NeoPixel Rings for Robot State Visualization

Bachelor Thesis

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Outline

Motivation and Project Goal

Motivation

- With the help of the PR2 robot, the members of the TAMS group research current topics in robotics.
- The robot is given a variety of tasks, which it tries to solve using the research group's solution approaches.
- It is often impossible to predict whether the robot is busy solving a task or whether a fatal error has occurred.
- The members of the TAMS group should therefor be able to clearly read the state of the PR2 robot when it solves tasks.

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PR2 Robot

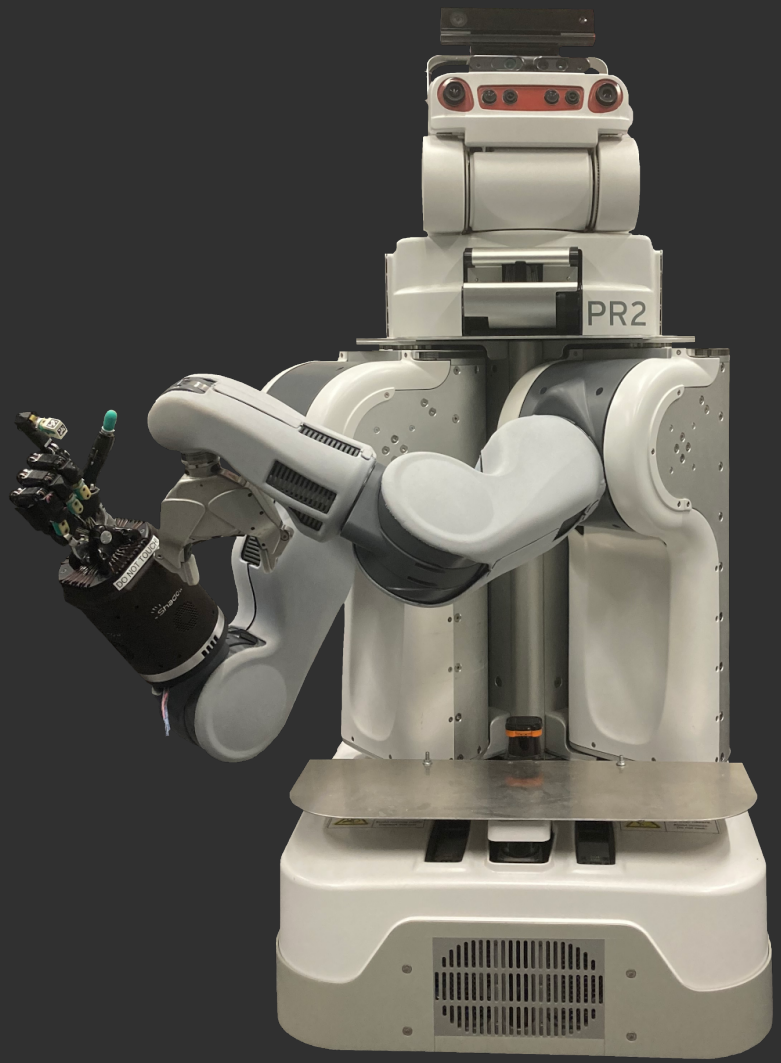

Figure: Willow Garage's PR2 robot wearing the Shadow Robot Company's Shadow Dexterous Hand. The robot also wears an XBox Kinect from Microsoft on its head.

Project Goal

Finding visualizations for the robot state of the PR2 robot, which should be displayed using two LED rings (NeoPixel rings).

- How is the state of a robot defined?
- How can visualizations be assessed? Which metrics are available?

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Robot State I - Functionality Based

- The state of a robot is made up of the individual states of its components.
- The condition of individual components can be classified on a scale from 0 to 1.
- A scale value of 0 certifies that the respective component is in an error-free condition. A classification with the value 1, on the other hand, indicates that the corresponding component is inoperable.

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Robot State II - Task Based

- The state of a robot when solving a task is the progress of the solution.
- Accordingly, there is an individual spectrum of states for each task to be solved.

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Visualization Metric I - Information Content | Entropy

How much information can be encoded with the help of the selected visualization and thus conveyed to the viewer.

Visualization Metric II - Intuitiveness

- How intuitive is the selected visualization to be understood by the viewer.

- *A technical system can be used intuitively if it leads to effective interaction through unconscious application of preknowledge by the user* - Mohs et al.

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Visualization Metric II - Intuitiveness

Figure: Taxonomy of preknowledge according to Mohs et al. when interacting with technical systems

State of Research

Song and Yamada

- Song and Yamada try to depict the emotions anger, happiness, sadness and serenity with the help of the robot Maru. The robot can communicate with the help of colored eyes, vibrations and rudimentary noises.

- In a study, Maru managed to successfully communicate the emotions anger, sadness and serenity using one or more of his modalities.

Emotion	Anger	Happiness	Sadness	Serenity
Color	Red	Green	Blue	White

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Löffler et al.

- Löffler et al. try to give recommendations for the representation of the emotions joy, sadness, fear and anger with the rudimentary modalities movement, color and sound.

- It can be shown that some modalities are more suitable for representing certain emotions. Movements in particular, but also colors, are suitable for depicting emotions.

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Visualization Concepts

Basic Decisions | Assumptions

- Focus on the functinality based definition of a robot state.

  => It can be assumed that the status of individual components is always present as a value between 0 and 1.

- Find concepts / visualizations based on preknowledge that exits in the TAMS group, to increase the metric intuitiveness.

  => A conflict arises between the intuitiveness metric and the information content metric!

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Visualisation Concepts

Solution: Two visualization concepts, one that is very intuitive but hardly conveys any information and one that conveys more information but is less intuitive.

- Concept 1: Aggregate the individual component states of the robot and map this value to one of the three emotions happiness, serenity and anger. Then try to visualize these three emotions using the NeoPixel rings.
- Concept 2: Assign a component to each NeoPixel of the NeoPixel ring. Then show up to 32 states of components at the same time. Use letters to explain the assigned components of the individual NeoPixels.

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