Methoden van AI onderzoek – opdracht 5 & 6

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Abstract

In this document I give a view of my observations within the field of Artificial Intelligence focused on using a human operator in robot control, extending this field to the field of telepresence. Following from that, I will state the research question for my Bachelor thesis and the results I expect from this. Finally, I will present the schedule I will try to follow.

1 Introduction

Within the field of Artificial Intelligence (AI), the focus lies at designing and building rational agents, where an agent differs from most programs in at least the fact that they operate autonomously [RN03, p.4]. This science hasn't developed enough to design autonomous applications that can be used in all situations. Even within the AI community there is debate whether these "AI-complete" problems [JM00, p.738] would ever be solved. To make optimal use of the currently developed techniques, researchers are looking at the best way of putting a human on the spot of an autonomous agent. One of these fields of research is telepresence. Telepresence focuses on converting sensor data to corresponding human experiences and letting the human act upon this remote environment. Examples of telepresence systems include telephones and video conference systems. One could also think of remotely operated robots. This is called remote robot presence, and lies at the intersection of the fields of telepresence and human robot interaction (HRI).

There are many cases in which robots can be used. They are regularly summarised by "the 3 D's: jobs that are dirty, dull or dangerous" [Mur00, p.6]. A fourth class of tasks in which robotics is often applied, are those involving areas which are otherwise inaccessible. This last class is one of the classical areas in which telepresence is applied. But it is also interesting to look at designing telepresence systems for dirty and dangerous jobs, as it could increase the comfort of the human operator.

Throughout the years, the role of the human has moved from robot operator, having full control over the robot, to someone who monitors the status of the robot and gives high-level instructions [vEDJ+06]. It is shown that fully automating tasks does not always ensure better system performance [vE00], which is an argument for keeping the human in the operating position.

Telepresence lets the user experience a remote environment and act upon it. One way of reaching this, is raising the situation awareness of the human operator [End88, vEDJ+06]. Even though it has been demonstrated that the sense of touch, or haptic sense, is accurate and fast [KLM85], it is often not used in telepresence systems.

Most human senses consist of multimodal input. For example, vision is

composed of properties describing color and light intensity. The haptic sense has been broken down into seven properties: texture, hardness, temperature, weight, volume, global shape and exact shape. Humans investigate each of these properties with stereotypical hand movements, called "exploratory procedures" [LK87]. In a remote robot presence system, one could implement all of these, but it might be preferable to shield off the user of some of these properties, like temperature. Other properties, like hardness, volume and shape, are very useful when represented with little to no modification to the human operator.

2 Research question

For my Bachelor thesis I will investigate the following question:

> How do you create a haptic model of the environment with optical range sensors and act upon it from another point of view?

This question can be broken down into several parts. First, the system needs to acquire a haptic model of the environment. To capture each of the properties by means of optical range sensors might be difficult. The volume and shape properties can be obtained by scanning the area with a 2D laser scanner (see for example [CL96, **?**]). Temperature can be seen by infrared cameras. One can experiment with computer vision techniques to obtain some heuristic information on the other haptic properties (texture, hardness and weight).

3 Expected results

The hardware specifications I am to use give restrictions on the possible input and output methods.

The robot which will act upon the, for the human remote, environment will be a Nao [Rob] with a laser scanner mounted on top of its head. Nao is a humanoid robot. It is equipped with two CMOS cameras by default, which might be an aid in discovering haptic properties. It also has a 2 channel sonar. Besides these, it can connect via Wi-Fi 802.11b or an ethernet cable to a network, running an internal server by which a computer can communicate with the robot.

I will use two Novint Falcons for the human input and haptic output of the system [Tec]. The Novint Falcon has three robotic arms, each with 3 degrees of freedom. The three arms hold a sphere with buttons on it. This is the human handle. It generates force feedback on the sphere by varying the tension on the arms' motors. It does not have a module to control temperature. Because I cannot test how well this correspond to the human experience, I will not try to work with this haptic property. Each Novint Falcon will control one arm of the Nao.

I expect that recognizing the arms of the robot as not being a haptic barrier to be one of the problems in a setting where the model is updated dynamically. I expect that I have this problem solved at the end of the project. I do not expect to have designed or implemented heuristics for extracting haptic properties from visual images.

4 Schedule

In the first three weeks, I expect to be busy reading up on techniques that generate a 3D model from 2D data. As most tangible objects have a reflection and reflecting objects are tangible, it might be sufficient to take this model as the one for the haptic volume and shape properties. To be sure, I take one week for this.

In the two weeks after that, I will have to make the module which con-

Table 1: A more structured representation of my working schedule for getting my Bachelor thesis finished.

Week number	Activity description	Hours
14	Generating 3D model from 2D data	$\frac{1}{4}d$
15	Generating 3D model from 2D data	$\frac{1}{4}d$
16	Generating 3D model from 2D data	$\frac{1}{4}d$
17	From 3D model to haptic model	$\frac{1}{4}d$
18	Study trip to England	0
19	Inverse kinematics and arm control	$\frac{1}{4}d$
20	Inverse kinematics and arm control	$\frac{1}{4}d$
21	Examination period	0
22	Moving arms with feedback in line with head	d
23	Moving arms with feedback in line with head	d
24	Extending to full 3D, 2 arms	d
25	Final presentation	d
26	Extending to full 3D, 2 arms	d
27	Extending to full 3D, 2 arms	d
28	Write report	d
29	Write report	d

trols the robot arms. I could only find a description of the inverse kinematics of Nao's legs [RLM$^+$09], which means I have to calculate the inverse kinematics of its arms and head myself. When finished with that, I will have the head follow one of the hands in such a way that the laser scanner is just a bit ahead of the hand.

After the examination period, I will work on scanning the area just in front of the hand and generating a haptic model of that. In the last week before the final presentation, I will start developing a method for moving both arms with haptic feedback, and having the head move independently from the arms. I will continue working on this in my honours time, after the final presentation.

In the final two weeks I will write my report.

When I have time left, I will work on making a module that heuristically adds additional haptic properties to the model based on computer vision techniques.

The schedule is given in a more structured way in Table 1. In the first column are the week numbers. In the second column one can find the activity I will undertake for my thesis in that week. In the last column you can see the time I think I will spend that week on my thesis. During VIA's study trip to England and the examination period I expect to do nothing noteworthy. In the weeks after the examination period, I expect to work full-time (d hours) on this project. In the weeks before, I work one-fourth of full-time, as that is the time rostered for this project.

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