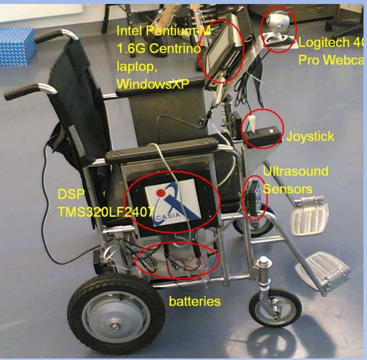
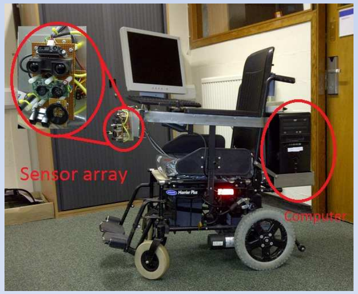


SYSIASS – an intelligent powered wheelchair

A. Kokosy, T. Floquet, G. Howels, H. Hu, M. Pepper, M. Sakel, C. Donzé

August 30th, 2012

ICSCS'2012, Villeneuve d'Ascq, France



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Some information about the project

- **Project supported by the Interreg IVA 2 Seas Programme and ERDF**
- **5 partners and an external consultant**
  - Scientific: ISEN Lille (lead partner), EC Lille&CNRS, University of Kent, University of Essex
  - Medical: East Kent Hospitals, Hospital St Philibert (Lomme, France)
- **Collaborators**: Hospital of Garches, associations of disabled people (APF, La vie devant Soi), team ALIEN (INRIA Lille), DynamicSystem
- **Start/end date**: 1st December 2010/31st December 2013
- **Website**: www.sysiass.eu

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SYSIASS Disability and Independence

Some information about the project

- **Goals:** to design
  - intelligent devices for assisted navigation of the powered wheelchairs
  - intelligent devices for the secure communication of the data
  - multi-modality human machine interaction
- **Project challenges**
  - to take the needs of the users and the constraints that it implies into account at each stage of the project development
  - to interface the devices with manufactured powered wheelchairs
  - to evaluate the devices through clinical trials

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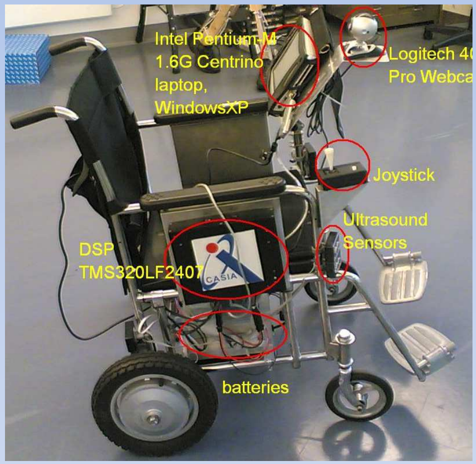
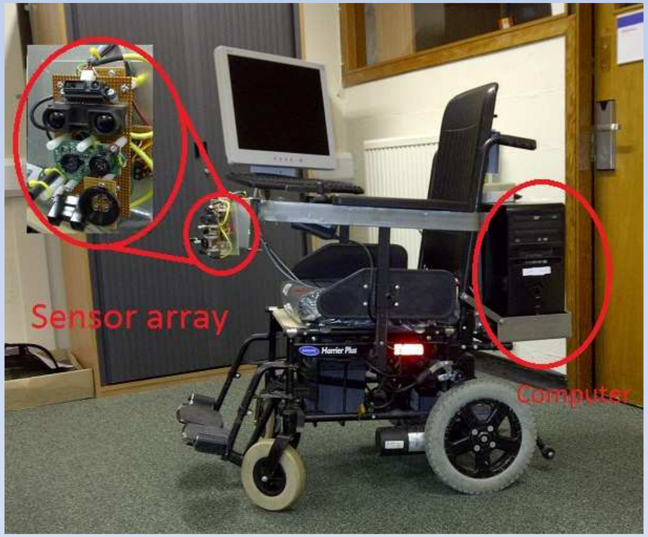
Some information about the project

- **Test benchs**



Wheelchair with electronics system from University of Essex

University of Kent



INVACARE Harrier Plus wheelchair Dynamic Controls System

ISEN Lille

DupontMedical with Dynamic Controls System

Invacare Storm 3 with Dynamic Controls System

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Plan of presentation

I. Context of the project

II. Main results

- Intelligent device for assisted navigation
- Intelligent device for secured communication
- Human-Machine Interface for Hands-free Control

