

A Sensorized Companion Robot for Elderly Care and Home Control

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ABSTRACT: To reduce the cost of health care and improve the quality of life of elderly people, more and more robots are being designed to interact with a human being to provide the kind of care that traditionally can be offered by a health care professional. The approach is to design a sensorized “autonomous robot” to monitor the elderly person. Also this design includes an integrated circuit to control the home devices, the sensorized robot for health, safety and security to the home. The main robotic system is designed using Raspberry pi, which is a low cost credit card sized single-board computer. The goal is to setup a low cost home companion robot to provide some care to the elderly person by monitoring the health through a band provided to that person. Ultimately, the home companion Robot would be able to navigate autonomously in typical home environments to perform tasks such as health monitoring of the elderly person, home devices control, sensors for safety and security, in case of emergency has wide cloud access using IoT (Internet Of Things). Medicine reminder etc...

KEYWORDS: Autonomous robot, Cloud access, Companion robots, IoT (Internet of Things), Raspberry pi.

I. INTRODUCTION

Because of the graying of our today’s population, there is a growing necessity for new technologies that can assist the elderly in their daily living. The main arguments for this is that the shortage of staff for health care, also people prefer more and more to live in their own homes instead of being institutionalized. To address these issues, we not only need sufficient health care personnel but also the presence and appliance of high-tech devices. Robotics is developing quickly nowadays to play an important role in assisting the elderly. An autonomous user companion robot might be viewed as a special kind of service robot that is specifically designed for personal use at home. Robots designed for the home are a growing industry from both a research and commercial perspective. Companion robots in the home should ideally be able to perform many tasks such as home surveillance, control home devices, diary duties, entertainment etc...

To reduce the cost of health care and improve the quality of life of elderly people, more and more robots are being designed to interact with a human being to provide the kind of care that traditionally can be offered by a health care professional. The approach is to design a sensorized “autonomous robot” to monitor the elderly person. Also this design includes an integrated circuit to control the home devices, the sensorized robot for health, safety and security to the home. The main robotic system is designed using Raspberry pi, which is a low cost credit card sized single-board computer. The goal is to setup a low cost home companion robot to provide some care to the elderly person by monitoring the health through a band provided to that person. Ultimately, the home companion Robot would be able to navigate autonomously in typical home environments to perform tasks such as health monitoring of the elderly person, home devices control, sensors for safety and security, in case of emergency has wide cloud access using IoT (Internet of Things).

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The work in this paper is divided in two stages. 1) A companion robot 2) Health monitoring band. A companion robot makes itself 'useful' i.e. it is able to assist humans in a domestic home environment. The elderly person is always monitored by the companion robot. The sensorized autonomous robot provides safety and security to the domestic environment, through the sensors included in the design. This includes sensing the intruders at the home, senses gas leakage and detects fire. The main architecture of the companion robot is built using Raspberry Pi. The companion robot is able to monitor the health (heartbeat, temperature etc...) of the elderly person, home surveillance, any intruders can be sensed, gas leakage and fire can be detected and provide necessary actions related to the situations. The companion robot can handle emergency situations such as calling an ambulance, informing police or fire station or contacting any relative (of the elderly person) etc... through wide cloud access using IoT.

Also the person from wide access can instruct the robot, and can know the current status of the elderly person as well as the home. The companion robot also speaks text strings and reminds the elderly person to take medicines, do exercise etc...

The health of the elderly person is monitored using a band provided to the user, in which the heartbeat, temperature etc. can be monitored by the companion robot continuously. Also the band consists of an emergency switch to alert the robot in case of emergency.

Paper is organized as follows. Section II shows the literature survey. Section III describes the main architecture and their component description. The implementation details are given in Section IV. Section V presents experimental results. Finally, Section VI presents conclusion.

