Small Robots With Big Tasks

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A Proof of Concept Implementation Using a MiRo for Fall Alert

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ABSTRACT

A significant portion of the over 65 population experience a fall at least once a year in their home environment. This puts a faller under significant health risks and adds to the financial burden of the care services. This Late Breaking Report explores a proof of concept implementation of a fall alert system that uses MiRo (a small mobile social robot) in the home environment. We take advantage of MiRo's pet-like characteristics, small size, mobility, and array of sensors to implement a system where a person who has fallen can interact with it and summon help if needed. The initial aim of this proof of concept system described here was to act as a demonstration tool for health professionals and housing association representatives, gauging their needs and requirements, driving this research forward.

CCS CONCEPTS

• **Human-centered computing~Human computer interaction (HCI)** • **Human-centered computing~Interaction design**

KEYWORDS

HRI; Computer vision; autonomous navigation; fall detection

1 Introduction

It has been estimated that falls cost the NHS in the UK alone more than £2.3 billion a year causing distress, pain, injury and death to the people who experience the falls and affecting the family and carers of the people who fall [7]. More than a quarter of the population of community dwelling adults over the age of 65 are expected to fall at least once a year. The incidence rate doubles for people over 80 [7]. There has been a lot of research into fall detection, from devices that manually alert carers when a fall occurs [6], to device [1] and device-free [12] algorithms that automatically detect falls.

HRI '20 Companion, March 23–26, 2020, Cambridge, United Kingdom

ACM ISBN 978-1-4503-7057-8/20/03.
https://doi.org/10.1145/3371382.3378331

However, the main objective of this research is not to detect falls, but use a social robot for assessing and evaluating the situation immediately after a fall. One reason to monitor the post-fall situation is in the case of a "long-lie" (more than 60 minutes). Almost half of fallers are unable to get up without assistance even if they have not been injured during the fall [1]. This may lead to: hyperthermia, dehydration, pneumonia, and sores [1].

In some cases, people experiencing a "long-lie" did not activate an alarm, even though they had it with them, either because they forgot that they had an alarm [8], or they did not want to 'bother anyone' by calling for an ambulance thinking they could eventually get up by themselves [8].

Fallers also often restrict their activities due to the fear of falling. This is associated with functional decline. Therefore, falls affect people mentally as well as physically. However, it is reported that people who have fall alarms experience better peace of mind and increased sense of security [8]. One of the aims of this research will be to investigate if a robot that assess and monitors a post-fall situation could provide the same benefits, particularly if it is equipped with the functionality of alerting a carer in case of fall.

For this proof of concept study, a biomimetic social robot was chosen. Biomimetic is the process of using biological based ideas in technology [11] and it has been demonstrated that robots that display behaviours similar to animals are more engaging [2] and therefore have the potential of being more easily accepted by people. The use of anthropomorphic robots, such as Pepper (Fig.1 Right), was also considered.

However, due to its design and limitations in its interactions capabilities, a Pepper robot would have stood tall next to a person who has fallen, resembling a human looking down on them but not physically helping them get up, Therefore, we chose not to use an anthropomorphic social robot for this research. Conversely, we did chose the MiRo robot (Fig.1 Left) because of its small size and 'generic mammalian' form that resembles a cross of a number of domestic animals (rabbit, cat and dog). Its small size means MiRo will be at the fallers eye level after a fall, and will behave as a pet would; arriving to its 'master' to see if they are OK. This may also help to promote its acceptance in the home environment for the purpose of monitoring, as robots that look and behave in a way similar to living beings increases their acceptability [10].

Figure 1 Examples of robots.
Left: MiRo; Right: Pepper robot.

2 Implementation and proof of concept scenario

This paper gives an overview of our work, attempting to simulate a post-fall scenario in a controlled lab setting, focusing on the interaction with MiRo, starting from the moment a fall is detected. In this scenario, a researcher plays the role of a faller (person who has recently fall) and another researcher manually navigates the MiRo to them (see Figure 2).

Figure 2 MiRo in the home environment tending to a person who has fallen.

Once the faller is located, MiRo turns its head and angles its neck to get the best possible view of the faller through two cameras mounted behind its eyes. It the proceeds to ask them to acknowledge they are conscious. This acknowledgement interaction can happen in a variety of different modalities; the faller can either reply vocally to MiRo saying they are "OK", or they can touch MiRo's body – MiRo is equipped with capacitive sensors running its entire body length and top of its head.

After it interacts with the faller, the MiRo tries to ascertain if they are moving using computer vision algorithms implemented in OpenCV[1]. These algorithms take every frame generated by the MiRo's camera and compares it to the next frame. Differences between subsequent images are rendered in contours, and for each difference found, a rectangle is super imposed upon the contours. In order to only select big movements, like those generated by a person moving, only contours of a certain size are considered (See Figure 3). If they are moving, MiRo continues to monitor until they get up and logs it as a 'fall but successful recovery'. However, if they are not moving, or if they do not respond to MiRo's earlier request for interaction, a notification is send to the appropriate responder.

Figure 3 MiRo using computer vision algorithms to detect movement while a person is trying to get up. A green squeare is drawn around the area movement is detected.

3 Conclusion

The aim of this proof of concept implementation is twofold. Firstly, to investigate the use of a social robot as an agent for assessing and evaluating the situation immediately after a fall. Secondly, to gauge how health professionals and housing association representatives would respond to the idea of using small social robots for interacting with fallers in their home environment.

The use of small robots with big tasks is not novel by itself (e.g. in swarms for search and rescue [3] or to supplement a human therapist as companions [4]). However, to our knowledge, small socially assistive robots have not yet been used for helping people in distress in their home environment by being active social agents – asking the person if they are OK, and monitoring them until they are in a 'safer state' (i.e. back on their feet in this case).

Even though MiRo was initially chosen for this proof of concept because of its portability, small size, and friendly look, it also raised interesting discussions during demonstrations regarding privacy. Privacy implications of social robots, especially in the home environment, is not a new topic (e.g. [5] provides an in-depth review). However, it would be interesting to investigate further how being monitored through a robot that looks like a small pet fares against humanoid robots, or even against other conventional monitoring installations such as CCTV.

Initial informal demonstrations to health professionals and housing association representatives indicate that it has the potential of higher acceptance than CCTV cameras since you are 'fully aware when it is looking at you' - like a pet animal would – and being an 'animal' may appear less judgmental than a humanoid robot. The implications and link with previous work on topics such as embodiment (e.g. [10]) will also be investigated.

In a more technical level, as a future work, we also need to implement automatic navigation, allowing the MiRo to navigate a changing home environment to reach the faller. Using relatively low resolution sensors, such as the ones currently found on the MiRo[2] has been successfully used in the past for navigation and human detection purposes [9]. The next step is to then integrate our system with existing fall detection systems before trialing our new system in a real assistive living environment, first with simulated fallers before moving on to homes of people who are at risk of falling, giving this little robot a big task.

4 REFERENCES

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[1] https://opencv.org/

[2] At the time of writing, we were using the MiRo-b version of the robot. We understand the newer version (MiRo-E) has far superior sensors on board and we will consider switching to MiRo-E for later iteration of this research.