An approach to Evaluating Usability of VANET Applications

Ciprian Dobre[1], Catalin Fratila[1], Liviu Iftode[2]

[1]University POLITEHNICA of Bucharest, Romania
[2]Rutger University, USA
Emails: ciprian.dobre@cs.pub.ro, catalin.fratila@cti.pub.ro, iftode@cs.rutgers.edu

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Outline

- Scope and motivation
- System design
- Usability test methodology
- Experimental results
- Conclusions

Context

- Talking on the phone while driving - scientific psychological studies showing a negative effect
- VANET applications are designed to assist the driver in making correct decisions (regarding safety, navigation, etc).
- Informative role
  - Present a situation to the driver and let him take decisions
- But in this process they introduce new stimuli
  - Visual - do you need a blue screen while driving?
  - Audio – navigator voice picking on the driver for missing an exit?
- Is there a psychological side-effect on the driver?

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Contributions

- Evaluate the usability effects of introducing vehicular applications
- Driving simulator equipped with :
  - an interface between the user and VANET applications,
  - components to monitor and assess the influence of the interface on the driving capability of the test subjects.
- A usability test methodology to evaluate the psychological impact on the driving capabilities.
- Experimental results to show how information (visual, acoustical) affect real-world subjects (drivers) with their driving capabilities.
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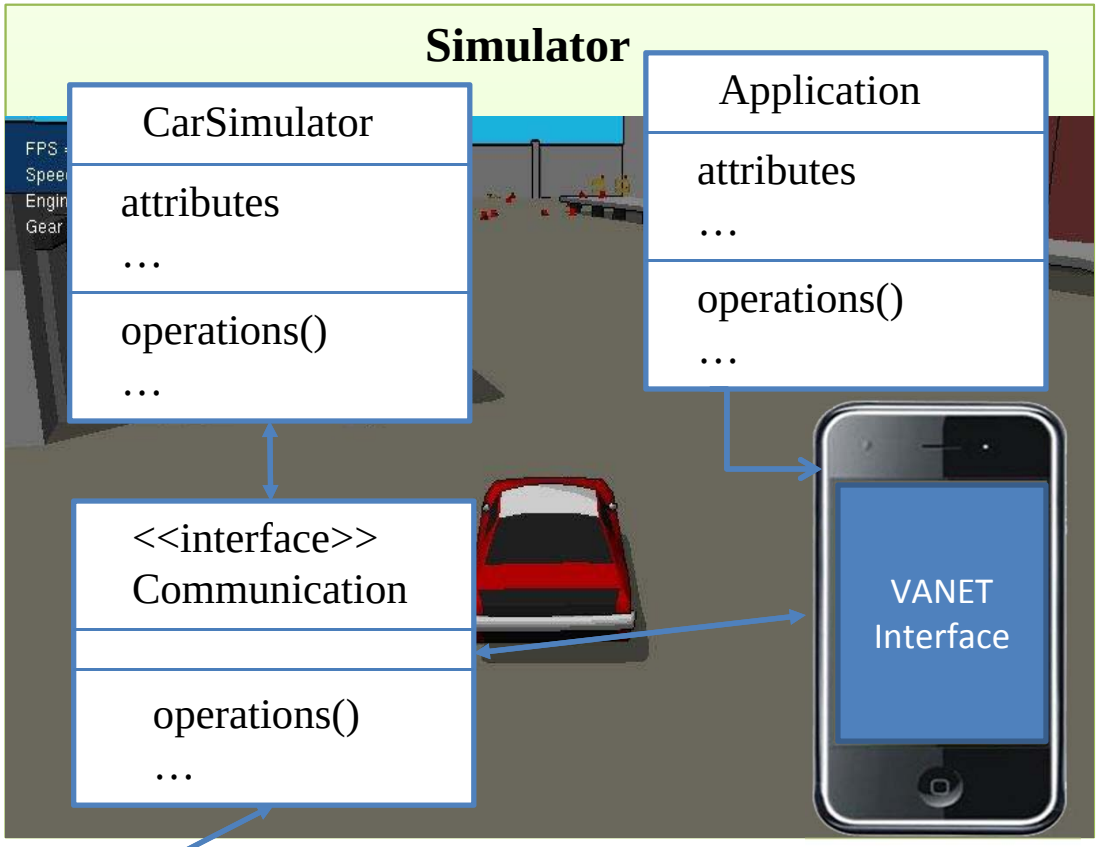
System design



