
Left
256 km/h
D
Rear Mirror

Universität Bremen

TARPAN

Natural User Interaction in Cars

Winter Semester 2013/14 • Master Project

Motivation

Distracted driving

1. Visual
2. Manual
3. Cognitive

In the US in **2011**:
3,331 killed
387,000 injured

In-car distractions: GPS navigation, radio, CD player, MP3 player, windows control, mirrors adjustment, phone calls, SMS, emails, (twitter and FB), reading, watching videos, eating, etc.

Motivation

Car cockpits are getting more and more complex

Traffic gets denser and driving becomes more demanding

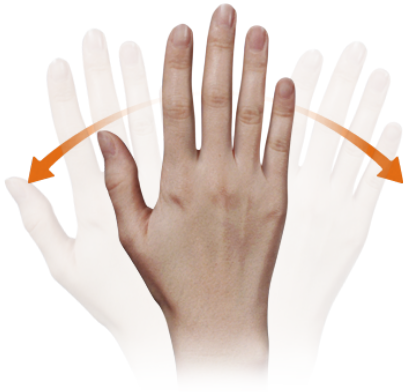
Increased cognitive load

Goal

Develop an interactive system with car components:

- Intuitive
- Touchless
- No wearable devices
- Robust and reliable

Natural User Interaction (NUI)



Gesture recognition

Speech recognition

Robust interaction

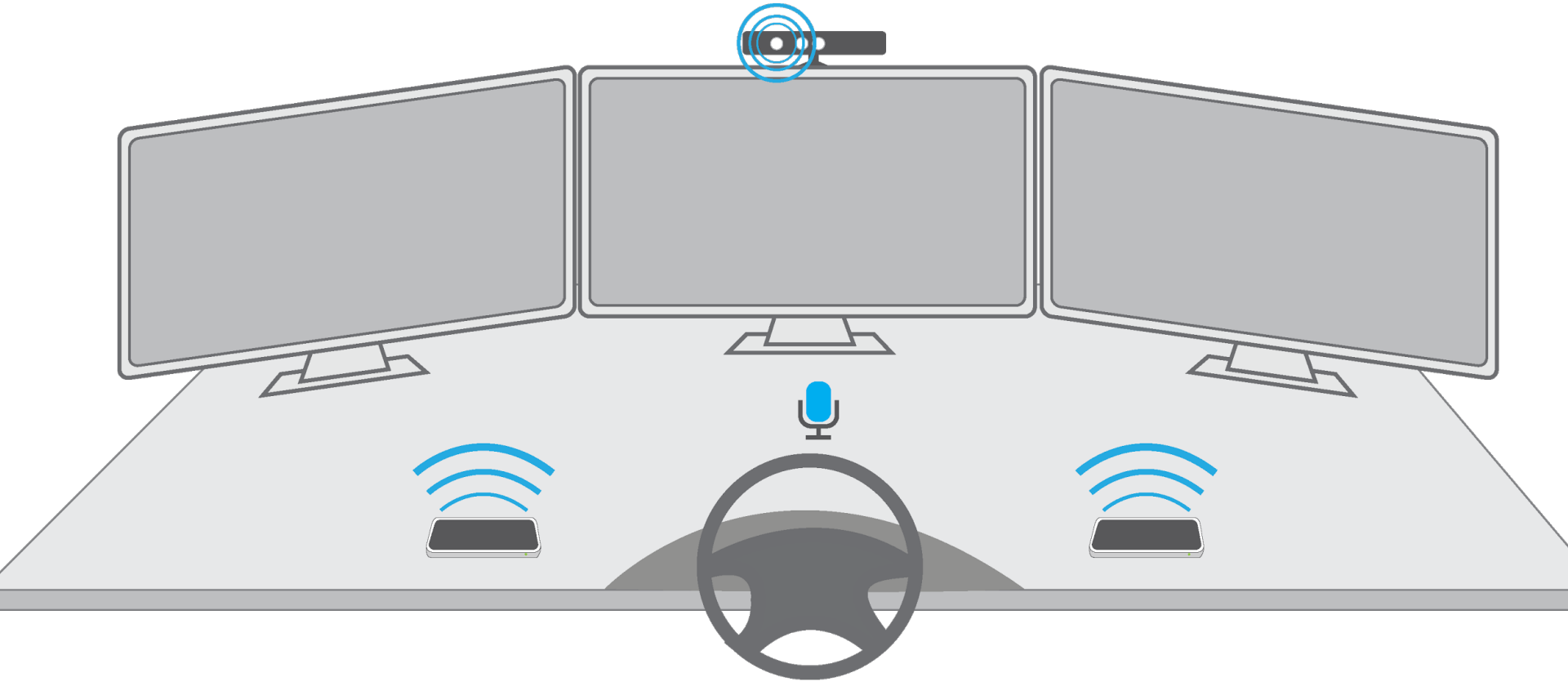
Interaction Metaphors

- **Problem**: Most people can remember few gestures if they are not meaningful.
- **Solution**: Limited set of natural gestures that are derived from daily life.

We combine speech recognition with hand and body tracking.

