



EC Grant Agreement n. 288917

The DALi Project: A special walker for seniors with cognitive impairments

Heraklion, September 26th, 2013

REACTION Clustering Event

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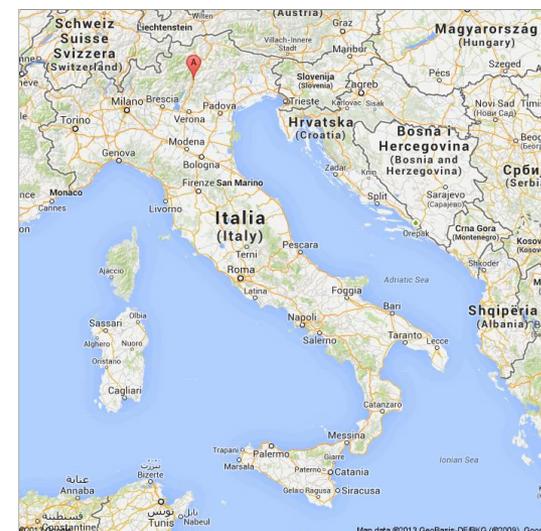
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9/26/13

Indirizzo Trento - Google Maps

Google

Indirizzo Trento



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SEVENTH FRAMEWORK PROGRAMME



DALi: Devices for Assisted Living

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PROJECT OVERVIEW



DALi: Consortium

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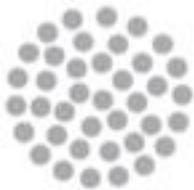
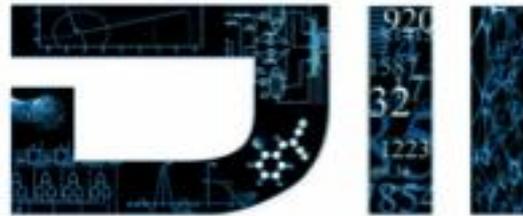
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VISUAL TOOLS



indra

SIEMENS



DALi's goal

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Support people with **moderate** sensory and cognitive impairments for navigating in un-structured or semi-structured environments



Why?

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- Reduced mobility is a major worry for older adults
- The inability to go autonomously to shops is a clear indicator of decline
- Extending autonomous life of older adults
 - Beneficial from a socio-economic perspective
 - Positive action against the the negative effects of aging
 - Higher degree of acceptability and efficacy than other solutions (e.g., smart Homes) that
 - create a cacoon of safety around the person
 - could discourage her/him from executing the daily duties



How?

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- By a **Cognitive Navigation Prosthesis (CNP)** meeting the following requirements
 - Autonomous Sensing and Cognitive abilities
 - Acquire information on the environment
 - Identify and classify entities
 - Anticipate the intent of human targets
 - Decide a course of actions
 - Flexibility
 - Operate in a configuration of sensing and actuation mandated by the specific needs of the Assisted Person
 - Adapt to the evolving needs of the Assisted Person
 - Non-intrusive role



What?

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- We will reinvent the paradigm of the walking assistant, endowing it with cognitive abilities
- The **cWalker** will assist the Assisted Person in her navigation (very much as a care—giver would do)
- The Assisted Person's remains in charge of the motion
- The cWalker gently guides her through





Where?

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- The c-Walker will be applied in semi-structured environments where:
 - The topology of the place is known upfront
 - There can be external sensors providing information (the “cloud”)
 - The illumination condition are relatively constant simplifying the use of visual sensor

- but...
 - The regularity of the environment can challenge the Assisted Person sense of direction
 - The number of people and the variability create stress and potentially confusion





Sensing apparatus

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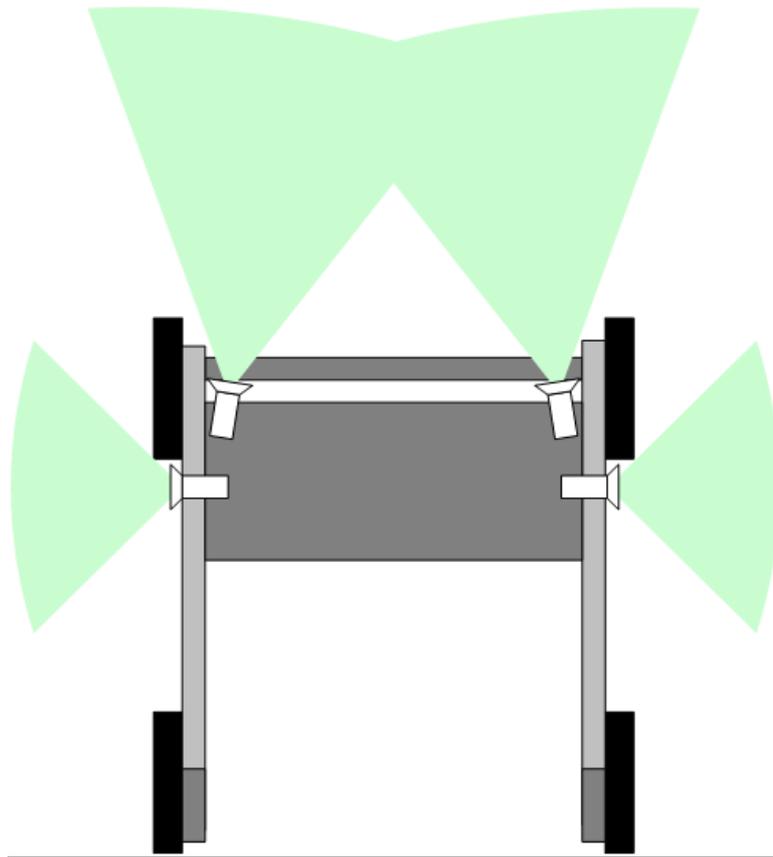


- Stereo Camera Pair
 - 3D perception of the environment
 - Smart OCR for real world text recognition
 - Localization
- Kinect™ Sensors
 - One used for monitoring the user
 - Second is used for the 3D perception of the environment (short range)
- Low Res Side Cameras
 - Improved localization
- Encoders + RFID and IMU for localization