Behavior Analyzer

Psychology Profiler

Driving Simulator

- Previous studies show that driving simulators can be use to measure accurate on-road driving
  - A higher chance of passing the driving test the first time can be associated with making fewer steering errors on the simulator (regression analysis with a correlation of 0.18)
- Vehicle Dynamics Engine at the core
  - Allows synthetic measurements of driving conditions related to driving accuracy
- Virtual 3D simulation of various landscapes
  - The landscape can feature hills and cliffs, obstacles such as trees, rocks, building, and vehicles
- The car realistically reacts according to environmental physical forces
  - Also including realistic interactions between objects in the scene (collisions, bumps, etc)

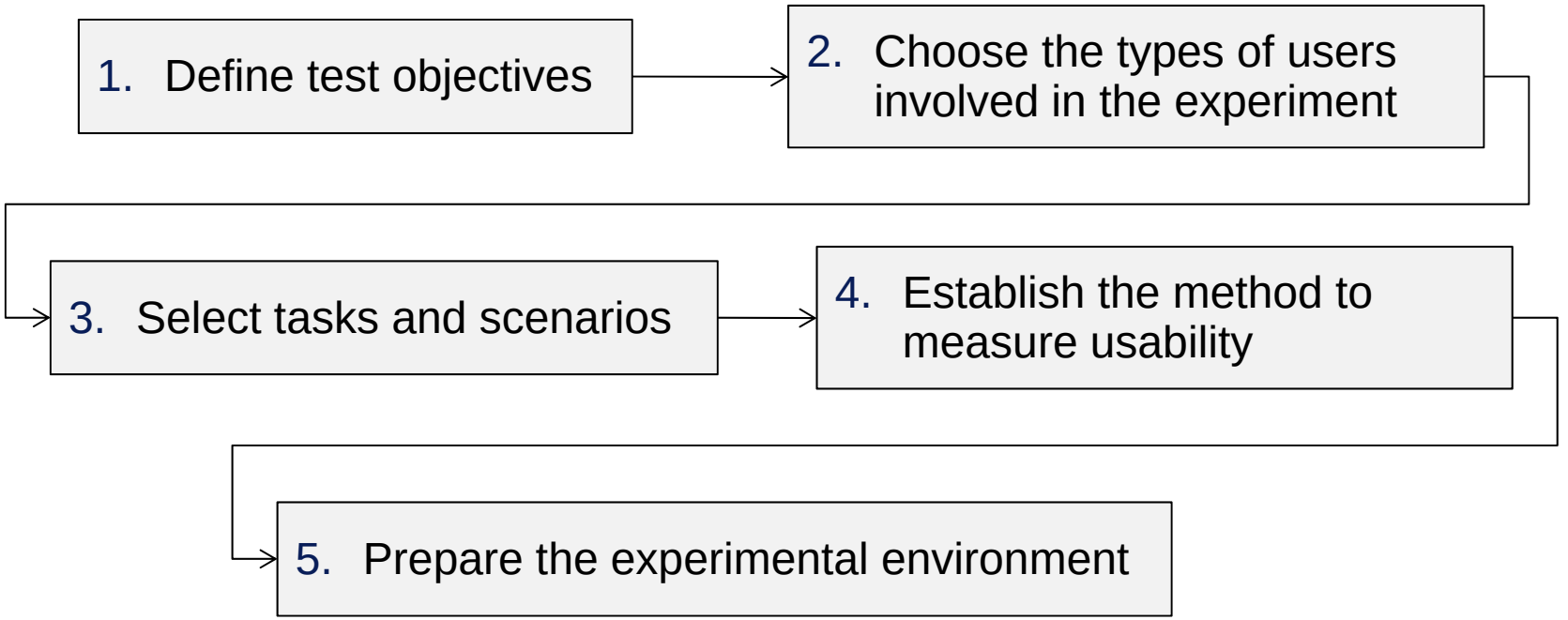
Implementation details

- The user interface includes sounds, graphical aspects, etc.
  - *E.g.*: text-to-speech component capable of emulating user listen to driving instructions
- The behavior analyzer measures the user's reactions
  - Monitors parameters such as *time to finish*, *driving accuracy* in terms of collisions, *number of breaks,* etc.
- Usability testing methodology
- Psychology profiler
  - Statistical results → profile for each driving scenario