Example Interaction: **Adjusting right window**

Hardware



Software overview

Programming languages

- Middleware: C++, Qt
- Unity: C#, Javascript
- Test applications: C#, Python

SDK’s

- Unity 4.3 SDK
- OpenNI Kinect SDK
- NiTE Kinect software
- Leap Motion SDK
- Open Sound Control (OSC)

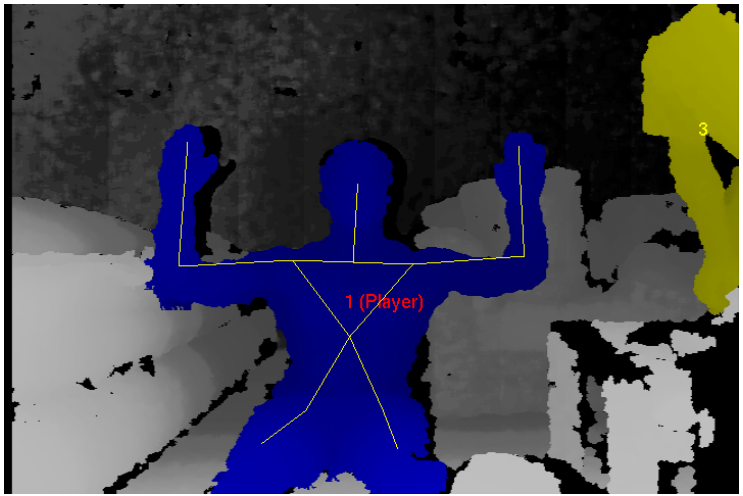
Toolchain

- Microsoft Visual Studio 2012
- Unity 3D Engine & Editor 4.3
- MonoDevelop (C# IDE)
- 3D Studio MAX 2014
- MiKTeX 2.9 (Documentation)
- TortoiseSVN (Apache Subversion (SVN) client)
- Google SketchUp
- Eclipse

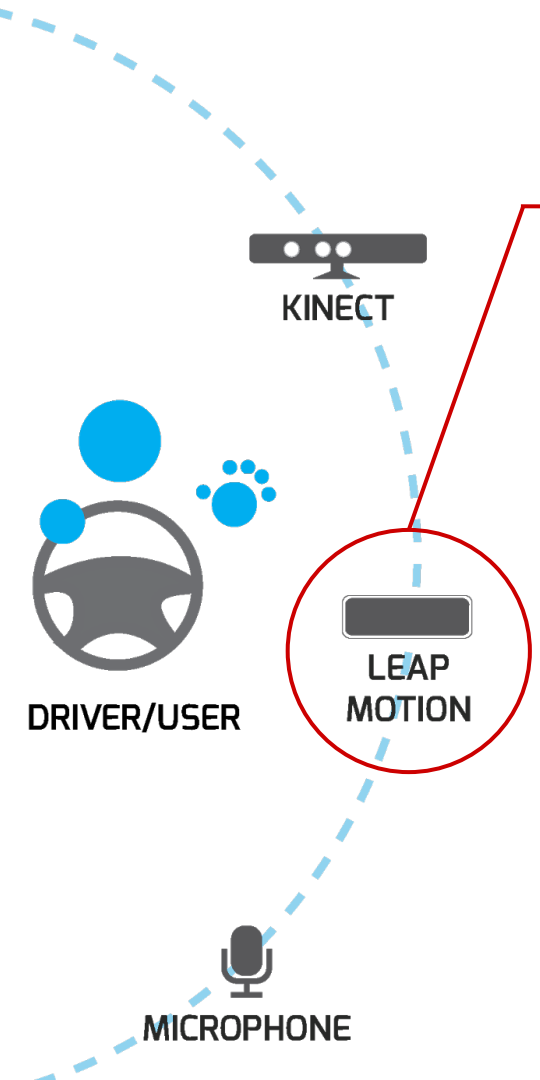
TARPAN SYSTEM OVERVIEW

Microsoft Kinect

- Arms pointing direction (user interaction intention)
- Hands location (on / off the steering wheel)
- User body tracking (VR user representation)

