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Abstract

The main idea of the ongoing research is to use robotics to create new opportunities for older people to stay alone in their apartments which can be achieved by using robots as an interacting tool between older people and their family members or doctors. This can be achieved by building a system (software) for Mobile Robots to work autonomously (self-driving) and semi-autonomously (controlled by user) when necessary, depending upon the situation and surroundings. This system is integrated with social cues, particularly proxemics, to know and understand human space, which is very important to socially interact. In conclusion, we are interested in having a Socially Intelligent robot, which could use the social cue, proxemics, to have a natural interaction with people in groups.

1. Introduction

The changes that are expected with an increasing elderly demographic bring both challenges and opportunities at the same time. One expected challenge is how to provide high quality of service and contact despite that many countries, such as Sweden, expect to have a reduction in workforce to sustain the growing elderly population. The other expected challenge would be as more and more elderly people go into the groups receiving social benefits the burden on the welfare system will be too much and unsustainable. Technology is often one solution that is proposed to mitigate this challenge. However, with the increase of advocacy of technology, there is also a concern that the technology per se may also increase isolation, the sense of loneliness, or stigmatization. As a consequence, new subsets of technologies are being proposed with the sole purpose of promoting interaction, whether this interaction be directly between two persons, or between an artificially
intelligent agent (social robot) and an elderly person. For example, recently, robots are used for many uses for the older people in the context of telepresence (MRP). Mobile Robotic Telepresence (MRP) systems allow users to teleoperate a robotic platform while interacting with other people in a remote location. Telepresence robots are specially designed for the older people who want to stay alone and they can have video call enabling a Skype-like interaction with the added advantage that the remote user can move around in a remote environment. Other examples include a growing use of social robots as personal assistants. These are robots, which display full autonomy and have important functions like reminding to take medications, raising alerts or providing a general social interaction by answering queries.

During this interaction, the robot either operated manually or automatically should respect the older people’s space, understand their behavior, dynamics and intention behind their actions. For this to happen, they need to understand human social signals, which include non-verbal behavioral cues such as facial expressions, body postures, gestures and proxemics. Proxemics particularly is very important in social interactions. Proxemics is defined as the study of human spatial and orientational behavior, while interacting with each other in co-present face-to-face social interactions. The concept was developed by E.T. Hall [1]. Robots need to understand, learn and execute this proxemics while interacting with humans. Proxemics is divided into four different zones: Intimate space, Personal space, Social space and Public space. Interaction between partners falls under Intimate space. Interaction between family members and close friends falls under Personal space. Social interaction, which includes interaction between colleagues, little known or unknown people are under Social space. The public speech and similar conversations where one person is speaking and others are far away listening can be considered in this Public space. We are mainly concerned with Social space as human-robot interactions falls under this zone. In social interactions, humans have a tendency to organize themselves spatially while interacting with each other. Regarding these spatial arrangements, one of the promising framework is Adam kendon’s Facing formations [2] famously know as F-formations. These F-formations are very helpful in increasing the quality of interaction and further could be used to have a collaborative work between humans and robots. For the social interaction between humans and robot, the robot should be enabled to automatically adhere to F-formations while joining the groups. For this, Firstly, the robot should detect the formations in which people are standing. Secondly, find a spot in the group and
navigate itself into the formation to socially interact with the people. During the process, the challenges faced could be categorized into two. One is people detection such as body occlusions, cluttered background and image quality. Body occlusions, while people are standing in formations one person may occlude other person. The background has many objects, which makes detection difficult. If we increase the image quality then the processing speed of the robot should be compromised either the image quality or the robot’s number of frames per second should be selected. Second, formation detection such as theoretical model to mathematical model, changing formations and multiple group formations. There is a psychological model for F-formations but there is no standard mathematical model. The robot should be in a position to cope up with the formations as they change and also with multiple formations.

Solving this problem is very useful for both social and telepresence robots. In our case, we are studying both the robots. The project is about developing methods to enable the robots to join the groups and understanding the effect on users.

2. F-formations:

Adam Kendon’s F-formations are originally defined as “F-formation arises whenever two or more people sustain a spatial and orientational relationship in which the space between them is one to which they have equal, direct and exclusive access” ((Kendon, 1990), pg.209).

An F-formation gives rise to three social spaces. O-space is the convex empty space where all the people standing in the formation surround this space and look towards it. P-space is the narrow strip on which people are standing while conversing and R-space is the space beyond P-space, which can be observed in Figure 1a.