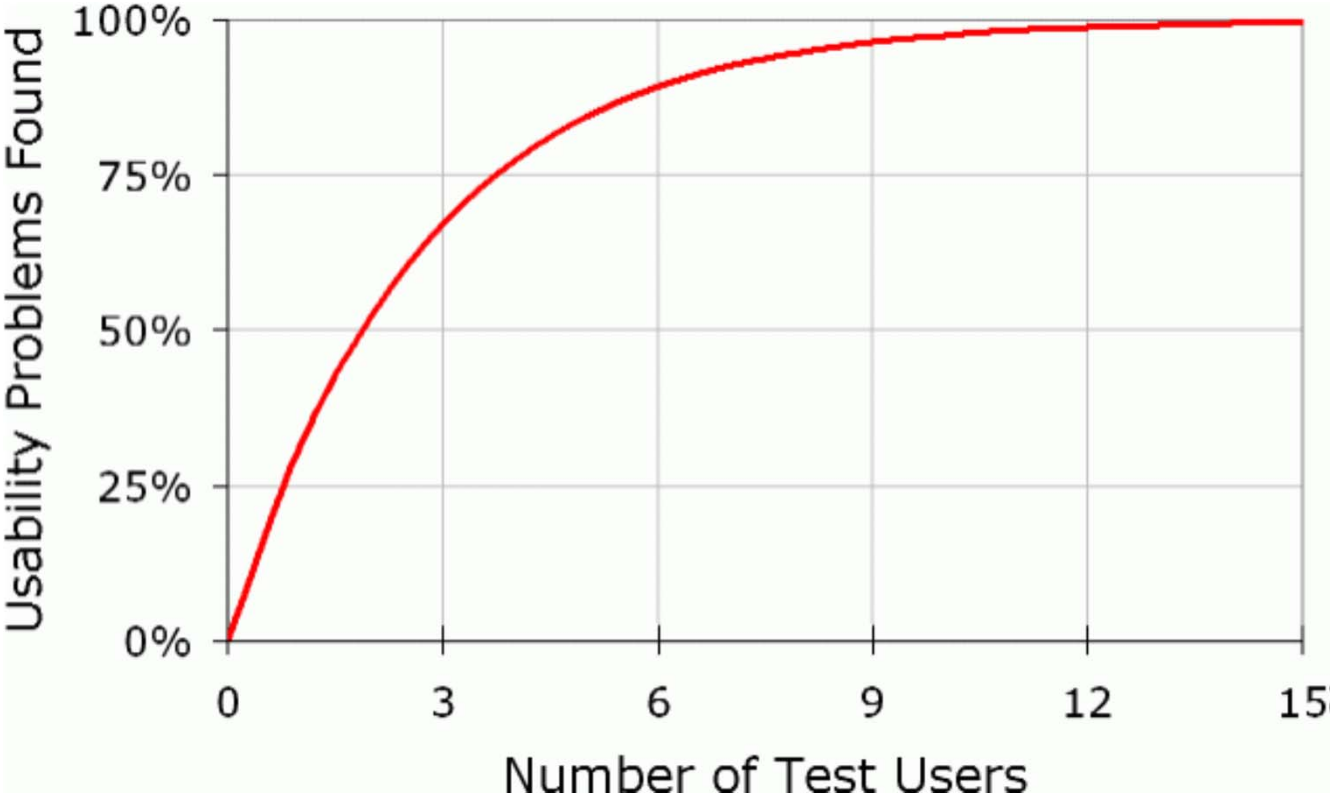
Usability test methodology

1. Define experiment objectives
2. Choose subjects
   - Experience level, age, experience in using similar applications, etc.
3. Decide on the types of tasks and scenarios to use
   - Tasks must resemble activities users are normally expected to perform when operating the real application
4. Measure the usability level of the system under test
   - *Subjective data (customer satisfaction, difficulty of use, etc.)*
   - Quantitative data (time to finish a task, number of breaks, etc).
5. Preparation of the experimental environment
   - Introduce sensors and other devices to record information,
   - Establish the role of each members of the testing team,
   - Prepare support materials.