Camera positions

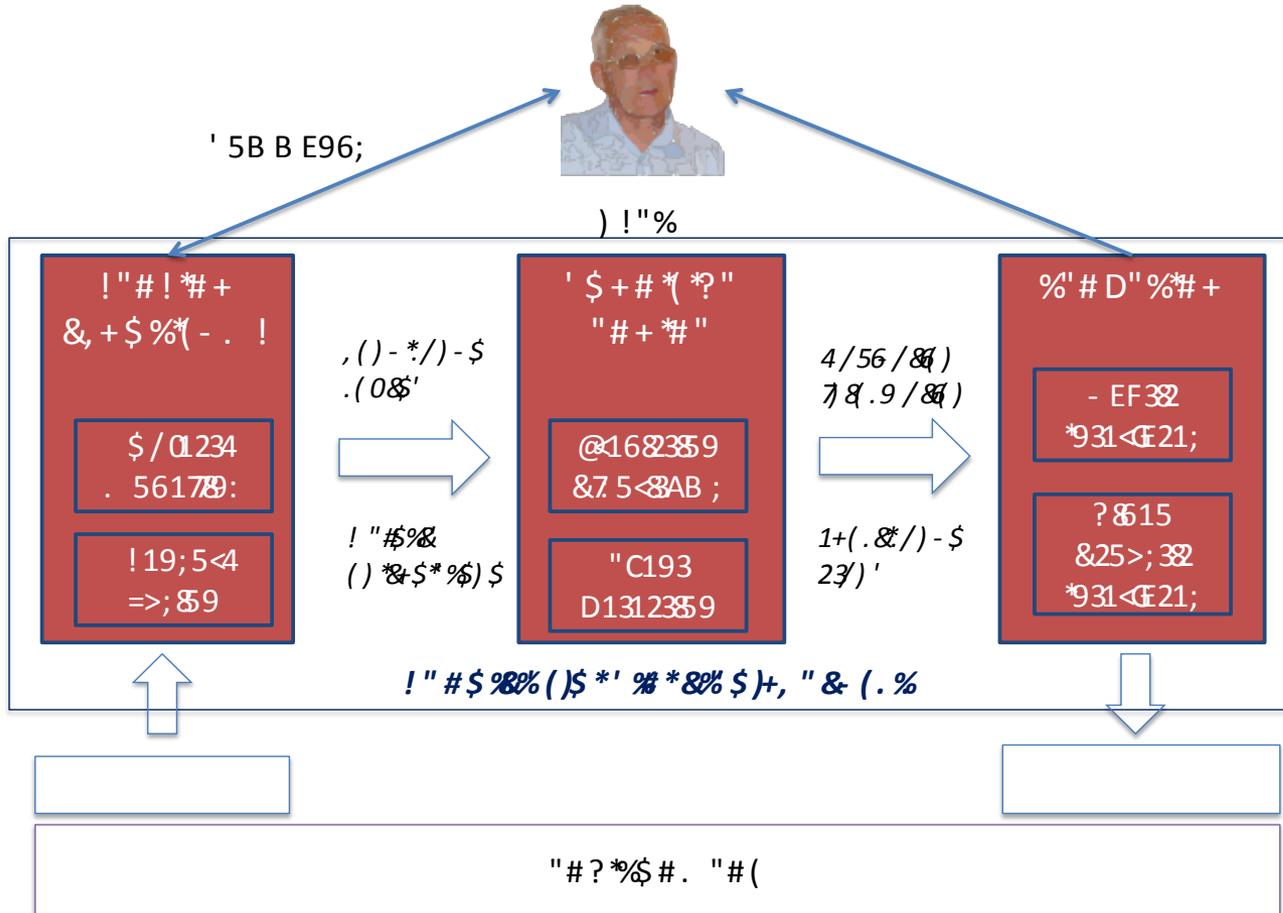
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The system as a whole

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DALi: Devices for Assisted Living

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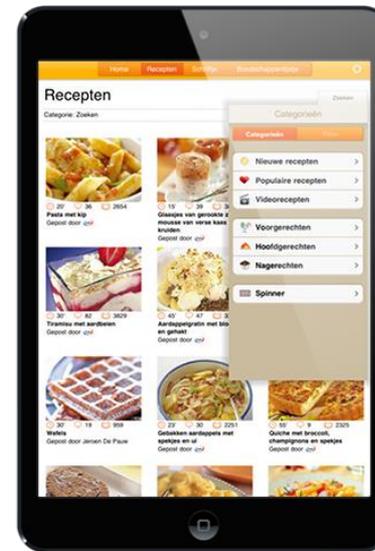
USE CASE



Use Case - 1

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- Anna is 76 years old
- She wants to go shopping
- She goes to her favourite mall
- She chooses her shopping list