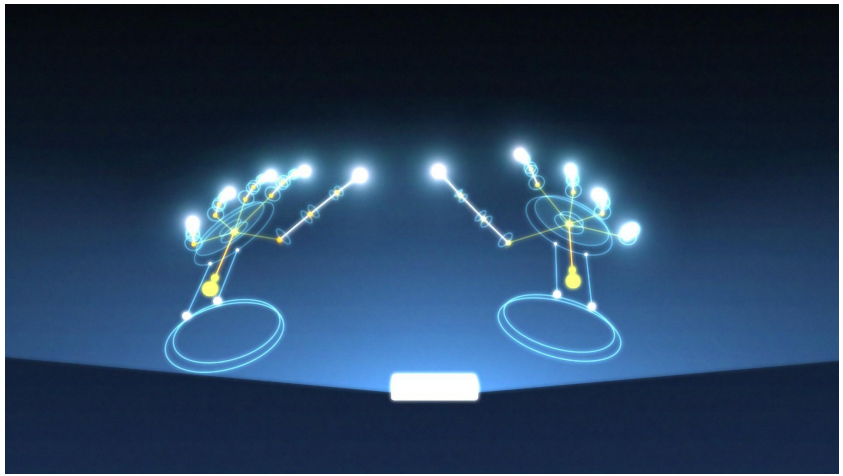


TARPAN SYSTEM OVERVIEW

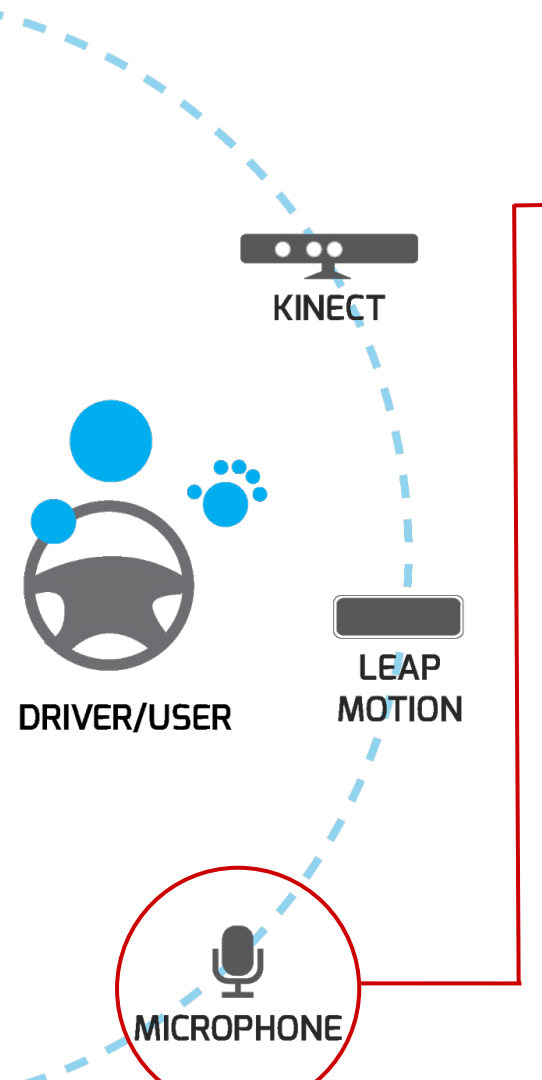


Leap Motion

- Main device for interactions
- Precise and fast local hand tracking (movements)
- Gesture recognition (grabbing / swiping)



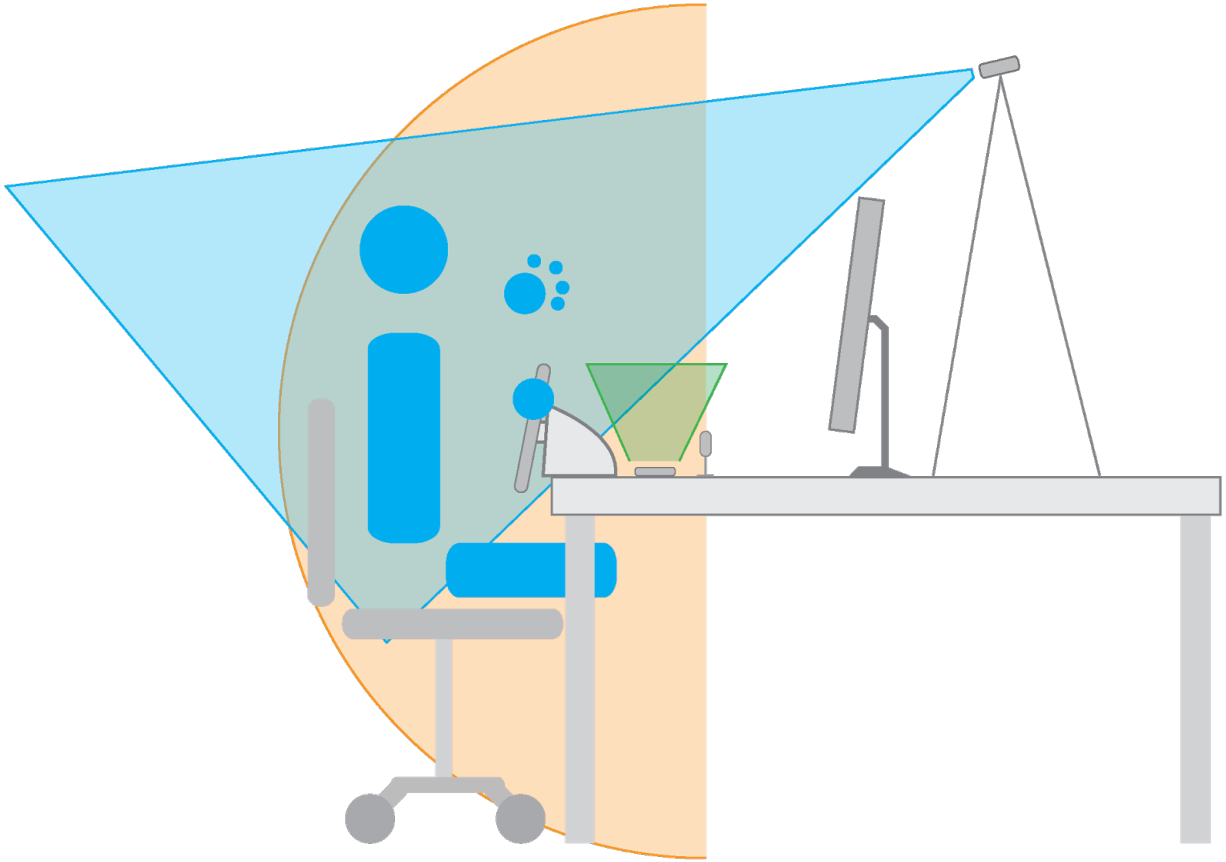
TARPAN SYSTEM OVERVIEW



Speech Recognition

- Continuous input processing
- Filtering by keyword
- Selection of any interaction
- Toggle of simple interactions

