Smart Elderly Monitoring with Mobile Robots

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Introduction

The goal of this project is to build a smart system that provides consistent and timely support to elderly people. We target effective detection of elderly events, as well as their prevention, with the aim of facilitating independent living. Its relevancy relies on the latest elderly population growth, since it is increasing in more rapid levels in comparison to other age groups.

The challenges of this project consist on the effective delivery of healthcare services, since this group has complex care demands, while also providing comfort without intruding in the patient’s privacy. We propose a contactless solution for elderly monitoring by equipping a smart robot with a set of sensors via wireless signal. Sensor-based technologies should be useful to provide immediate assistance, but could also prevent possible elderly events.

Method

The present method was evaluated by the comparison of different projects involving the recreation of smart home systems, where a vast variety of sensors were applied differing in functionalities and combinations, according to the patient’s needs, as well as its main purpose, which in this case is being mostly directed to fall detection, one of the most recurrent events for the elderly.

The proposed algorithm for the fall detection and alerting process involves four different steps after the event has occurred:

1. A wireless signal will be sent to the smart car to let it know that something happened.
2. Then, the car will automatically send a notification message to the care provider for them to be aware of the situation.
3. After the message is received, the car will move to the location where the signal was obtained from.
4. Finally, the car will start live streaming the situation to the care provider, so they can complete the patient-care provider assistance communication.

The following elements were employed for the development of the prototype and its system:

- **PIR Sensor** (HC-SR501 Module): Used for detecting motion in environments. The sensor is sensitive to motion detection.
- **Vibration Sensor** (SR410 Module): Measures the amount and frequency of vibration in a given environment.
- **ESP8266 WiFi Module**: A single-board computer with integrated TCP/IP protocol stack that can be connected to a Wi-Fi network.
- **Raspberry Pi**: Used for processing data and controlling other devices.
- **Controller App**: Used for sending messages to the care provider.

Results

We ran several tests to determine the accuracy and reliability of our final product.

The PIR sensor was compared to recordings from an Apple Watch (2nd generation), showing very similar values as a quick response. The PIR sensor responded with great accuracy, however, it functioned on a very limited range. Because of this, a large number of sensors would be needed to reliably detect movement in a room.

The vibration sensor was the only one that varied its accuracy depending on its location. Showing a better response when placed over a wooden floor.

The human detection worked correctly even with different postures and objects obstructing the view. However, with an average of 1.3 fps, the tracking of the car is somewhat slow and may lose the target with any quick movement, leaving plenty of room for improvement.

Conclusions and Future Work

The use of mostly ambient-based sensor elderly monitoring technology at home to prolong their independent living in a safe and reliable way. This demands the process of real-time monitoring of the resident’s environment and daily activities using an event-driven system. This works considering that the combination of various ambient sensors with different purposes each makes an efficient monitoring system, implementing a less invasive and tedious method.

The key takeaways were in relation to the importance of considering durability, acceptability, communication, and power requirements of the sensors, as well as them being versatile and adaptable. Also, the key role of that a user acceptance degree plays in the success of the project. In the future, we plan the optimization of the built monitoring system, according to the obtained results, by broadening the system’s environmental setting, as well as the experimental testing.

References


