eXtended reality and passengers of the future

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The aim of Viajero is to radically improve all passenger journeys by facilitating the use of immersive Virtual and Augmented Reality to support entertainment, work and collaboration when on the move.
Overview

Support new passenger experiences with XR

Journeys often repetitive and wasted time
  Autonomous cars could make this worse
Limited access to technology
  Phone, tablet, laptop, seatback display

Entertainment, productivity, collaboration

Research challenges
  Interaction, sensing, social acceptability, motion sickness
What could we do with XR?

**Entertainment**
- IMAX cinema in the back of a car
- Playing immersive games

**Work**
- Multi-monitor desktop setup when on the move and out of the office

**Collaboration**
- Work together with remote collaborators
- Meet with friends and family
such content can induce motion sickness
Activities

Entertainment
  IMAX cinema in the back of a car
  Playing immersive games

Work
  Multi-monitor desktop setup when on the move and out of the office

Collaboration
  Work together with remote collaborators
  Meet with friends and family
Study 2 - Implicit versus explicit control of workspace
Anonymous Project Notes

Introduction

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Activities

Entertainment

IMAX cinema in the back of a car
Playing immersive games

Work

Multi-monitor desktop setup when on the move and out of the office

Collaboration

Work together with remote collaborators
Meet with friends and family
Interaction challenges
Confined spaces

No room for ‘big’ interactions typical of XR
Can smaller movements be mapped into larger space?
Can we make efficient, high-throughput interactions?
How can we use the physical environment?
Passive Haptic Surfaces
Armrest
Passive haptics
Results

Passive haptics significantly improves reaching and dragging input performance in all orientations
  Reduces time taken and error rates
  Improves agency, self-location and workload

Horizontal performance on tray table best
  Neck issues made it uncomfortable

CHI 2023 paper 😊
Perceptual retargeting
Results

Perceptual retargeting / movement remapping of 45° - 60° good for user comfort and good performance

No neck issues

Greater mappings very confusing!
Sensing challenges
In-car sensing challenges

Maintaining the forward bearing of IMU-based headsets in vehicles

   Need to separate head movements and car movements

Conflicts between optical and inertial tracking of inside-out headsets

Obtaining vehicle telemetry

   PassengXR: Low-latency sensing platform to separate car and headset motion
**PassengXR platform**

PassengXR is an open-source Unity platform for creating vehicular XR experiences.
Social acceptability challenges
Social acceptability

Headset use in social settings
We may be alone in vehicle car or sharing
   With people we know / With people we don’t know

Where should displays be located?

What kinds of interactions are socially acceptable?

What information from the real world is needed?
Display layouts in vehicles

Investigated how people want to layout content in different scenarios and for different tasks
Input techniques

Surveying the Social Comfort of Body, Device, and Environment-Based Augmented Reality Interactions in Confined Passenger Spaces
Results

Environment has a strong effect on social acceptance of interactions!

Face-to-face seating layouts affect acceptability

Mid-air interactions less acceptable
Motion sickness challenges
Motion sickness

Many people suffer from motion sickness

Reading, phone/tablet
Can’t use travel time

Visual / vestibular mismatch

Immersive content can make this worse

Exocentric head-locked content most useful but causes most motion sickness
Motion sickness

How to reduce motion sickness so that we can use immersive displays in cars?

Two parts:

Reliable detection of onset

Effective mitigation
Motion Sickness Detection

Highly-integrated Biosensing Platform for VR study (including EEG, PPG and skin temperature sensors)
Paradigms:
To induce moderate motion sickness, we used 3 stimuli: from a mild stimulus (attention task) to a more ‘spicy’ stimulus (rollercoaster)
Motion Sickness Detection

Brain frontoparietal connectivity decreases with the increase of sickness ratings

New brain biomarker for motion sickness detection, validated by proxy references, such as increased heart rate and fingertip temperature

New brain biomarker opens a door for brain stimulation-based motion sickness mitigations
Motion Sickness Mitigation Solutions

How to reduce motion sickness so that we can use immersive displays in cars?

Two solutions

Brain stimulation

Visual displays
Brain stimulation for motion sickness mitigation
Peripheral visual display for mitigation

Motion environment tightly coupled to car motion
Presented in peripheral vision
6 VR Video w/ Peripheral Feedback
Perceive Motion in Mid-Peripheral Vision
Results

Neurostimulation experiments are on-going
  Initial significant results for neurostimulation
Peripheral visual cues can reduce motion sickness
  Peripheral multimodal displays: Audio and haptics can help

Multimodal cues
Conclusions
Conclusions

We spend a lot of time as passengers
  Can we use time more effectively?
  Entertainment/work/collaboration

Research challenges
  Interaction in confined spaces
  Social acceptability
  Motion sickness
  Sensing an issue across all of these

Unlock the potential of travel time in future vehicles
eXtended reality and passengers of the future

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