Working Volume of Devices

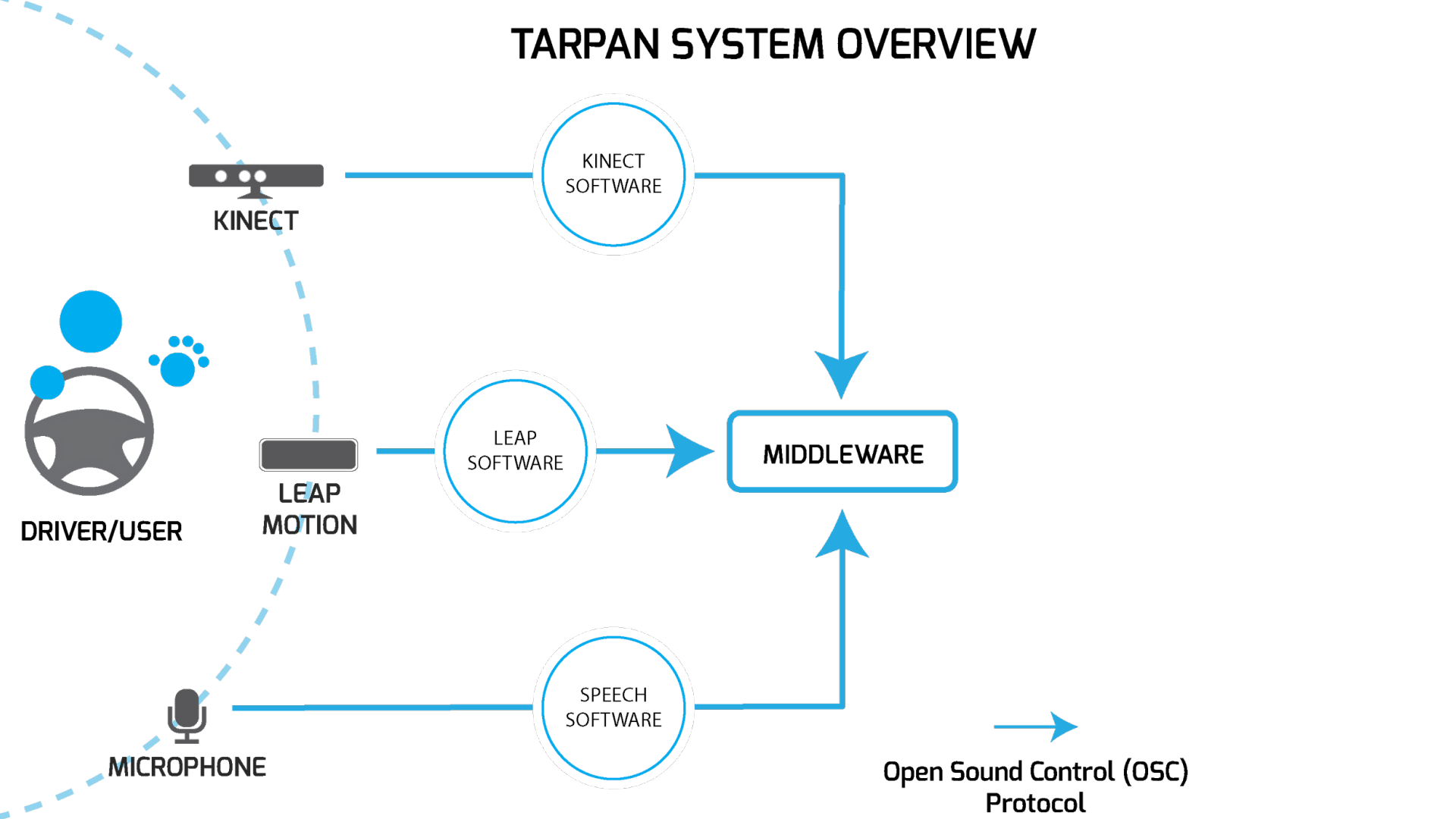


KINECT

SPEECH

LEAP MOTION

TARPAN SYSTEM OVERVIEW



Middleware

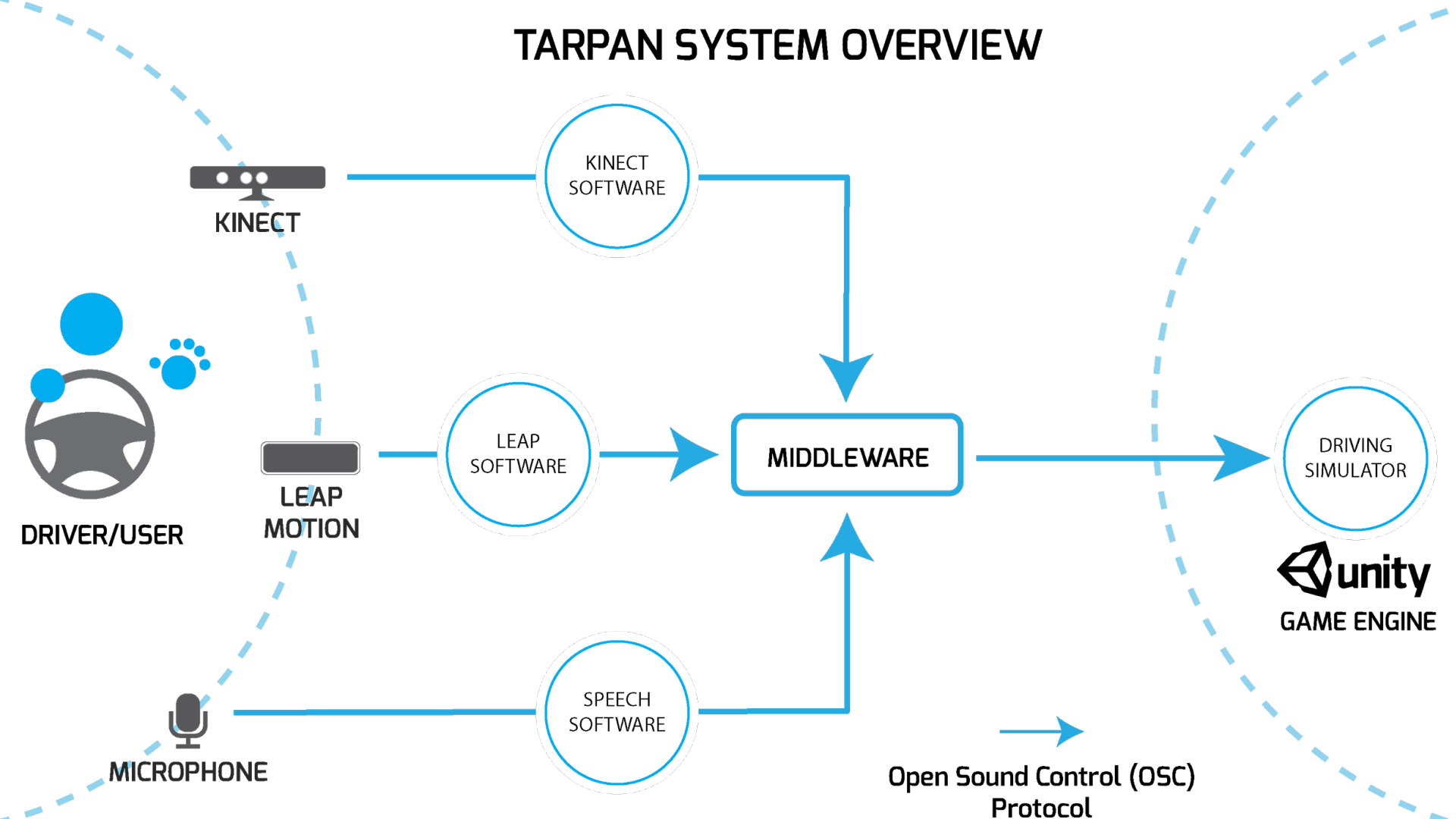
- Written with C++ and Qt
- Defines and evaluates interaction metaphors
- Interaction state handling
- Internationalization for windshield UI

Config file example:

```
/leap/1:grab:grabbed ||
/leap/2:grab:grabbed +
/leap/1:direction:left ||
/leap/2:direction:left +
lockedDevice:radio=
reset:device:timer +
reset:/leap/2:grab +
osc:/radio:previoustrack;

/leap/1:grab:grabbed ||
/leap/2:grab:grabbed +
/leap/1:direction:right ||
/leap/2:direction:right +
lockedDevice:radio=
reset:device:timer +
reset:/leap/2:grab +
osc:/radio:nexttrack;
```