III. Conclusion

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Context of the project

- The number of users using a wheelchair is expected to increase in Western countries
  - National surveys in UK showed that Multiple Sclerosis and stroke survivors consider **mobility** as their top priority
- Across Europe, with a progressively ageing population, policies for supporting older people are increasingly
  - **Care** should be provided efficiently to the patient wherever they are based

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Main results: Intelligent device for assisted navigation

- 3 scenarios
  - Collision avoidance (user in the loop)
  - Semi-autonomous navigation (user in the loop)
  - Autonomous navigation (the user defined the final location or the direction)
- Challenges for autonomous navigation
  - Localization
  - Path plannification
  - Robust tracking control

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Main results: Intelligent device for assisted navigation

- 1st Scenario: Collision avoidance
  - The user drives the powered wheelchair via a joystick
  - The intelligent device must
    - Detect obstacles
    - Slow down the PW proportionally to the distance between the obstacle and the wheelchair
    - Stop the PW if the distance between the PW and the obstacles is less than the security distance, overriding any action by the user
    - Provide the user with visual feedback on the distance (measured by the sensors) between the wheelchair and the obstacles in its way
    - Have a switch to allow the user to enable or disable the device

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Main results: Intelligent device for assisted navigation

- 1st Scenario: Collision avoidance
  - 2 electronic boards: 1 for the joystick and 1 (Arduino) for the data processing and navigation strategy
  - 9 US sensors
  - 2 IR sensors
  - visual feedback

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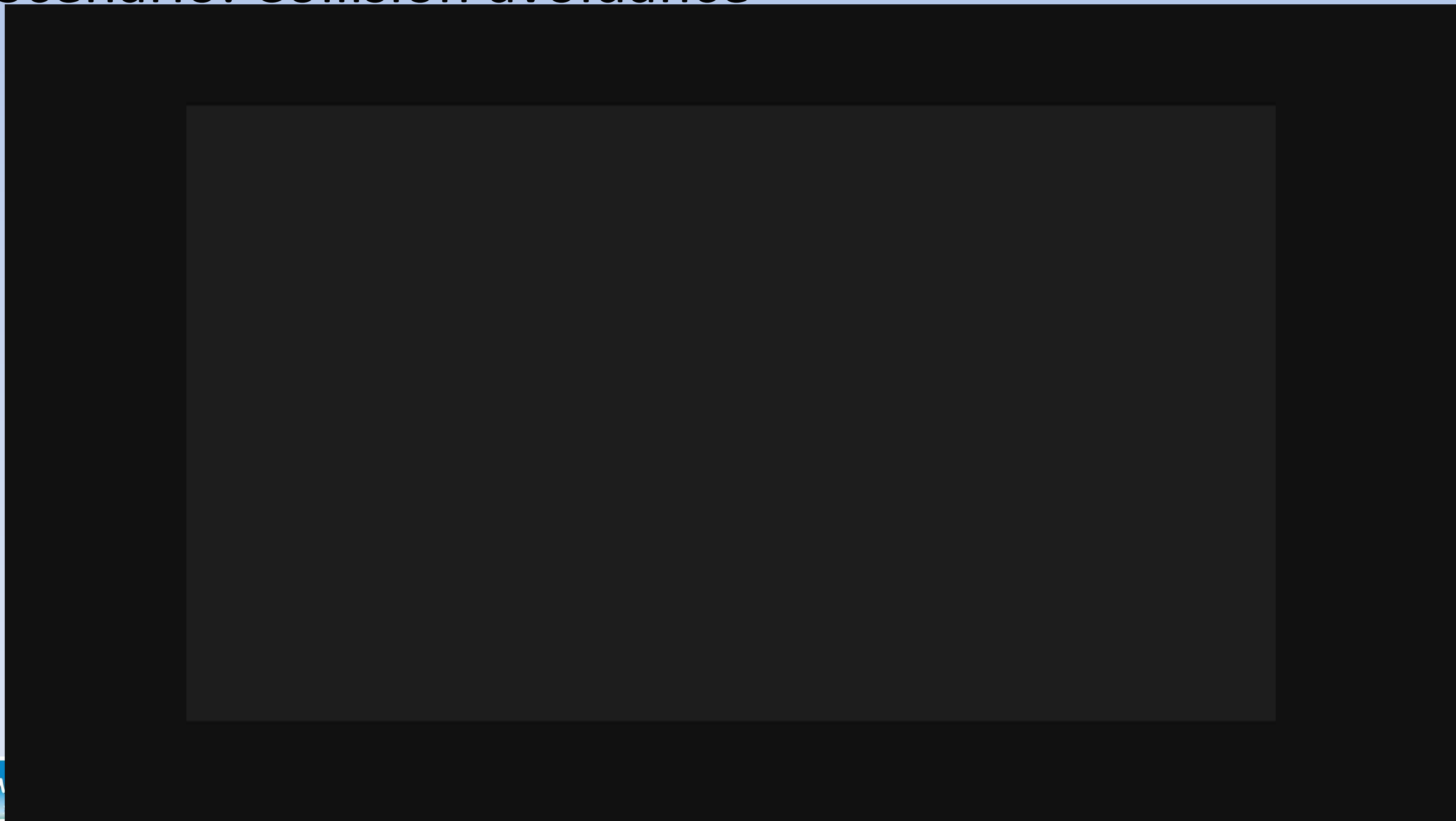
Main results: Intelligent device for assisted navigation