![Figure 1: Kendon’s F-formations](image)
F-formations are spatial patterns formed during face-to-face interactions between two or more people. Kendon proposed different spatial arrangements depending on the number of people in social interactions and the type of interaction. There are four standard F-formations, which are formed generally without any physical constraints and independent of any particular situation. They are: Vis-a-Vis, Side-by-Side, L-shape and Circular. When two people are facing each other while interacting, then it is called Vis-a-Vis formation. Side-by-Side formation is when two people stand close to each other and face the same direction while conversing. The L-shaped formation is when two people face each other perpendicularly and are situated on the two edges of the letter ‘L’. When three or more people are conversing in a circle, then the arrangement is called Circular formation, which can be observed in Figure 1.

![F-formations](image)

(a) Triangle formation  (b) Rectangle formation  (c) Semi-circular formation

Figure 2: Constraint-based formations

There are some other formations, which are constraint based formations proposed by Marshall et al [3]. These formations are formed when the physical environment limits the interaction. These are three formations: when one person is facing two or more people while interacting, it is called Triangular formation. Rectangular formation is formed in board meeting rooms or at dinner tables. When three or more people are focusing on the same task while interacting with each other, then the arrangement is called Semi-circular formation. This formation is mainly seen in front of a wall while watching information or a piece of art, which can be observed in Figure 2.

3. Research Plan

The research plan is divided into 3 phases which are:

1. Phase I: Find the important of F-formations in robotics.
2. Phase II: Develop methods to detect F-formations with respect to robot.

3. Phase III: Develop an approach to navigate the robot into the formations

3.1. Phase I

In social interaction, people organize themselves in F-formations for better interaction as proposed by Kendon [2]. A better quality of interaction was observed between human and robot while socially interacting using these F-formations [4]. When telepresence robots were placed according to F-formations, the older people and the teleoperator had a nice quality of interaction [5](which can be see in Figure 3a) but we are not sure, would the teleoperator follow F-formations while teleoperating the robot and place the robot in the formations.

For this, we studied the behaviour of teleoperators of mobile telepresence systems. The purpose of the work was to determine to what extent teleoperators adhere to spatial and orientational relationships known as F-formations, while remotely interacting with groups. To prove this, we have drawn 3 expectations. The expectations are:

[E1]: People teleoperating a mobile robot will respect F-formations while joining a social interaction or group.

[E2]: Teleoperators will consume time to place themselves within a configuration that it takes to simply approach the group.

[E3]: An autonomous feature is necessary to navigate the robot to join the social interaction or group.

In order to validate our expectations, a simulated environment was created with simulated characters and conducted the experiment by inviting the participants. The simulation environment is a conference lobby where humans are having their break time after the sessions. From the Figure 3, we can observe the robot and the humans standing in different formations. The participants joined the groups through teleoperating a mobile robot. The evaluation was done using different tools, on one side a questionnaire was provided for participants to answer and on the other side a qualitative method was used to validate the formations made by the teleoperators. From
the results obtained, we conclude that people teleoperating the mobile robot do respect F-formations while joining the groups or social interactions.

From this experiment, we have also found that teleoperators consume more time to place the robot in the group and there is a need for an autonomous feature to navigate the robot to join the social interactions.

3.2. Phase II

From Phase I, we have found that there is a need for autonomous feature to join the groups. Developing an autonomous feature can be further divided into two phases, which are, Phase II, a method to detect F-formations and Phase III, an approach to navigate the robot into the groups or social interactions.

![Figure 3: (a) The older person is interacting in L-shape formation, while cycling (b) The robot observing the humans interacting and the inside image shows the view from robot’s camera (c) Humans standing in different formations in the simulation environment.](image)

Regarding developing a method to detect F-formations, many researchers have proposed different methods to solve this problem but all the strategies are developed from computer vision and machine learning communities and none of them are implemented on robots.

The problem should be approached from a functional point of view such that the developed algorithm should work on a mobile robot with an egocentric camera, in real time, low memory, less computational time and in
natural scenarios. Some researchers have worked in robotics but still do not satisfy the mentioned requirements. So, still there is an open question to detect F-formations in real time on a robot in natural settings [6].

For this, we did develop a preliminary approach to detect F-formations using Pepper robot. Further, we would propose a new method, which would take into account the present limitations and handle the uncertainties, which would also be a probability model. When a person is going to join or leave the group then the robot should be in a position to calculate the probability for the next formation, which is going to occur and also detect multiple formations in one scene.

3.3. Phase III

In this phase, we would develop an algorithm to estimate the best spot in the group and move the robot automatically into the group to socially interact with people in the group.

4. Conclusion

Our work presents robotic software, which could be used by the doctors, nurses and caretakers to visit the older people from time to time. The older people can use this technology to stay in touch with their family and friends on daily basis, which is also health and decreases the diseases. So, for an effective interaction, the robots need to be integrated with the presented software.

References