II. LITERATURE SURVEY

In the studies included in this review, a variety of effects, or one could say functions, of assistive social robots have been studied. These functions include: increased health by decreased level of stress, more positive mood, decreased loneliness, increased communication activity with others, and thinking and remembering the past. Most studies report positive effects, and the effects are diverse. With regards to mood, companion robots are reported to increase positive mood, typically measured using evaluation of facial expressions of elderly people as well as questionnaires. Further, elderly people are reported to become less lonely with the intervention of companion robots as measured with loneliness measurement scales. With regards to health status, companion robots are reported to alleviate stress and increase immune system response. Some studies report a decrease on existing dementia measurement scales. One study explicitly reports that a companion robot elicited memories about the past. Many studies report positive findings with regards to social ties between elderly in homes as well as between elderly and family. Typically, the companion is the topic of conversation.

Studies on social robots in eldercare feature different robot types. First, there are robots that are used as assistive devices which we will refer to as service type robots. Functionalities are related to the support of independent living by supporting basic activities (eating, bathing, toileting and getting dressed) and mobility (including navigation), providing household maintenance, monitoring of those who need continuous attention and maintaining safety. Examples of these robots are 'nursebot' Pearl, the Dutch iCat (although not especially developed for eldercare) and the German Care-o-bot. Also categorized as such could be the Italian Robocare project, in which a robot is developed as part of an intelligent assistive environment for elderly people. The social functions of such service type robots exist primarily to facilitate interfacing with the robot. Studies typically investigate what different social functions can bring to the acceptance of the device in the living environment of the elder, as well as how social functions can facilitate actual usage of the device. Second, there are studies that focus on the pet-like companionship a robot might provide. The main function of these robots is to enhance health and psychological well-being of elderly users by providing companionship. We will refer to these robots as companion type robots. Examples are the Japanese seal shaped robot Paro, the Huggable (both especially developed for experiments in eldercare) and Aibo (a robot dog by Sony, see below). Social functions implemented in companion robots are primarily aimed at increasing health and psychological well-being. For example, studies investigate whether companion robots can increase positive mood in elderly living in nursery homes. However, not all robots can be categorized strictly in either one of these two groups. For example,