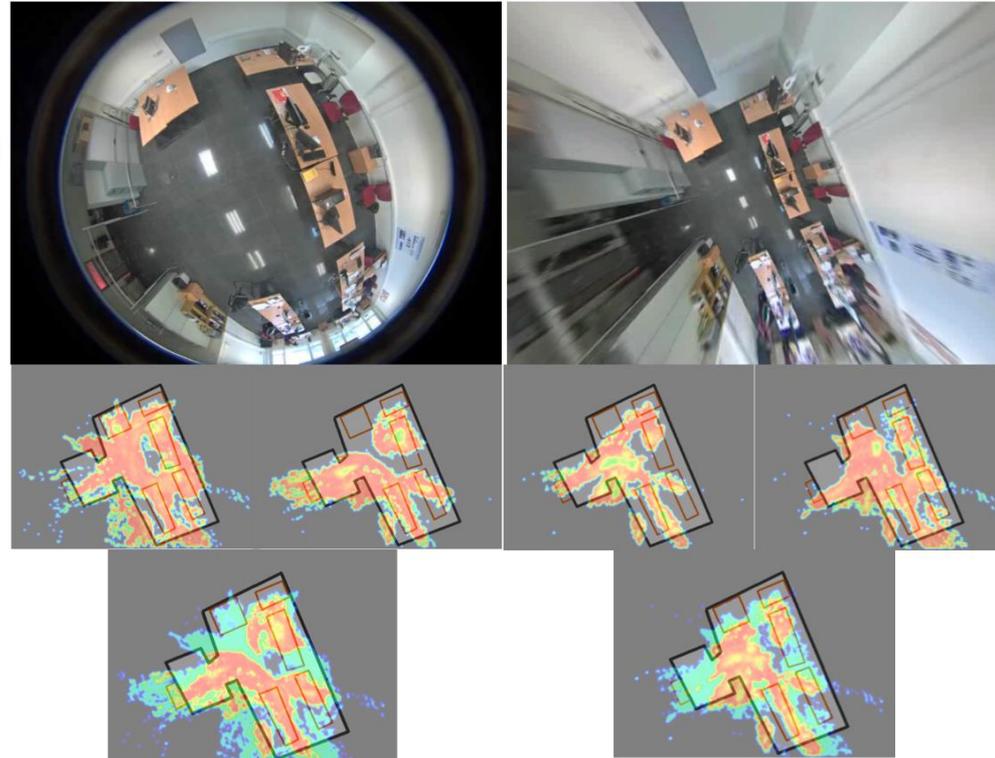




Use Case - 2

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- The c-Walker plans a route in the environment
- Compute shortest path from start position to goal
- Can take into account weights to adapt to needs
- For example, it avoids potentially stressful or dangerous places: “heat maps” with the crowdedness information and detected anomalies

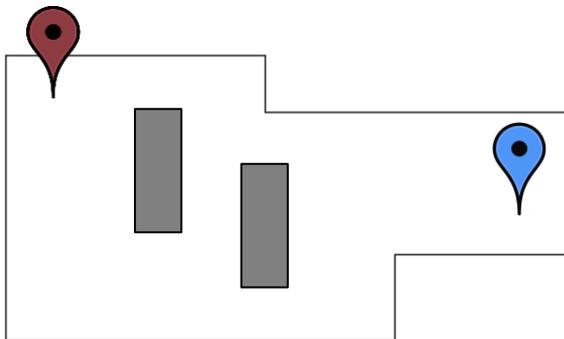




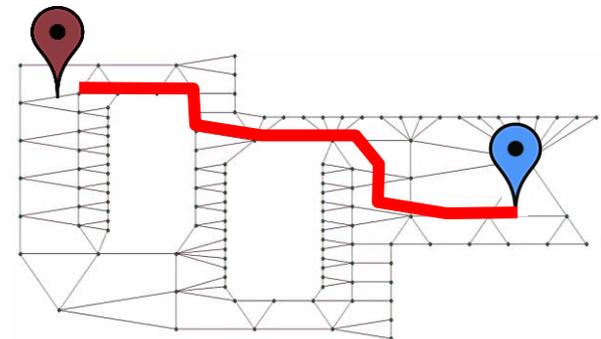
Use Case - 3

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- Shortest path can take into account (weights):
 - Heat maps
 - Road blocks
 - Assisted Person preferences
 - ...
- Provided almost “for free” using a spatial database
 - Need to format proper SQL queries. E.g., routing node 1 to 20:
`select * from waylines_net where nodefrom = 1 AND nodeto=20`



Map



Connectivity graph



Use Case - 4

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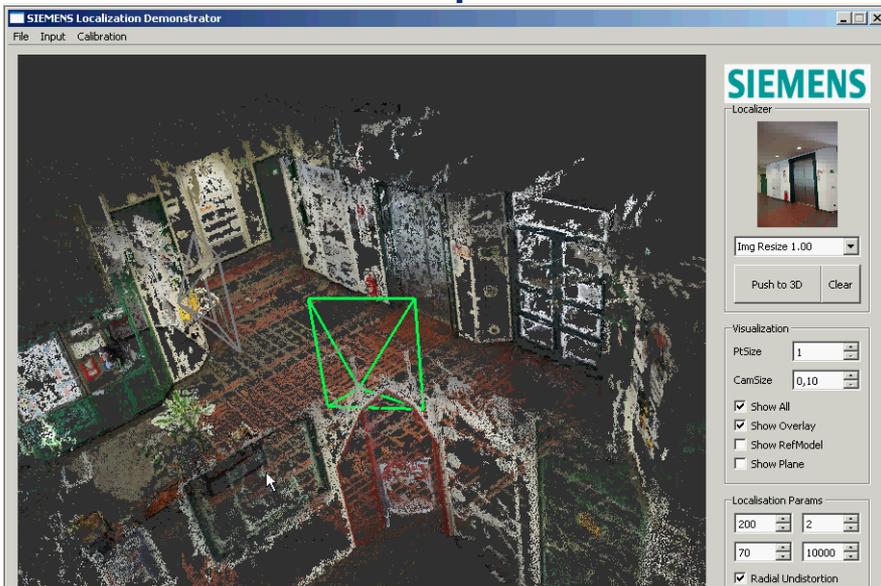
- Anna starts travelling across the mall
- The display shows her the **direction** to take
- The localization module detects her position inside the mall



Localization Module - 1

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- Localization is based on two sensing sources:
 - An inertial platform (gyroscope + accelerometers);
 - cWalker Encoders.
- When available, mapped visual cues are used for an additional input to the localization module