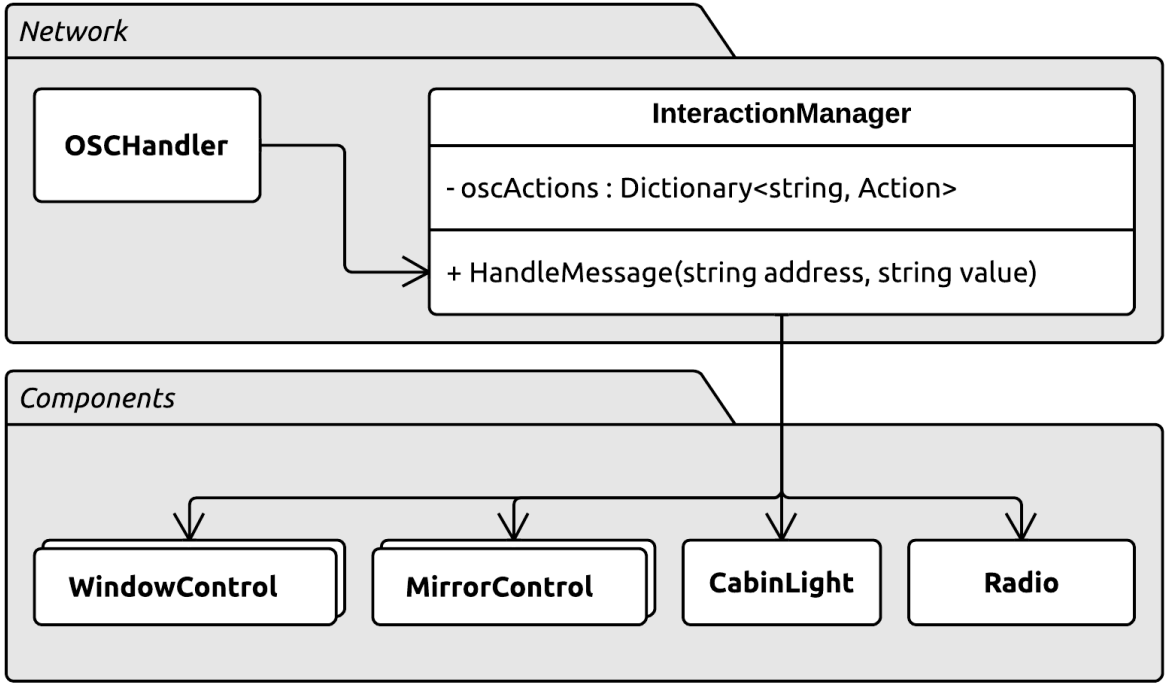
TARPAN SYSTEM OVERVIEW



Driving Simulation

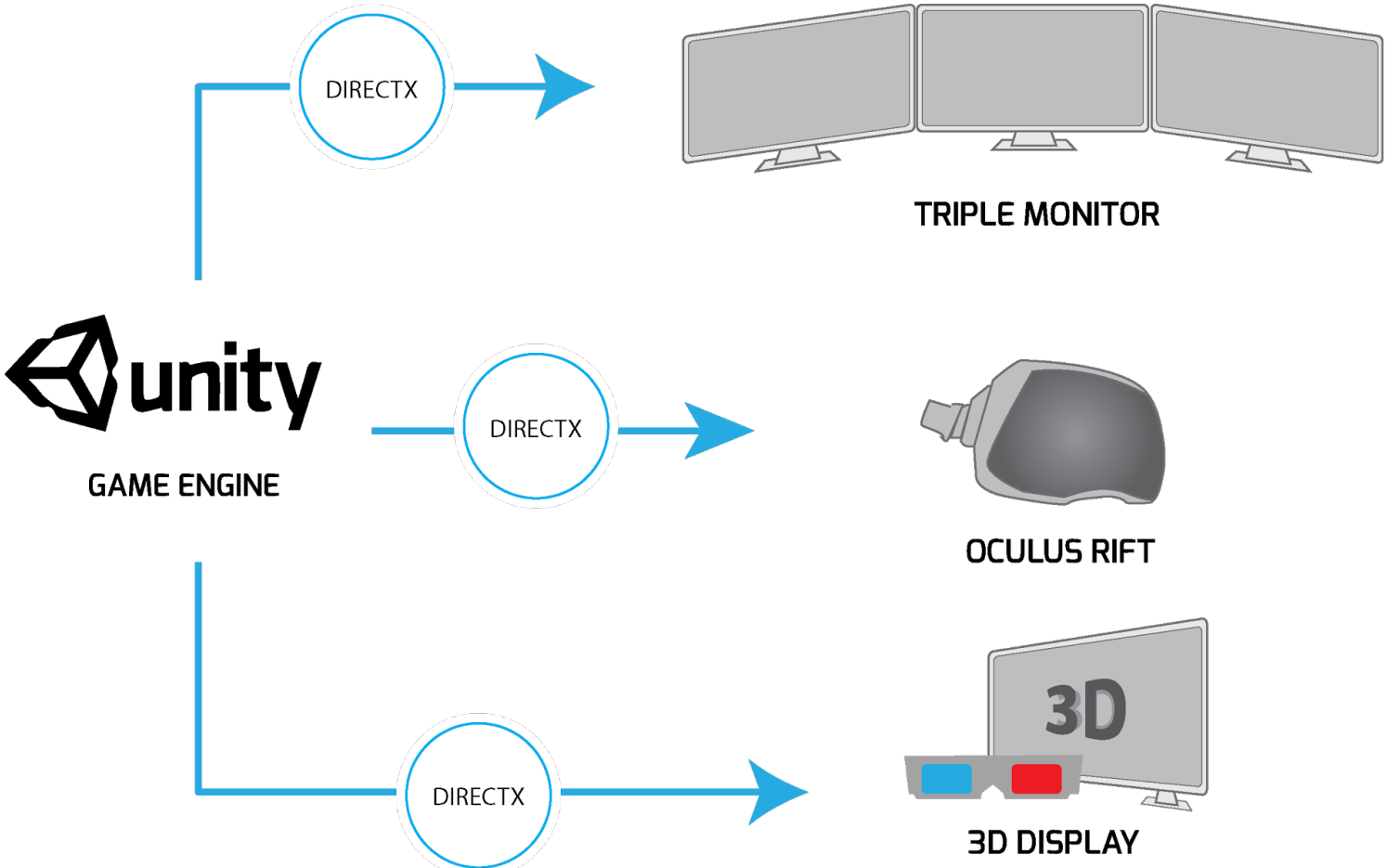
- Engine: Unity 4 Pro
- Major Features:
  - Interactive components
  - Windshield UI
  - Virtual Hands
  - Custom Scene
  - AI Cars