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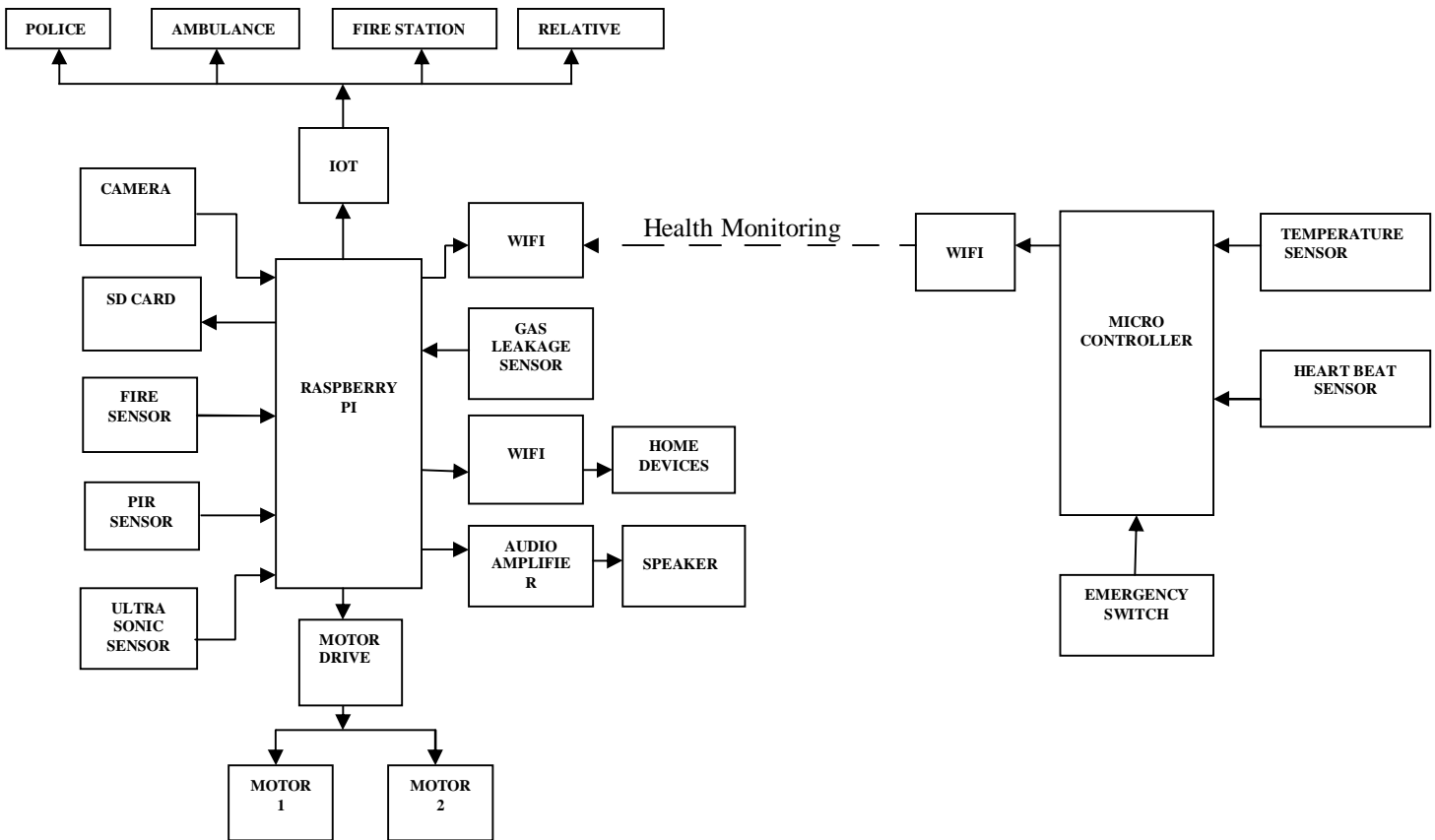
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Aibo is usually applied as a companion type robot, but can also be programmed to perform assistive activities and both Pearl and iCat can provide companionship.

This review aims to provide a first overall overview of studies that investigate the effects of assistive social robots on the health and wellbeing of elderly. Since the majority of the assistive social robot studies with actual elderly people as subjects involve the robots Aibo, Paro, iCat and ‘nursebot’ Pearl.

In this paper we discuss about a sensorized companion robot for health and home care, which is relevant in many different environments such as elderly care, their health monitoring, safety, security, emergency situation handling and controlling house hold devices. The main architecture of the companion robot is build using raspberry pi. The companion robot is able to monitor the health (heartbeat, temperature etc...) of the elderly person, home surveillance, any intruders can be sensed, gas leakage and fire can be detected, and provide necessary actions related to the situations. The companion robot can handle emergency situations such as calling an ambulance, informing police, or fire station or contacting any relative (of the elderly person) etc...through wide cloud access using IoT.

III. ARCHITECTURE DESIGN



System Design of Companion Robot

Health band

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The main architecture consists of the following sections