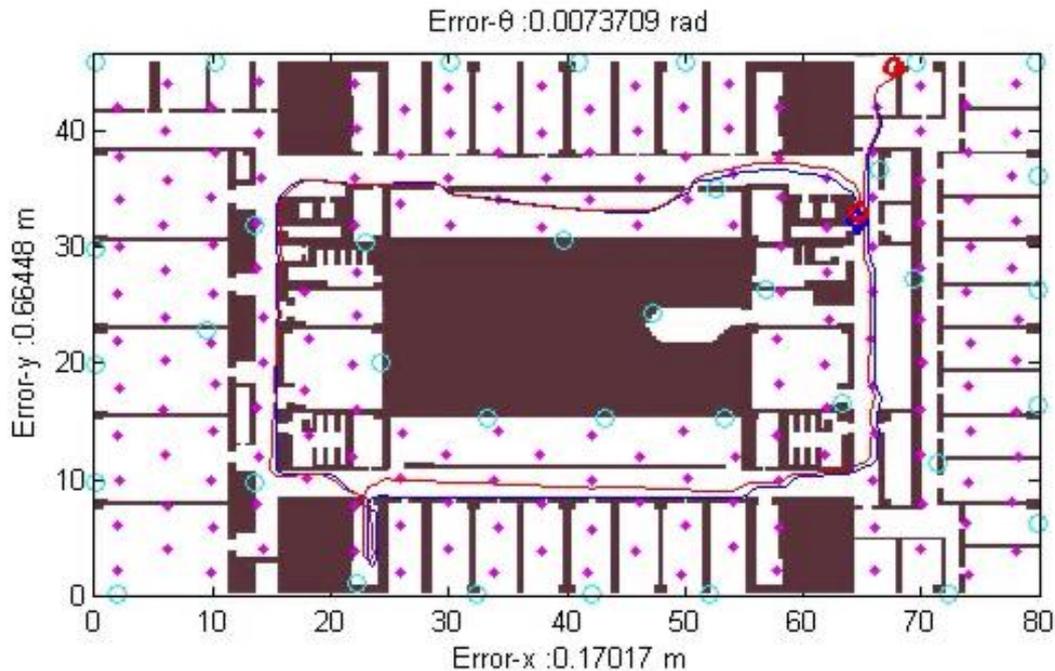




Localization Module - 2

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- Additionally, **RFID tags** are used for an additional input to the localization module

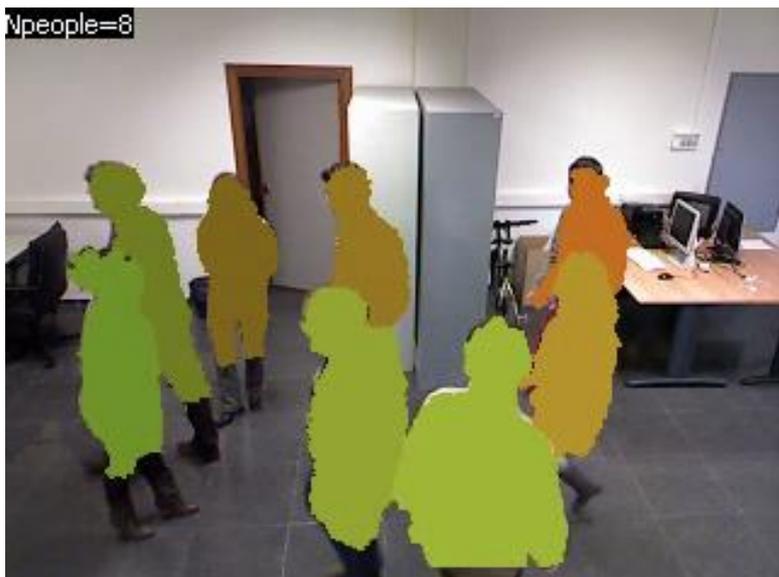




Use Case - 5

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- Moving obstacles and humans are detected by the cWalker

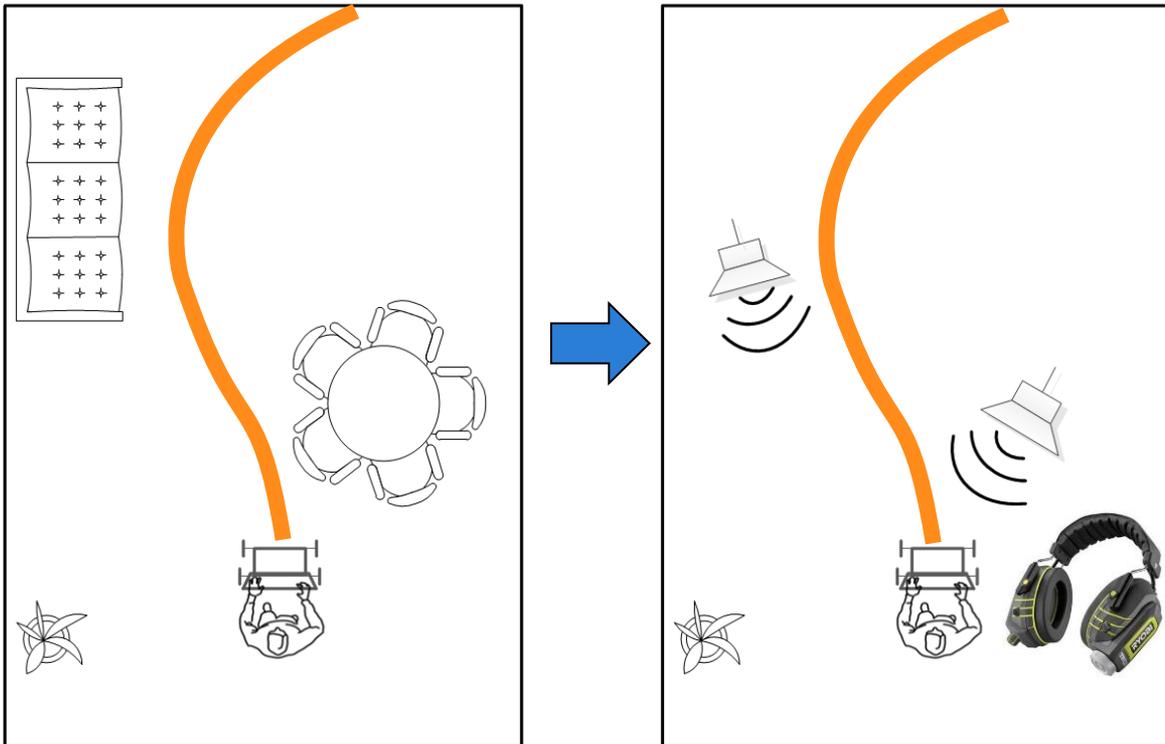




Use Case - 6

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- A 3D modulated sound in the headphone notifies fixed and moving obstacles

