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A Low-Power Elder Tracking and Fall Detector using RFID and Accelerometer

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ABSTRACT

Automatic fall detection is a major issue in taking care of the health of elderly people and has the potential of increasing autonomy and independence while minimizing the risks of living alone. It has been an active research area due to the large demand of the healthcare association for fall detection goods. Owing to the recent rapid advancement in sensing and wireless communication technologies, fall detection systems have become possible. They allow detecting fall events for the elderly, monitoring them, and consequently providing necessary help whenever needed. This project proposing the ongoing work of detecting falls in independent living area using RFID and 3-axis accelerometers concealed under the cement wall. With thresholds, accidental falls can be detected in the tracking healthcare section positions. The readings from pulse rate sensor, temperature sensor and accelerometer sensor is compared by Arduino UNO. If any of the sensor reading cross the set value then fall is detected. Now a day there are many technical solutions to care of the elderly person are implemented The RFID permit detecting elders' location tracking and accelerometer recognizing human activities (walking, standing, sitting, falling, and the transitions between them). The proposed system is ready to be implemented on an elderly person.

1. INTRODUCTION

Nowadays, aging population shows a drastic increasing during the past decade; it's one of the greatest social and economic challenges of the 21st century. Advances in medicine and public health services have improved the overall longevity of people, and it is expected that over the next 50 years, the proportion of people aged more than 60 years is expected to be doubled from 10% to 22%. Those people prefer growing old at home and saving their independent lifestyles that often come with high risks. According to the statistics of Centers for Disease Control and Prevention (CDC), one out of three adults age 65 and older falls each year in the United States, and 61% of these falls occur at homes that cause 10,000 deaths. Yet obtaining a quick assistance after a fall reduces the risk of hospitalization by 26% and the death by 80%.

Accordingly, many supportive technologies and systems have been developed to track and monitor activities of elderly persons at home in order to assist their independent living and reduce the cost of premature institutionalization. But generally, all of these systems are relying on only one data provider (movement-sensor, camera, or accelerometer, etc.) that have their own limitations and do not ensure 100% reliability. Moreover, there still is a lack in experience and systematic knowledge to intelligently assemble the components into a robust, friendly-user and effective system, making no false alarm and detecting each fall case, without affecting elderly daily living patterns.

Falls are a major threat to the health of older people. It is estimated that approximately one in three people over 65 years of age fall at least once every year, and these falls account for 90% of hip and wrist fractures and 60% of head injuries. In addition to physical injuries, many older people develop a fear of falling, which significantly reduces confidence to live independently and to actively participate in social activities, ultimately reducing the quality of their lives and contributing to an increase in frailty due to reduced activity levels.

The whole project report is grouped into 5 sections. Section II talks about the literature survey and discusses about the current problems that exist in making way to an ambulance and other vehicles. Section III talks of how the proposed model will overcome the problems faced in developing Countries as well as developed countries. Section IV gives the implementation details of the proposed model. Remaining presents the enhancement and conclusion of this work.

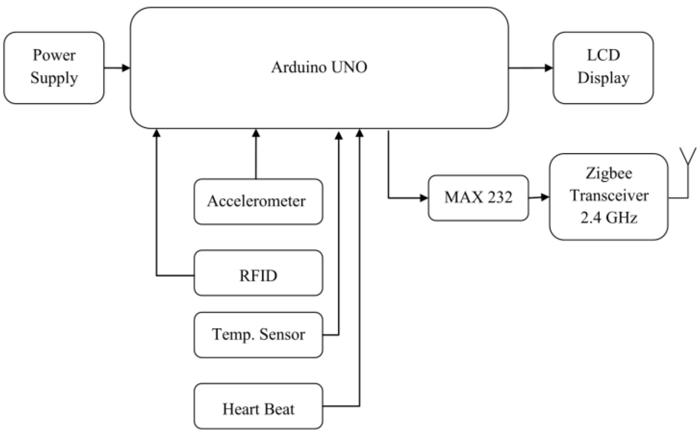
2. LITERATURE SURVEY

Lorenzo Chiari, Jorunn L Helbostad, Falls among older people remain a major public health challenge. Body-worn sensors are needed to improve the understanding of the underlying mechanisms and kinematics of falls. The aim of this systematic review is to assemble, extract and critically discuss the information available in published studies, as well as the characteristics of these investigations. Results: The main findings were the lack of agreement between the methodology and documentation protocols (study, fall reporting and technical characteristics) used in the studies, as well as a substantial lack of real-world fall recordings. A methodological pitfall identified in most articles was the lack of an established fall definition. The types of sensors and their technical specifications varied considerably between studies. Wiebren Zijlstra, and Jochen Klenk, despite extensive preventive efforts, falls continue to be a major source of morbidity and mortality among elderly. Real-time detection of falls and their urgent communication to a telecare center may enable rapid medical assistance, thus increasing the sense of security of the elderly and reducing some of the negative consequences of falls. Many different approaches have been explored to automatically detect a fall using inertial sensors. Although previously published algorithms report high sensitivity (SE) and high specificity (SP), they have usually been tested on simulated falls performed by healthy volunteers. The aim of the present study is to benchmark the performance of thirteen published fall-detection algorithms when they are applied to the database of 29 real-world falls. Jo-Ann Eastwood, Suneil Nyamathi Remote health monitoring (RHM) has emerged as a solution to help reduce the cost burden of unhealthy lifestyles and aging populations. Enhancing compliance to prescribed medical regimens is an essential challenge to many systems, even those using smartphone technology. In this paper,we provide a technique to improve smartphone battery consumption and examine the effects of smartphone battery lifetime on compliance, in an attempt to enhance users' adherence to remote monitoring systems. Dean M. Karantonis, R. Narayanan The real-time monitoring of human movement can provide valuable information regarding an individual's degree of functional ability and general level of activity. This paper presents the implementation of a real-time classification system for the types of human movement associated with the data acquired from a single, waist-mounted triaxial accelerometer unit. The major advance proposed by the system is to perform the vast majority of signal processing onboard the wearable unit using embedded intelligence. In this way, the system distinguishes between periods of activity and rest, recognizes the postural orientation of the wearer, detects events such as walking and falls, and provides an estimation of metabolic energy expenditure.

