses).

Head position tracking

Participant's head movements can be tracked, either for the purpose of data collection (e.g., measuring looking direction) or for the purpose of updating simulated visual/auditory inputs.

Eye-tracking

An eye-tracker can be used to measure the 3D eye movements of both eyes at up to 400 Hz with a resolution of less than 0.1 degrees.

Control Devices

Active control devices

There are currently several joysticks available to use for active control such as, simple gaming joysticks, steering wheels and a helicopter cyclic stick.

Current Projects

- Helicopter simulation
- 3D spatial updating based on inertial cues
- Vestibulo-ocular reflex
- Body vs. visual frames of reference
- Effect of movement characteristics on acceleration thresholds
- Motion cueing
- Perceptual upright
- Auditory/vestibular integration in music perception