Usability test methodology



Typical usability results



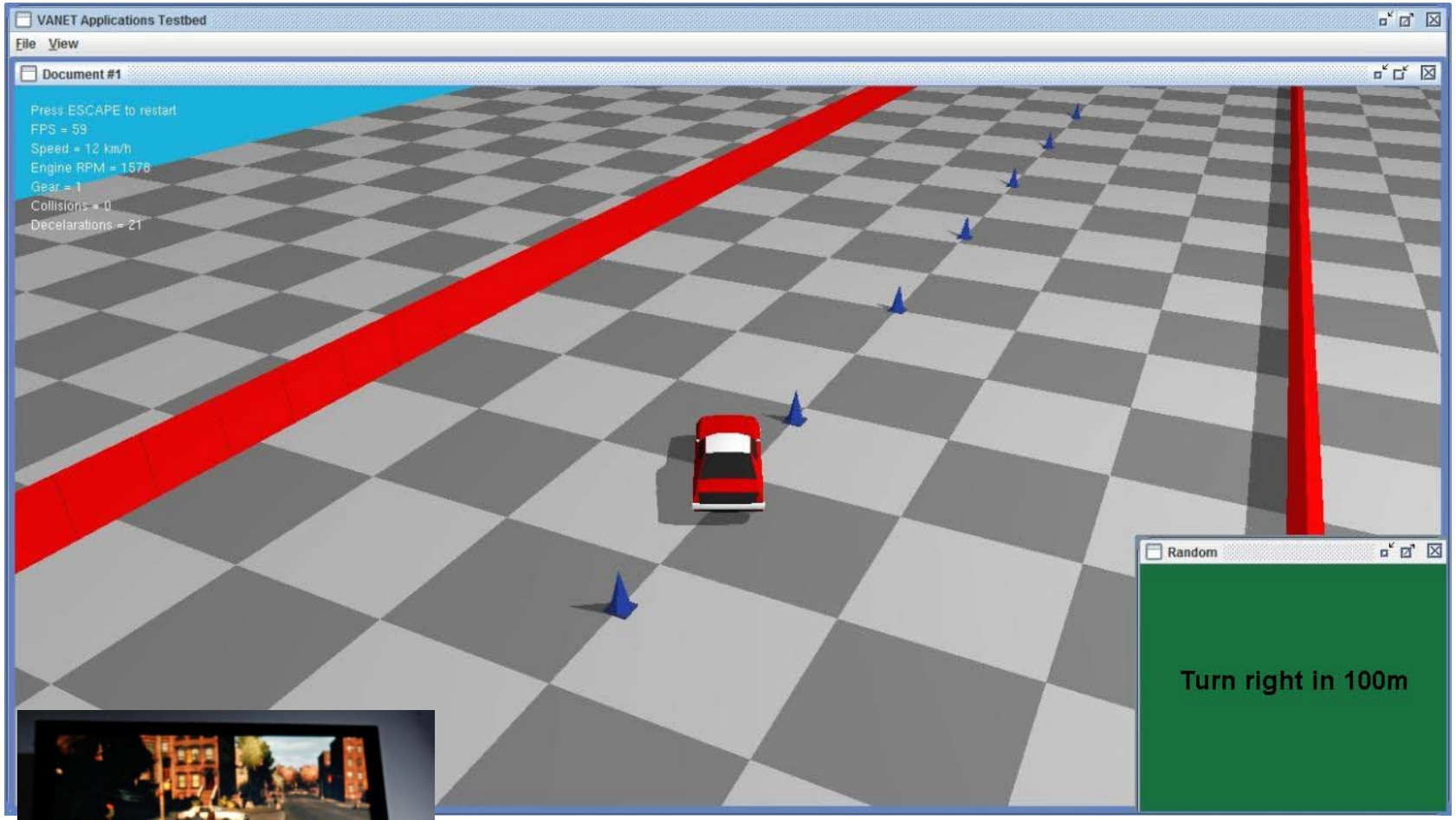
Five subjects are generally enough

* J. Nielsen, “Usability Engineering”, San Diego: Academic Press. pp. 115-148, 1994.