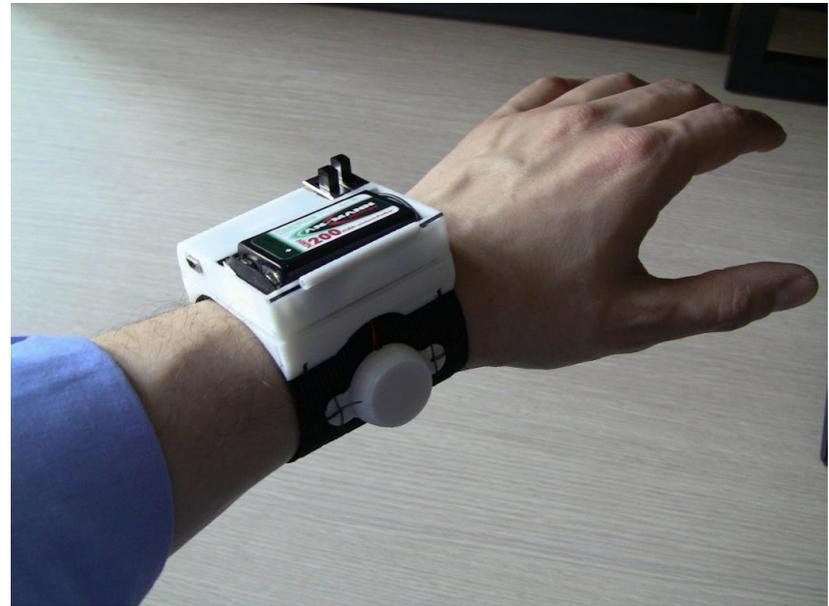
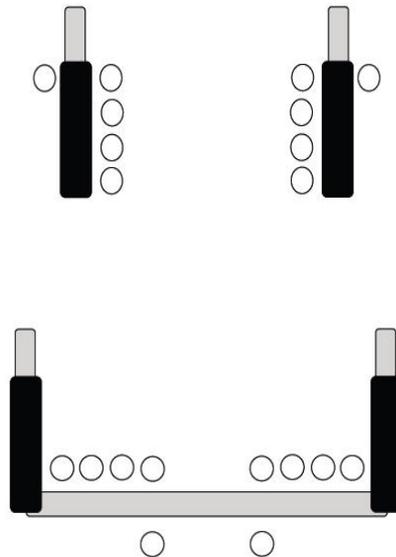




Use Case - 7

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- In addition to the display and the headphone, the **haptic handles and/or the bracelet** start vibrating to suggest the right direction

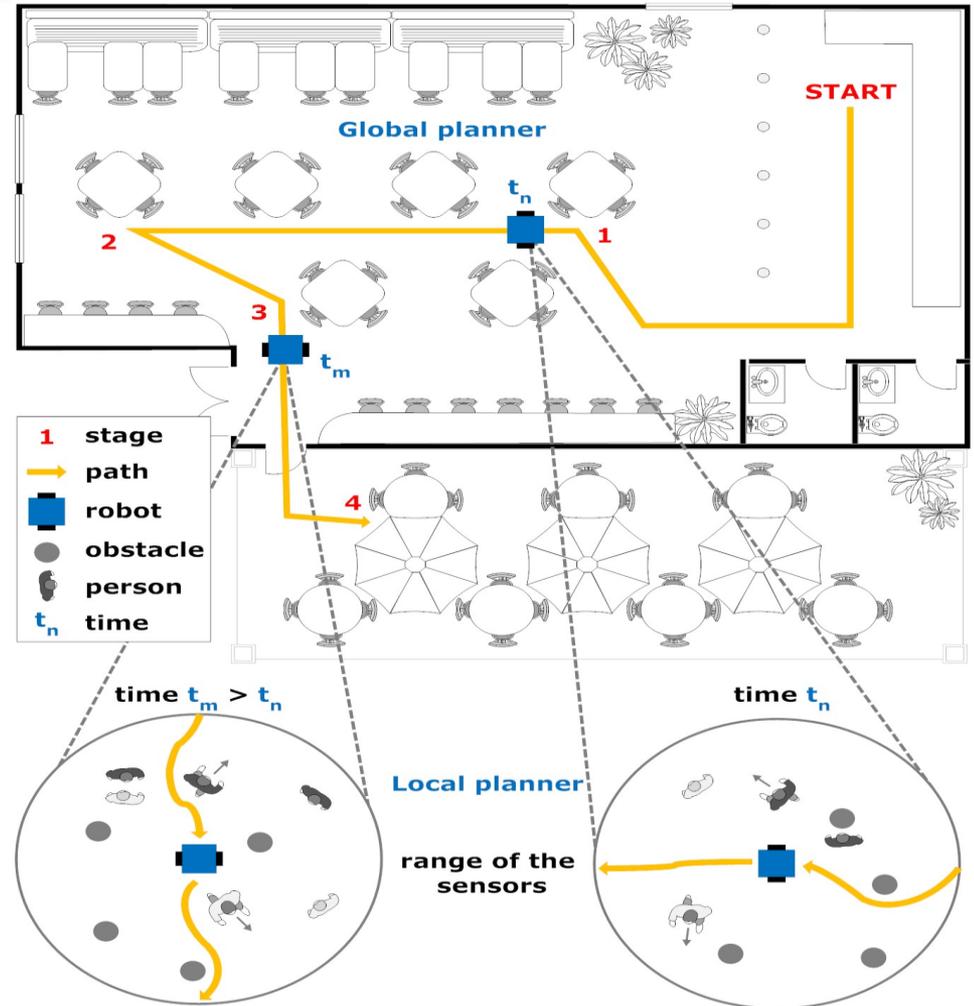




Use Case - 8

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- Anna encounters a group of bystanders on her way
- The cognitive engine modifies the global plan by **locally re-planning** the trajectory