- a) A companion robot
 - Raspberry pi: The Raspberry PI is a low cost credit card sized single-board computer developed by raspberry pi foundation. The core of the companion robot is this minicomputer. Here we use model B plus. The setting of raspbi consists of selecting raspbian OS from prebuilt SD card. The prebuilt SD card consists of raspbian, arclinux, pidora, open ELEC, risc OS operating system. After the OS selection we need to configure raspberry-pi using Raspi-config command.
 - Sensors:
 - The Passive Infra-Red (PIR) Sensor has been used to detect humans. The PIR sensor is a pyro electric device that detects motion by measuring changes in the infrared levels emitted by surrounding objects. This motion can be detected by the companion robot by checking for a high signal on a single I/O pin.
 - The Flame sensor is detects a flame or light source of a wavelength in a range of 760nm-1100nm, detection angle about 60 degrees, it is sensitive to the flame spectrum.
 - Ultrasonic sensor is used in the system to avoid obstacles during surveillance. HC-SR04 is a commonly used module for non-contact distance measurement for distances from 2cm to 400 cm.
 - Gas leakage sensor is used to sense LPG at home and thereby avoiding accident at home. The MQ-6 can detect gas concentrations anywhere from 200 to 10000ppm.
 - Camera: A high definition camera module compatible with the Raspberry Pi is used. It provides high sensitivity, low crosstalk and low noise image capture in an ultra-small and lightweight design. The camera module connects to the Raspberry Pi board via the CSI connector designed specifically for interfacing to cameras. The robot can capture images whenever necessary.
 - SD Card: These uses the serial data card which is the SPI line from Raspberry module. That is a bus interconnects wire. In these uses the SPI protocol also the technique used are multiple input single output (MISO) and multiple output single input (MOSI).
 - Wi-Fi: HLK-RM04 is a new low-cost embedded UART-ETH-WIFI module (serial port - Ethernet - Wireless network) developed by Shenzhen Hi-Link Electronic co., Ltd. This product is an embedded module based on the universal serial interface network standard, built-in TCP / IP protocol stack, enabling the user serial port, Ethernet, wireless network (Wi-Fi) interface. Through the HLK-RM04 module, the traditional serial devices do not need to change any configuration; data can be transmitted through the Internet network. Provide a quick solution for the user's serial devices to transfer data via Ethernet.
 - Cloud server: It makes the system connectivity through World Wide Web. IoT makes the path efficiently. The process of information passing to the hospital, police and ambulance makes faster and accurately. It has many branches in the wide range.
 - DC motors: A DC motor is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore so is its current. The current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque. The motor drive used here is the L293D which is a quadruple high-current half-H driver.
- b) Health band
 - Micro controller: The main unit in the health monitoring band is PIC 16F877A. it has high performance RISC CPU, Operating speed: DC – 20 MHz clock input , DC – 200 ns instruction cycle • Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
 - Temperature sensor: LM35 is the temperature sensor exhibit -15 to150 degree Celsius temperatures. It can be read the value in voltage. It gets 1 degree Celsius as 10mv output voltage. The LM35 series are

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precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.

- Heart beat sensor: Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse.
- Emergency switch: It is a common model switch as for the ON condition when VCC given and in OFF condition when ground is given. It just wants to initialize the microcontroller unit. When the elderly person has an emergency condition he/she press the switch to inform the robot.

IV. IMPLEMENTATION DETAILS

The implementation of this work starts with selecting the operating system that we prefer. In this project we have selected raspbian operating system. Now, we have boot the operating system that we have selected with the necessary configurations. The various configurations which can be done are such as enabling camera, interfacing sensor, etc... the configuration settings are done according to the users need.

After the configuration settings are done, the python program is to be typed in the leaf pad. Leaf pad is created by file manager-> click ok. Next the program is saved and executed by means of the LX terminal. LX terminal is used to view the status of the various interfaces and results of all the inputs given to Raspberry pi.

All the devices are interfaced using python language with Raspberry pi the GPIO pins. Python is a widely used high-level, general-purpose, interpreted, dynamic programming language. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than possible in languages such as C++ or Java. The language provides constructs intended to enable writing clear programs on both a small and large scale.

Python supports multiple programming paradigms, including object-oriented, imperative and functional programming or procedural styles. It features a dynamic type system and automatic memory management and has a large and comprehensive standard library.

After all the devices are interfaced, the companion robot is able to control any of the home devices and provides surveillance, security and safety to the elderly person as well as the home. Also the pulse and temperature of the elderly person is measured using a health monitoring band provided for the elderly person. This unit is set up using PIC microcontroller and it can be run by using c programming. The robot monitors the health of the elderly person frequently.