Experimental setup

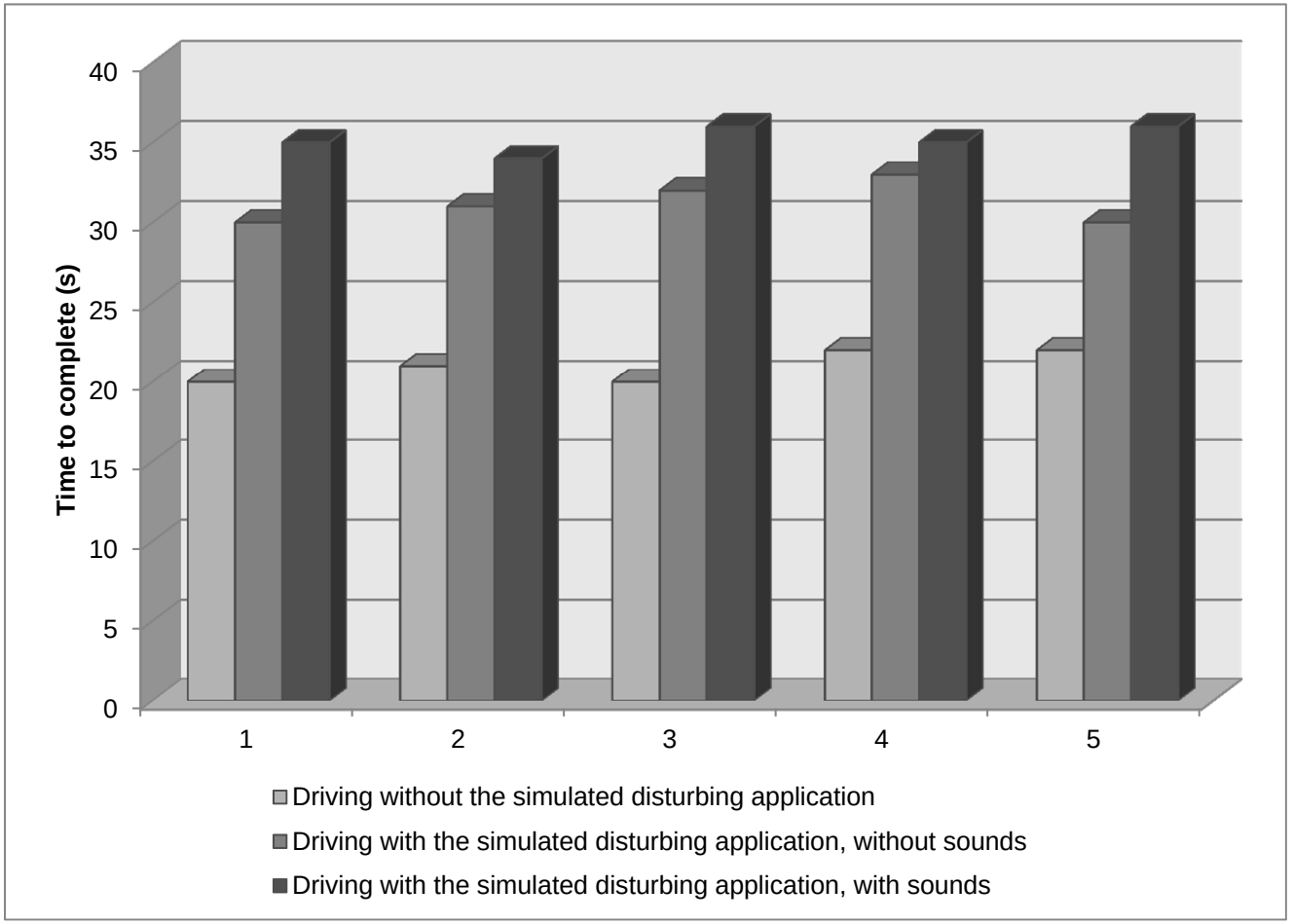
- Comparative experiments:
  1. Simulation + Simulated navigation application on the bottom right corner;
  2. Simulation + a navigation application running on a smart phone;
  3. Experiments conducted while driving in an real-world urban environment, and the same navigation application running on the smart phone.
- Five subjects chosen to cover various degrees of driving experiences and experiences in using modern technology
- The simulation experiment involves a circuit resembling one used in driving schools
- Monitored parameters:
  - Time needed to complete the circuit, number of collisions with the poles, and the number of sudden breaks.