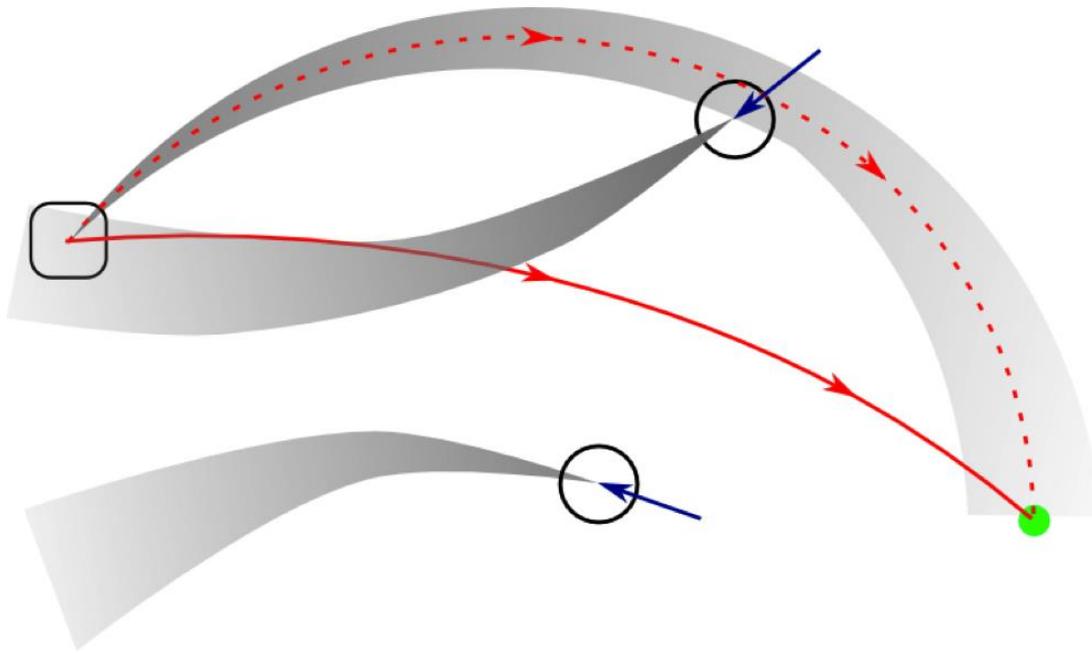




Use Case - 9

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- The cognitive engine **predicts** the motion of the people, and **decides** a deviation from the route

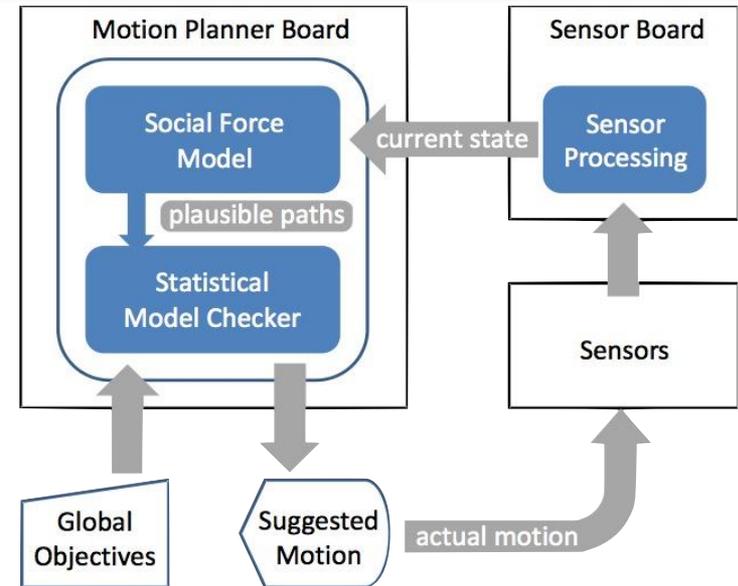




Re-planning Algorithm

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- Combines:
 - Statistical Model Checking (SMC)
 - Social Force Model (SFM)



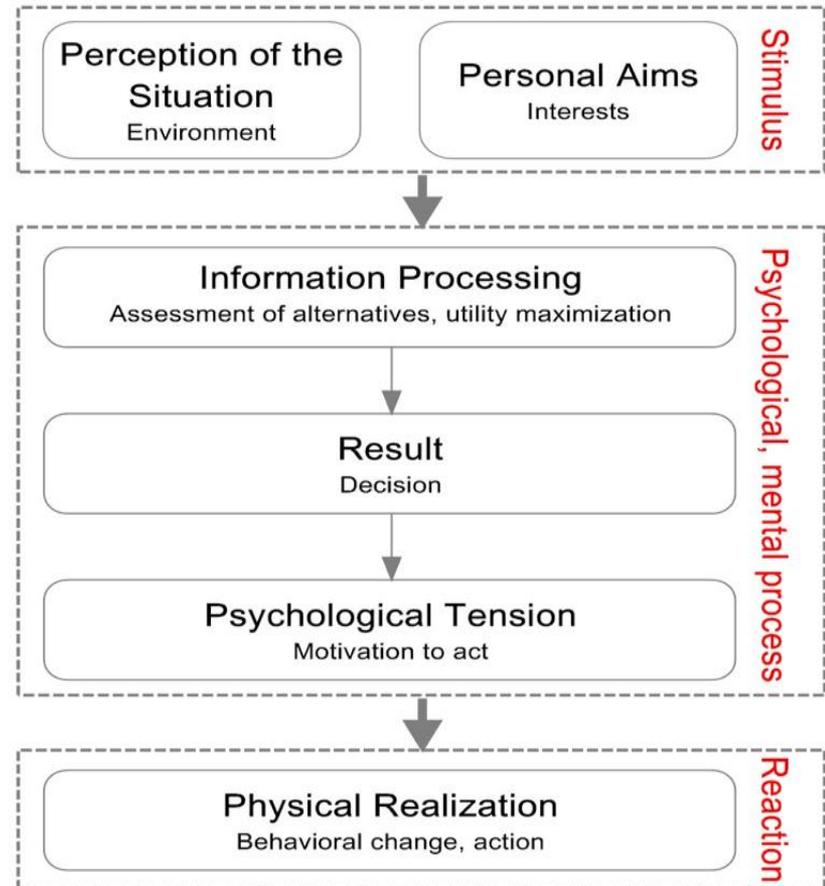
- SFM generates simulations to be verified against global objectives using SMC
- Motion planner periodically suggest a course of action to the user (assumed to be compliant)



