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A Robotic Home Assistant with Memory Aid Functionality

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***Abstract*— In this video, we present a robotic system that assists humans in their search for misplaced belongings within a natural home-like environment. Our stand-alone system integrates state-of-the-art approaches in a novel manner to achieve a seamless and intuitive human-robot interaction. The robot orients its gaze to the speaker and understands the person's verbal instructions independent of specific grammatical constructions. It determines the positions of relevant objects and navigates collision-free within the environment. In addition, it produces natural language descriptions for the objects' positions by using furniture as reference points.**

I. INTRODUCTION

We present a domestic robotic system that assists people in their search for misplaced belongings. It provides help in two ways, either by *moving* to the position of the requested object or by *describing* the requested object's position using other objects in the scene as reference points. The robot is able to navigate through the home environment in a collision-free manner, by using a map of the environment that has been created beforehand. Knowledge about the current positions of all objects is acquired by performing an initial exploration run through the environment, during which the objects are detected and located on the map.

To enable a seamless and natural interaction, the robot notices when a user wants to start interacting and turns towards the user once she begins to talk. Moreover, it reacts whenever the user phrases the intention to find a particular object. It interprets various sentence structures, such as direct and indirect questions or imperative statements, and correctly identifies the user's intention.

II. VIDEO DOWNLOAD LINK

The video file can be downloaded from `https://www2.informatik.uni-hamburg.de/wtm/videos/VideoSubmission_UniHamburgWTM_RO-MAN2016.mp4`

III. VIDEO DESCRIPTION

We begin the video with a short motivation and then go on to briefly show the hardware components of our robot. We follow this up with an overview of the system architecture and the functionalities of the different modules that make up the software system.

Next, the exploration phase is demonstrated. Here, with the help of a pre-created map, the robot travels through a sequence of way-points in the room and locates known objects. In the video, the display is divided into three parts. On the right hand window, the map of the environment is shown along with the path followed by the robot as it moves. The upper left section shows a view of the room as the robot moves about, and the bottom left part shows the depth video feed from the robot's camera.

Next a demonstration of the person detection ability of the robot is presented. When a user speaks to the robot, it correctly identifies the direction of the sound source and rotates until it can detect the user's face.

After this, the video shows how the robot can understand the user's command and responds to it. When the user asks about the location of an object, the robot answers by giving a natural description of the object's location using furniture as reference points. When the user asks the robot to show where an object is, the robot moves to the location of the object and verbally informs the user when it has found the required object. Some of the video clips involving human participants are from a user study that we had conducted.

IV. CONCLUSIONS

A robotic assistant such as this, can be especially helpful for people with impaired mobility or for elderly users. People with memory related disabilities can also benefit by having a robot that can help in locating necessary objects.

The results of a user study that was conducted with 20 participants show that the system is generally able to accomplish its tasks. Our robot achieved an average user satisfaction rate of 4.05, on a scale from 1-5 with 5 being the best. However, certain aspects of the system can be further improved. The robot is not yet capable of understanding anaphoric references (e.g. "I cannot find the milk. Can you show it to me?"). The person detection module sometimes recognized false positives due to environmental clutter. Object detection capabilities of the robot can also be improved by adding recognition capability for more objects. The additional task of fetching an object might also be a helpful form of assistance.

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