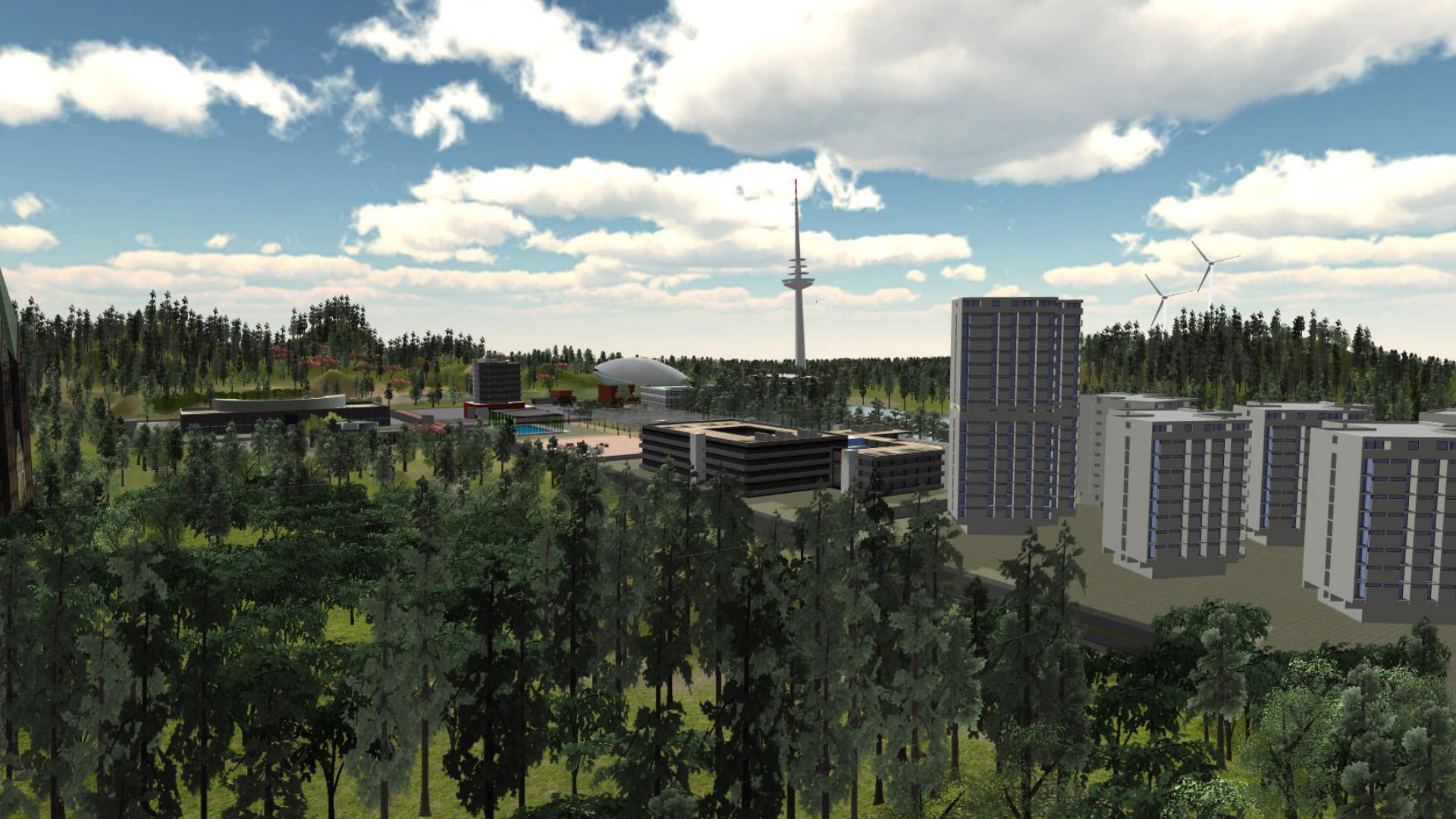
Game: Interaction Handling




Left
19 Km/h
D
20.0°C
AUTO

TARPAN SYSTEM OVERVIEW





User Studies

Goals:

- To analyze the naturality and robustness of the concept
- Compare important parameters like distraction time, safety, stability, attractiveness, hedonic and pragmatic features of the system

Method:

1) In game analysis

2) Interview

3) Questionnaire

Baseline comparison:

NUI : Natural user interaction (gestures + voice)

UNUI: Un-natural interaction (buttons in steering wheel, cockpit)

User data:

Number of subjects: 14

Training time : 4 minutes (each method)