And a setup is implemented using IoT such that in any case of emergency is detected by the robot; simultaneously it can inform police, ambulance or the relative. The relative can respond to the happenings from wide access through IoT. The IoT sensing means gathering data from related objects within the network and sending it back to a data warehouse, database, or cloud. The collected data is analysed to take specific actions based on required services.

V. EXPERIMENTAL RESULTS

The project is to be implemented using Raspberry Pi, which is used as a single board computer. The operating system used here is Raspbian OS. We discussed the sensorized companion robot for security and safety of elderly person and home using Raspbian platform.

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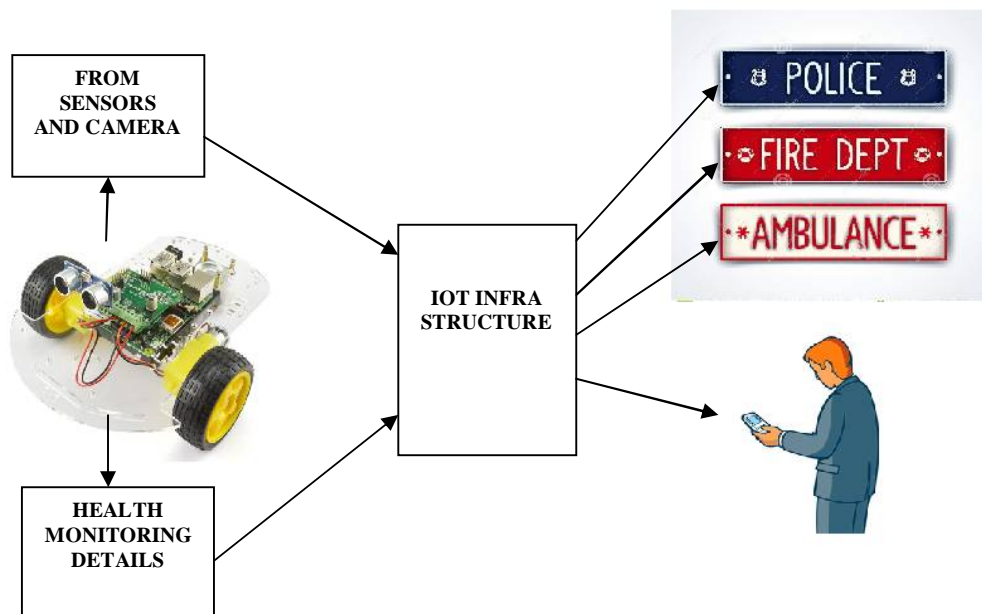
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The python programming is used for coding which is simple, user friendly and structured line by line execution. The difference from other programming languages is that error anywhere in the program affects only that part and it does not affect the other results; else in other any error affects the complete program.

Also the health of the elderly person is monitored by the companion robot. Thus we discussed A Sensorized Companion Robot for Elderly Care and Home Control using Raspberry Pi and have a wide access using IoT.



Implementation of sensorized companion robot

V. CONCLUSION AND FUTURE APPLICATIONS

We have described a robot system designed to be used by persons operating in assistive environments in homes, typically carers, relatives or the elderly person themselves.

In these studies the robot was operating primarily as a cognitive prosthetic. However a question that could be asked is “why use a robot?” and not simply another device such as a mobile phone? We would argue that the use of a robot differs in a number of ways to that of a mobile phone. First, the robots will find the person to inform them (a mobile phone may be somewhere else and ignored). Second, there is some evidence that the robot, by having a physical presence, is perceived as more authoritative, i.e., a person is more likely to follow a robot’s instructions or suggestions rather than, say, a phone.

This area of research also presents some ongoing design challenges, however a sensorized autonomous robot is implemented.

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In future, this companion robot can be further modified such that it can control more home appliances; more sensors can be included. In case of health monitoring more health parameters such as EEG, ECG etc...can be measured other than heartbeat and temperature. Also the exploitation of IoT technology can further be extended. By completely exploiting the scope of Artificial intelligence, the robotic activities can be upgraded such behavioural encoding, personalization etc...

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