CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

33809

Project Title

ZigBee-based Indoor Positioning System with Intelligent Assistive Technology for Alzheimer's Patients

Abstract

Objectives/Goals

Alzheimer's Disease (AD) is a neurodegenerative disorder that causes problems with memory and spatial orientation. Today, over 15% of the 5.4M Americans with AD live alone. I want to improve their lives by building an affordable indoor positioning system (IPS) that serves two functions: (1) guide them to their destinations indoors and (2) allow caregivers to locate them and to monitor vital factors remotely.

Methods/Materials

Materials used were 5 ZigBee digital radios, 4 Arduino microcontrollers, an audio wave shield, an infrared motion sensor (IR), LEDs, a switch, and a 9V battery. I built a small remote control for the patient with a ZigBee, a battery, and a switch. I installed ZigBee-Arduino pairs at the same height from the floor in the four extreme corners on the first floor of my home. The bathroom is in one of the corners, where I added the wave shield, IR, and LEDs to the master Arduino. I wrote and loaded a program into this bathroom setup. To test the spatial-orientation procedure, I pressed the button on the remote control. Then the LEDs in the bathroom went on and the wave shield played "Bathroom is here" repeatedly until the IR detected my motion. I tested the procedure starting in four positions, 30 times each. For the second function, I wrote a program with a 2D mathematical trilateration algorithm. Then, from an accurate map of the floor, I modeled the distances between the remote and each one of the corner ZigBees for five different scenarios (e.g. living-room). These data were put through my trilateration algorithm.

Results

The bathroom setup worked 100% of the time in all positions after I improved the spatial-orientation algorithm so that it matched the flow chart more accurately. The computer simulation on the trilateration algorithm worked to within 6% of the actual position in the five scenarios.

Conclusions/Discussion

GPS only works outdoors. My IPS is low cost, simple to install, and has low battery consumption and radio power. It is also integrated with intelligent assistive technology and can be expanded to include more functions. In the future, I will implement the trilateration using RSSI from the ZigBees and connect the main Arduino to the Internet so that caregivers can see the patient's indoor position by logging onto a secure web site.

Summary Statement

I created an affordable indoor positioning system with intelligent assistive spatial-orientation technology to help Alzheimer's patients and their caregivers.

Help Received

My math teacher and advisor, Dr. Carol Evans, helped me understand the math for trilateration. Dad helped me resolve engineering and programming problems. Mom helped me with edits.

Preliminary