Experimental setup



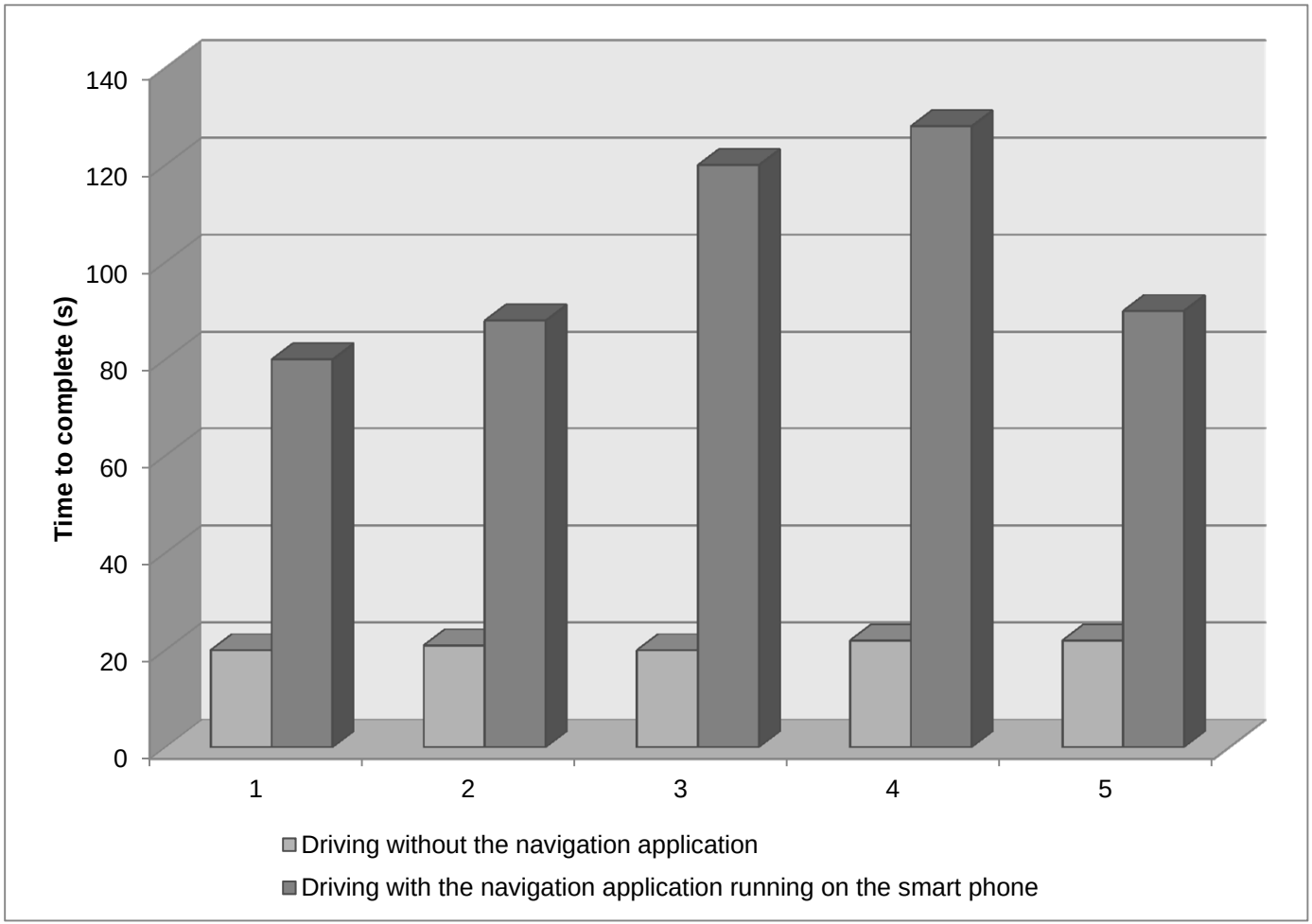
Experiment #1

- Navigation application on the same screen with driving simulator
- Effects of using texts with various colors for fonts and background (measuring the effect of the contrast perception), and sounds.