- 1st Scenario: Collision avoidance



Main results: Intelligent device for secured communication

- A secure wireless communication between the wheelchair and other location is necessary
- Tool: data encryption
- Problem: the encryption itself cannot necessarily protect against fraudulent data manipulation when the security of encryption keys cannot be absolutely guaranteed.
- **Solution**: *direct encryption* of data extracted from ICmetric samples which characterise the identity of the wheelchair.

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Main results: Intelligent device for secured communication

- ICmetrics possess the following significant potential:
  - Secure communication to and from each wheelchair devices via the direct generation of digital signatures and encryption keys from the internal behavioural characteristics of software and hardware associated with the wheelchair
  - Prevention of unauthorised access to the systems and devices associated with the wheelchair
  - Prevention of the fraudulent cloning or imitation of the electronics associated with the wheelchair
  - Implicit detection of tampering of the software or hardware associated with the wheelchair

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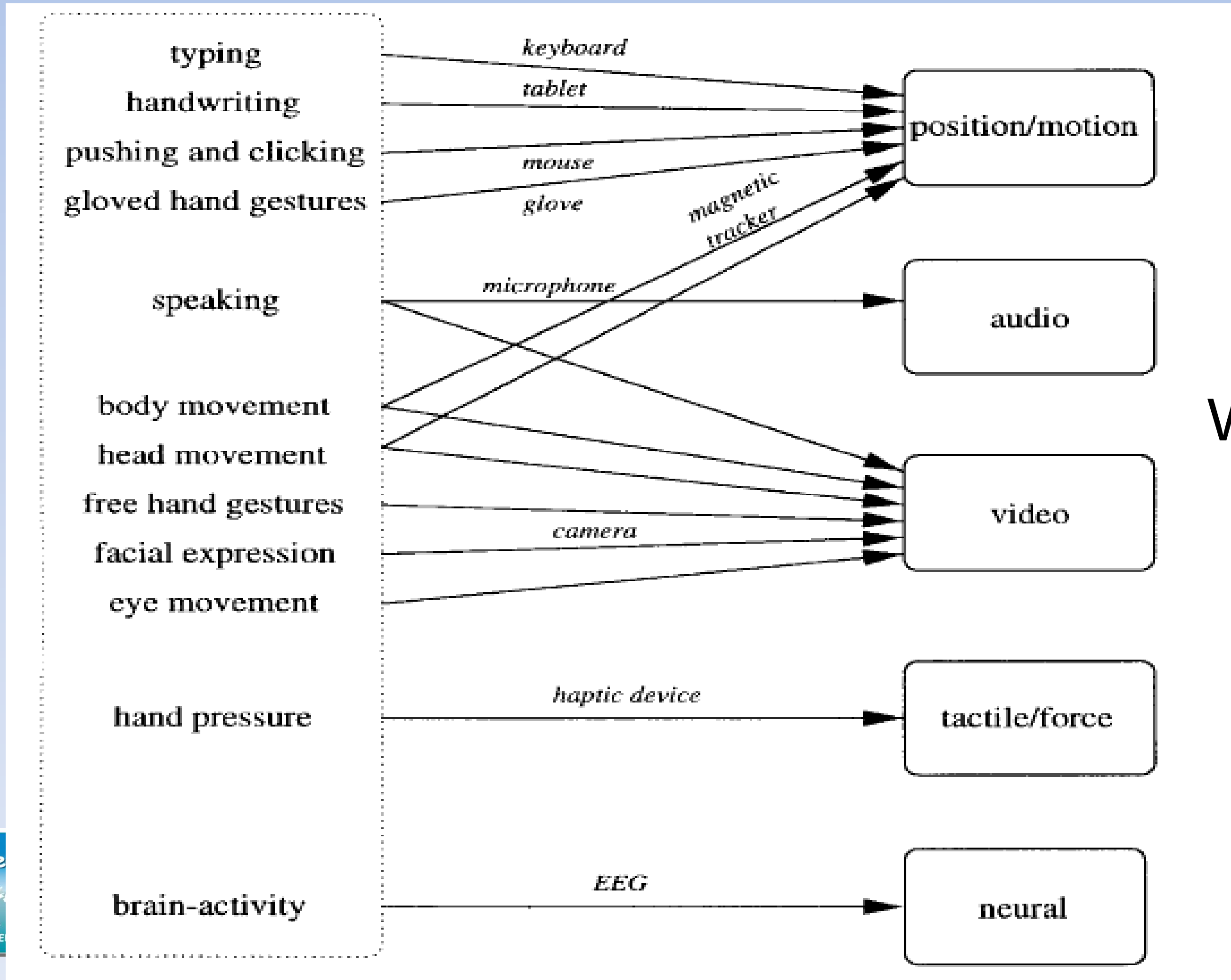
Main results: Human-Machine Interface for Hands-free Control