Social Force Model

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- Models human behavior
- The SFM models groups of people having goals, using repulsive and attractive social forces

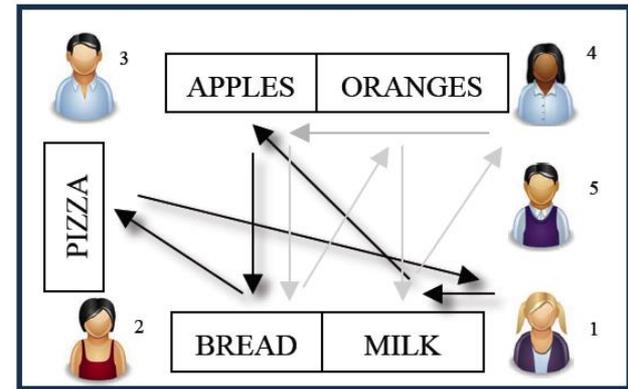




Beyond the SFM

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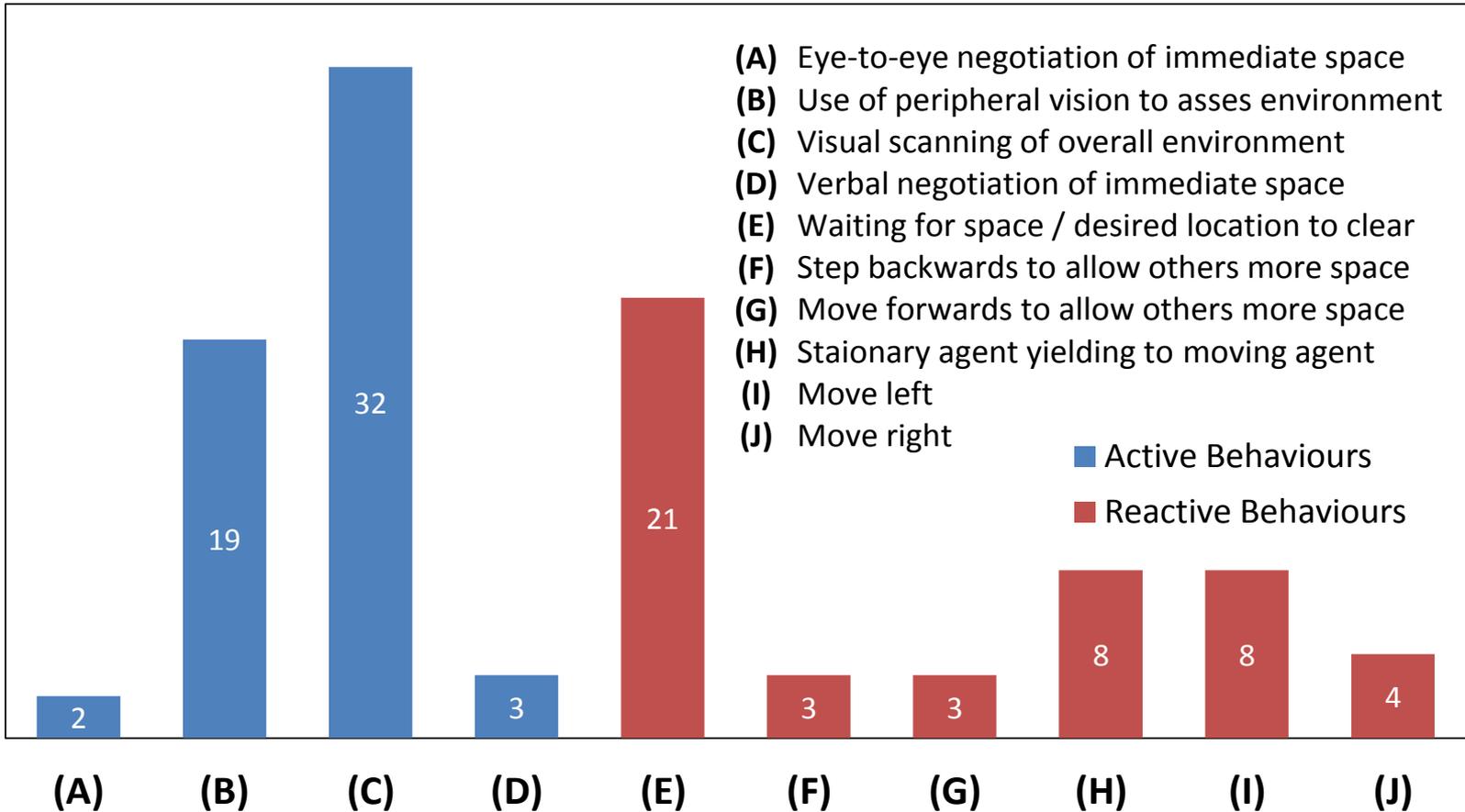
- Real life data emulating a market place
- Results show the complexity of human interactions