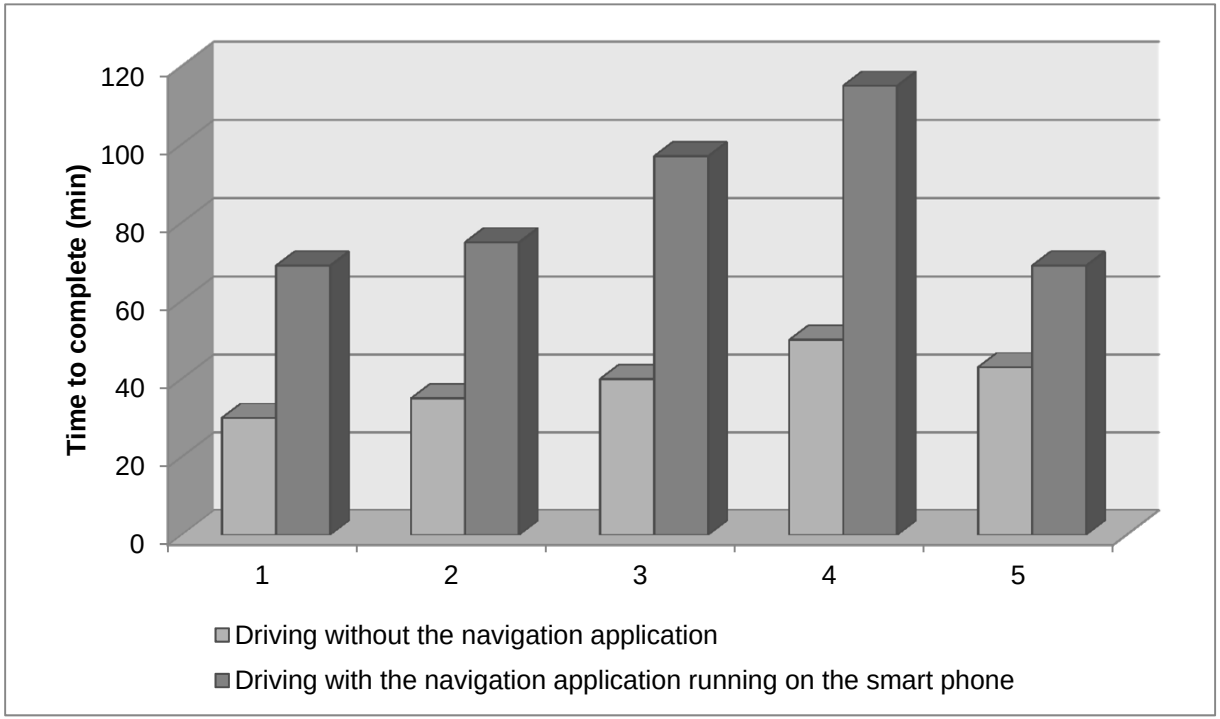
Experiment #2

- Real-world iPhone applications + simulator
- We asked our subjects to interact with the application and change certain parameters



Experiment #3

- Driving a car on a predefined real-world circuit, in an urban environment.
- In the first experiments, each subject finished the circuit without any disturbing application
- Then they were asked to complete the same circuit but using a navigation application running on a smart phone
  - Difficult to obtain results under similar conditions, because in the real-world the driving conditions change constantly



Experimental results - conclusions

- In all these experiments the navigation application increases the time needed to complete the circuit
  - When using the simulated navigation application the increase is roughly 48%
  - When sounds are involved the increase being of roughly 67%
- The number of breaks also increases by almost an order of magnitude when the subject uses the simulated navigation application
- When using a real smartphone navigation application the impact is even higher – the driver has to constantly take his eyes of the monitor and look at the smartphone
- This increase is sustained when using the navigation application on the smart phone while driving in a real urban scenario

Conclusions

- Little research conducted in the area
  - Usability of VANET applications is ultimately a safety issue - people do drive while using intelligent assistants designed to help with navigation, with fuel economy, or just entertain the user
  - And yet, researchers failed to test their psychological and physiological effects of their use on the driving capabilities of users
- Simulation proposed as a mean to assess usability effects
- Usability methodology proposed to evaluate the psychological impact of using such applications on driving capabilities
- Results show how different ways of presenting information (graphical, acoustical) in a car affect differently the driving capabilities of users
- We validated the results by comparing them with results obtained using a real-world driving experiment

Q&A

Thank you!

Ciprian Dobre

ciprian.dobre@cs.pub.ro

http://cipsm.hpc.pub.ro/vanet