The way to sense human intentions

Human



Wheelchair

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Main results: Human-Machine Interface for Hands-free Control

Multi-modality HMI can benefit from the 3 aspects:

- Expanded usability and controllability - Integration of multiple modalities into HMIs would potentially enrich the controllability of the interface
- Refined adaptability and flexibility – to optimize the combination from a number of potential communication methods, and customize itself into a special communication method for each user;
- Higher accuracy and better robustness –fusing various complementary information into a MMHMI will improve the overall performance of the interface.

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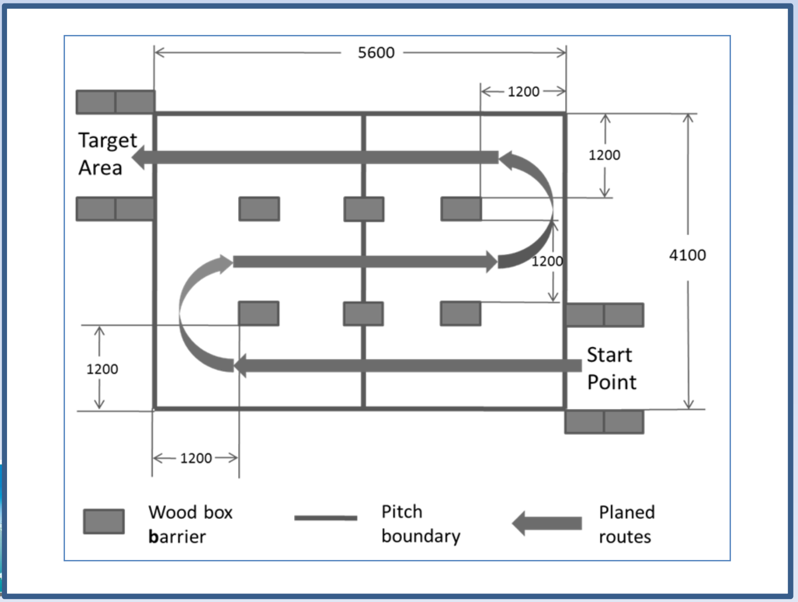
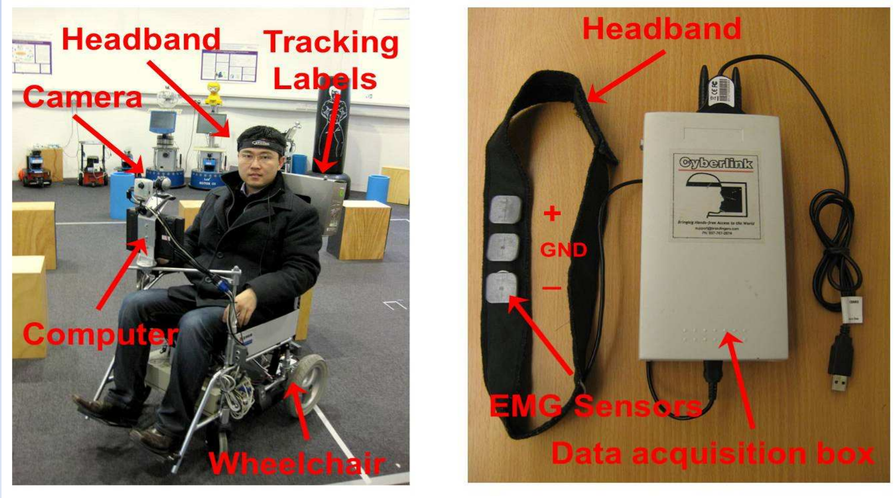
Main results: Human-Machine Interface for Hands-free Control

