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The Care-O-bot Platform Inspiring Development of new Technology





Care-O-bot – a mobile service robot









Care-O-bot – a mobile service robot



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- 6 DoF industrial arm
- Stereo + Depth camera
- Sound (speaker & mic)
- Actuated torso
- Tray (incl. touch screen)
- Laser scanners (x3)
- Omnidirectional base





Exploring use cases for welfare robots



Exploring use cases for welfare robots



Welfare robots



- Robot perception
 - Combining different modalities
- Human robot interaction
 - Proxemics
 - Effect of social cues
- Recent activities







Robot Perception – Sensor Fusion

Original image (left)





Disparity map (fused)





Suvei, S-D., et al., *Stereo and Active-Sensor Data Fusion for Improved Stereo Block Matching*. Int. Conf. Image Analysis and Recognition, 2016.



Robot Perception – Sensor Fusion

Original image (left)





Disparity map (fused)



Fusing stereo with LiDAR, applied to detect humans





Suvei, S-D., et al., Stereo and Active-Sensor Data Fusion for Improved Stereo Block Matching. Int. Conf. Image Analysis and Recognition, 2016.



Multimodal sensor processing

- Combining audio and visual information
 - Audio: fast, inprecise
 - Vision: limited field of view, slow, precise



Human robot interaction



Jensen, LC., Fischer, K., Suvei, SD., Bodenhagen, L., 2017 Timing of Multimodal Robot Behaviors during Human-Robot Collaboration. IEEE RO-MAN

Fischer, K., Jensen, LC., Suvei, SD., Bodenhagen, L., 2016 Between legibility and contact: The role of gaze in robot approach. IEEE RO-MAN.







Human robot interaction



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How it is done matters

- Timing: correlation of actions to dialog content
- Gaze: aggressive or ignorant

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Human robot interaction

How it is done matters

- **Timing**: correlation of actions to dialog content
- Gaze: aggressive or ignorant
- **Proxemics**: where to approach





Jeppesen KC., Bodenhagen L., Krüger N., 2017 Socially Acceptable Behaviour for Robots Approaching Humans using an Adaptable Personal Space, HUCAPP^{Denmark}



Seamless Human Robot Interaction - SMOOTH

Proactive robot behavior for smooth interaction between robots and humans







Seamless Human Robot Interaction - SMOOTH

 Proactive robot behavior for smooth interaction between robots and humans







Health-Care Assisting Technology – Health-CAT

- Seed idea: Mobile robot for measurement of vitals at e.g. geriatric ward.
- Needs analysis in the project:
 - Logistical challenges
 - Food registration
 - Hygiene (personal and equipment)
- Research focus: scene understanding -> robot control









Welfare robots within next years









Thank you