Testing time : 4 minutes (each method)

Experience in driving: 12

Experience with motion devices: 9

Results:

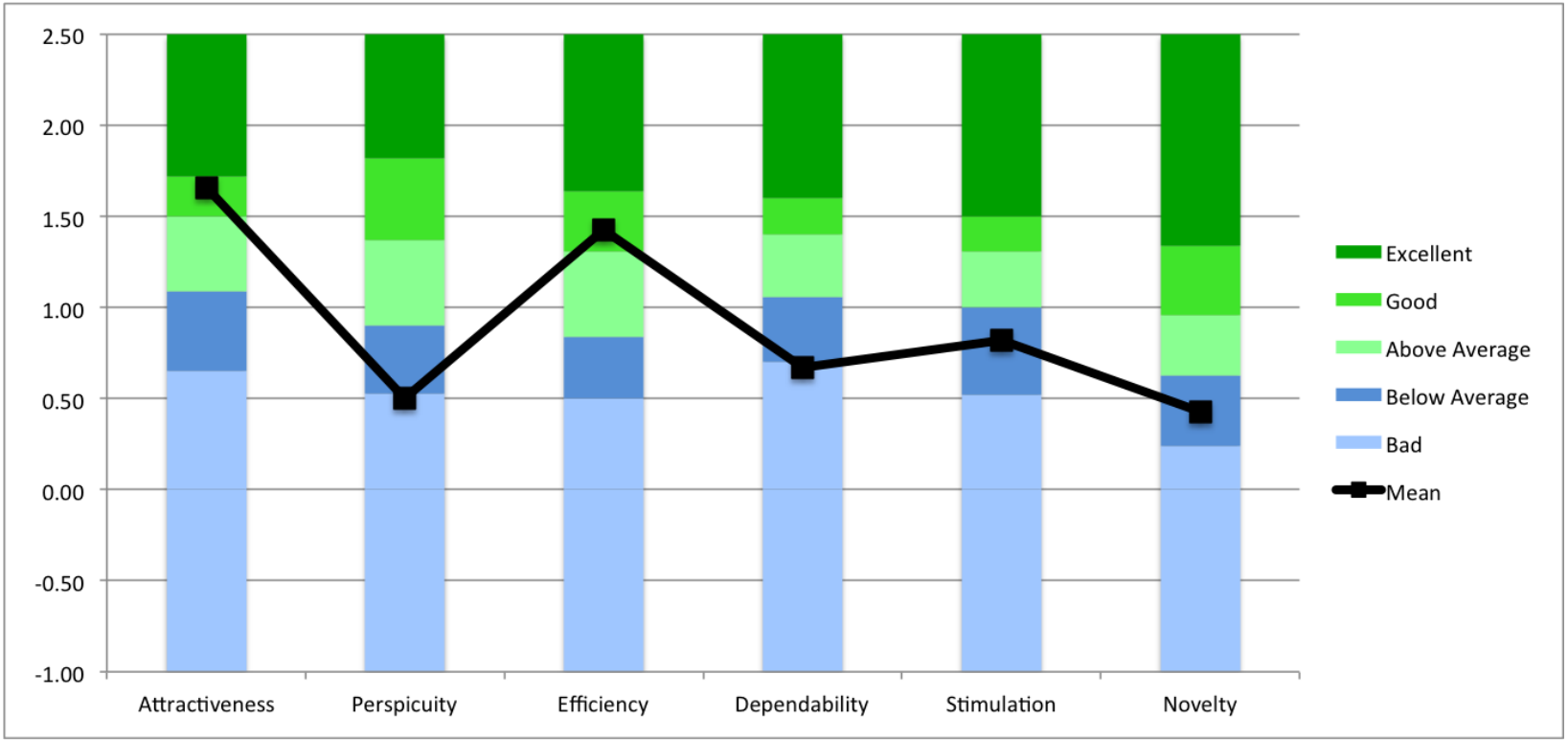
In-game analysis:

- **Collision:**
  - UNUI causes two times more collision
  - NUI is safer while driving
- **Distraction time:**
  - NUI is 3 times less distractive
  - Multiple modalities are more distractive
- **False positives:**
  - UNUI is twice more prone to errors

Interview:

- 60 % people preferred NUI and 40 % prefer UNUI
- Idea is innovative, enjoyable, but needs more robustness
- Cognitive load is reduced considerably

Questionnaire:



Future Work

- Eye tracking
- Facial expression recognition
- Adding interactions like sms/email writing, calling ...
- Implement the user studies outcome
- Force feedback, explore other methods
- Improving AI, map, performance, interactions

Team

Prof. Dr. Gabriel Zachmann

Dr. Daniel Mohr

Ana-Maria Ichim, Anusha Pulichintha,
Diego Sahagun, Dmitry Galkin,
Ernesto Araiza, Fabian Beuke,
Florian Petersen, Gabriel Lambers,
Mohammad Razavi, Muhammed Zaid Alam,
Murtaza Hussain, Narendar Reddy,
Saber Adavi, Shiva Mohseni,
Venkatesh Padmanabhan


Oculus
KEEP
CALM
AND USE
THE
TARPAN

Demo