Experiments

- EMG signal from user forehead and face image information from camera fixed in front of the wheelchair
- an experiment site is designed and consists of a combination of doorways, corridors, turning corners and docking places





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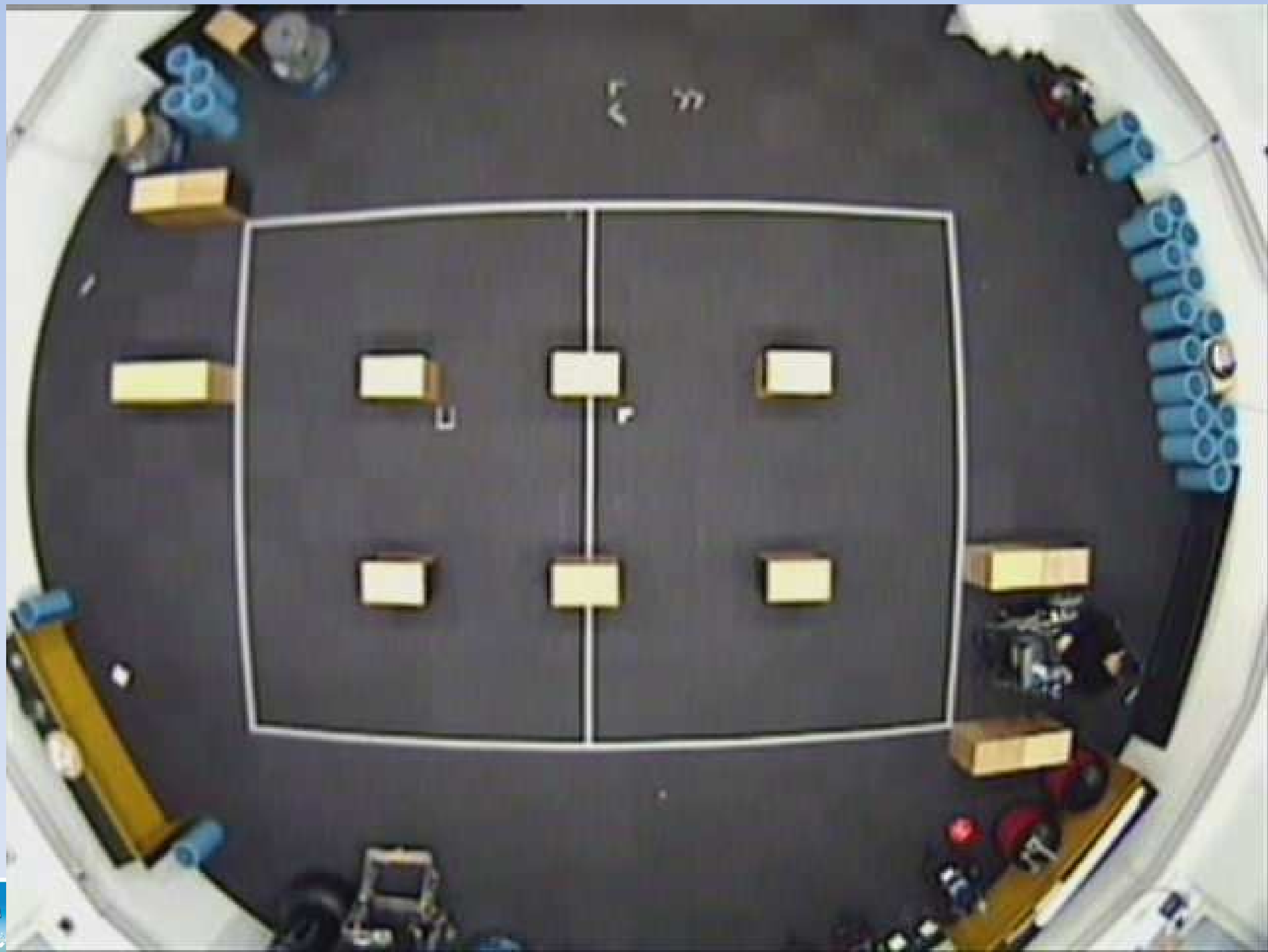
Main results: Human-Machine Interface for Hands-free Control



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Conclusions

The ambition of the project is to offer to disabled people personalized solutions in term of

- assisted navigation
- secured communication of data
- human-machine interfaces

which

- **answer at their needs**
- **take their physical and cognitive impairment into account**

These solutions don't ask major transformations on the user's environment.

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SYSIASS DISABILITY AND INDEPENDENCE