Beyond the SFM

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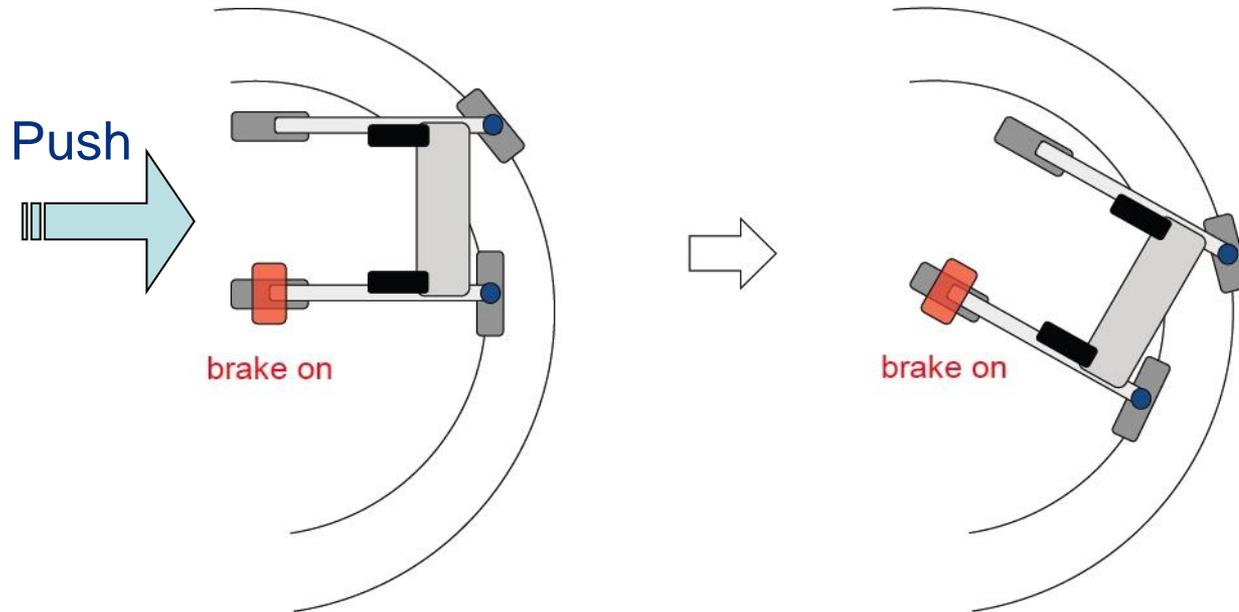




Use Case - 10

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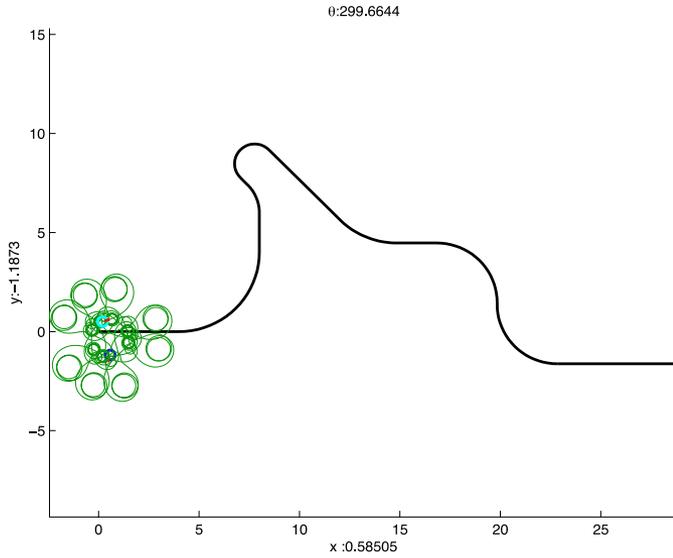
- Hence, the automated brakes gently correct her motion if she drifts away from the planned path





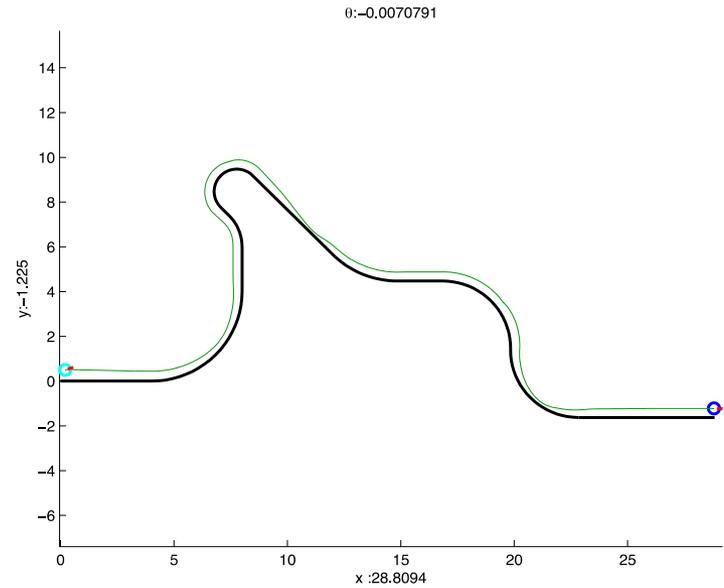
Use Case - 11

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Brakes Off

Brakes On





Use Case - 12

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- The system detects a **stress condition** in the facial expression of Anna

Kinect is at the bottom position



Use Case - 13

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- In a stressful situation, the cWalker suggests to proceed to the nearest sitting place or to the nearest mall employee or policeman





Conclusion

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- The cWalker may comprise all the devices previously presented
- The design of the cWalker is modular, hence it can be tailored on the user needs
- The overall system has been conceived taking into account the user perspectives
- At the moment we are working on the integration of the different components into a single prototype



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