Grid-pattern Indicating Interface for Ambient Assisted Living

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ABSTRACT

This paper proposes a grid-pattern indicating interface to provide instruction remotely from remote site for supporting independent daily life of senior citizens. Our aim is to realize smooth and easy telecommunication between supported senior citizens at local site and supporting caregivers remote site. Although we have used a monitoring method with video streaming the remote caregivers indicate work steps as a conventional way, occlusion and depth perception problem was occurred. Our method that provides grid-pattern interface to remote caregivers could be a solution to indicate the spatial instruction easily by 2D input interface. Our prototype has been implemented with a color camera, a range image sensor, and projector.

1. INTRODUCTION

Most countries are facing serial situations nowadays, and one of them is a super-aging society. It is estimated that by 2050, the percentage of the population of Finland and Japan over the age of 65 will be 27% and 33%, respectively. The number of senior citizens who suffer from varying memory impairments is also going to be more than double during the next 30 years (Ferri et al 2006). The increase of senior population requires more caregivers inevitably. However, most of caregivers have already reported physical and mental problems (Schulz et al, 1990; Rabins et al, 1982). We need to consider the balancing between supporting generation and supported generation, and to avoid from making negative feedback loop by increasing heavy supported persons. On the other hand, most of the persons who have mild cognitive impairment persons just need small help to avoid from getting bad in memory. One of our goals is to realize the ambient assisted living environment that allows 5 to 10 caregivers support 10 to 30 senior citizens remotely via the Internet connection. In this paper, we propose a grid-pattern indicating interface because easy instruction system would be required to make burdens as less as possible for caregivers.

We focus on a kitchen workspace because cooking is an important part of daily life. Our method is to utilize a camera and a projector, and the combination makes visual information as guidance or instructions onto the physical surface as Molyneaux et al has proposed (2007). Ju et al (2001) and Bonanni et al (2004) had applied the projection technology to kitchen workspace for supporting cooking. On the other hand, the research about the remote collaboration has been often done as references (Kuzuoka, 1992; Sakata, 2003) shows. We also are challenging to make a remote collaboration in kitchen situation better, and especially pay attention to how easily the remote caregiver provides instructions to a senior citizen at the local site. In this paper, we propose grid-pattern interface for the remote caregivers to indicate points in the space at the local site as one of the solutions.
2. OUR METHOD

We propose the grid-pattern indicating interface for remote caregivers to assist local persons remotely. The whole system consists of two sites: a local site where assisted persons are and a remote site where caregivers are. Figure 1 (a) shows the overview of our conceptual system. Remote site has remote monitoring view and grid interface on the computer screen. At the local site, a camera, a range image sensor, and a projector are installed at a kitchen workspace. The camera captures a scene including objects and a surface in the workspace. In order to realize our system, we need to calibrate geometrical relations between each device as shown in Figure 1 (b). Using the result of the calibration, we can keep the correspondence between grid-pattern interface view and real workspace.

Figure 1. Our conceptual system and coordinate systems of the devices. (a) Remote caregiver can monitor local site remotely with grid-pattern indicating interface via the Internet. (b) Geometrical relations between each device need to be calibrated in advance.

2.1 System Calibration

There are three coordinate systems: a camera coordinate system, a range image sensor coordinate system, and a projector coordinate system as shown in Figure 1 (b). We can know the geometric relationship with the colour in the target scene by calculating each transformation matrix between each coordinate system in advance. Using a referential coordinate system, these transformation matrices based on the referential coordinate system can be obtained.

Firstly, transformation matrix between a range image coordinate system and a referential coordinate system is estimated. The range image sensor captures the scene including the referential object as the range data, then three plane surfaces on the referential object in the scene are detected. The three normal vectors corresponding to the three plane surfaces are used as a basis vectors, and the intersection of the three plane surfaces is used as the origin, in the referential object coordinate system.

Secondly, we can estimate transformation matrices corresponding to a color camera and a projector by applying Gray code pattern projection [Sato, 1985]. The basis vectors and the origin of the referential object that is represented in the camera or projector coordinate system are estimated based on measured geometry of the scene including the referential object.

As a last step in main calibration process, we need to compute transformation matrices between each device. For example, the transformation matrix $M_{rc}$ is computed by simply multiplying as $M_{rc} = M_{rR}M_{Rc}$, where $M_{rC} = M_{cR}^{-1}$.

Only the relative positions between the devices should be maintained in use. In other words, a simultaneous movement of the devices is allowed. It indicates that the system can be moved freely if the devices are fixed in a housing.
2.2 Target Surface Estimation and Object Locating

There are mainly two steps, which are estimation of a parameter of the target planar for fixing the grid-pattern area in the workspace and visualizing a position and a color of the target objects on the grid-pattern view for the remote caregivers.

First, we estimate a dominant plane that has a certain color from the range image. A color of each pixel in the range image is given from the converted camera image via $M_{cr}$, where $M_{cr} = M_{rc}^{-1}$. Second, the pixels extracted as the target planar surface are clustered according to a distance between the points each other. Lastly, the center of the gravity of each cluster the system detected is projected onto the two dimensional coordinate system of the target planar surface, and an average color and a position of each cluster are shown on the grid-pattern view.

2.3 Grid Pattern Indication

We assume the situation where a remote caregiver gives some instructions to a senior citizen at his/her home. When the caregiver gives instructions, communication about spatial information of where the senior citizen requires the caregiver to indicate location. In conventional way, the remote caregiver monitors the senior with video streaming and indicates a location by speaking or clicking on the monitoring view. A monitoring makes understanding spatial information easy. Nevertheless there is still a remaining problem that occlusion and depth perception causes mistakes of a remote caregiver.

A grid-pattern indicating view for a remote caregiver is one possible solution that can avoid from occlusion and depth perception problems.

3. IMPLEMENTATION

We implemented a prototype system as shown in Figure 2. The camera was Logitech C910, which captures a image as 640x480 pixels. The range image sensor was Microsoft Kinect for Windows, which obtains a range image as 320x240 pixels with API. The projector was Optoma EP1691i Digital Light Processing Projector, which shows an image 1280x768 pixels onto a physical surface. Additionally, we applied Point Cloud Library 1.5.1, OpenCV 2.4.0, and Microsoft Kinect for Windows 1.5 to our prototype system.

Figure 2. Our prototype system: (a) overview of the prototype system that mainly consists of a colour camera, a range image sensor, and a projector on the pole to project visual instructing information onto the kitchen workspace, (b) the scene of local site with projected lights, (c) the scene of remote site with grid-pattern indicating interface on a computer screen, (d)(e) the view of local site and the grid-pattern interface, respectively, that are shown on the computer to the caregivers at the remote site.
We demonstrated the implemented system with several test users briefly. In the result of the observation, most of users as a remote caregiver could indicate where he/she wanted to indicate in the space of the local site. However, we did not confirm how precise indicating we can do with the grid-pattern interface.

4. CONCLUSIONS

We have proposed grid-pattern indicating interface for remote caregivers in ambient assisted living. Our method was implemented by installing a colour camera, a range image sensor, and a projector on the local site. The grid interface could have correspondence to the real workspace of the local site with calibration between each device. Finally, we briefly confirmed how the implemented prototype worked while the test user indicated remotely.

Future works include: a user test to confirm the accuracy or easiness of our method, making the available workspace bigger, and improving object recognition for representing the real situation into the grid-pattern interface.

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5. REFERENCES