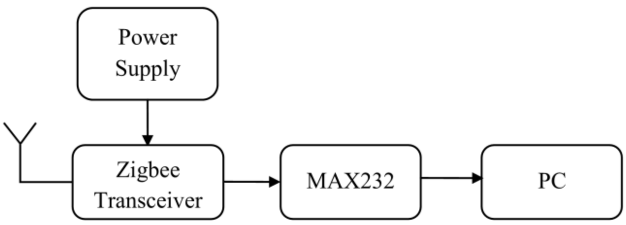
Fall detection, including vision-based, acoustic-based, passive infrared sensor-based, and inertial sensor-based methods. Provided information for reasoning about the observed space were later on integrated into smart environments, aimed at delivering assistance services like continuous diagnosis of users' health. These smart environments also integrated assistive robotic technologies with sensing networks. A method to assess foot placement during walking using an ambulatory measurement system consisting of orthopedic sandals equipped with force/moment sensors and inertial sensors An inductive sensor for real time measurement of plantar normal and shear forces distribution on diabetes patient's foot that can provide useful information for physicians and diabetes patients to take actions in preventing foot ulceration

3. PROPOSED SYSTEM

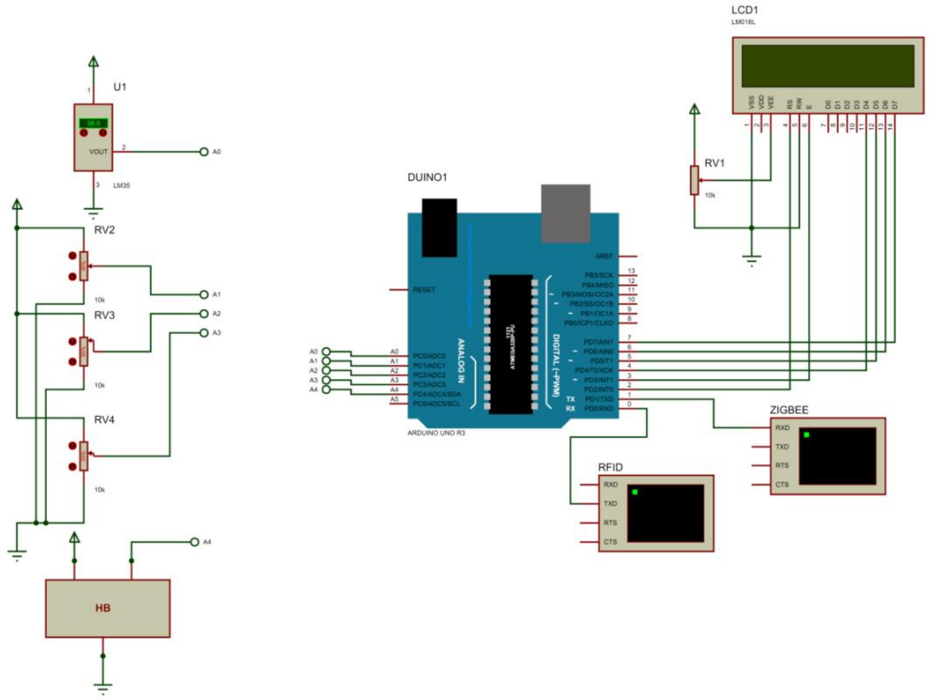
The Low power assist device is a part of an indoor fall detection monitoring system and assist device designed for elderly people living alone. The implemented network characterized by patients indoor location, fall alert, temperature and heart rate measurement capability through the usage of patients and remote monitoring. For each sensor the sampling rate associated with analog channel is programmed in order to assure good accuracy of health parameter calculation, also the guidelines of health monitoring index which defines the minimum number of samples needed to an efficient calculation. The remote service center receives the message; a medical monitoring group can contact the user, and then decide whether to send assistance. The remote monitoring center to send technicians to replace the battery when it runs low and the user can know the battery status of the LP assist device. In this project, it includes device and hardware part comprise of Zigbee module, LCD (16*2), Arduino UNO and different type of required sensor. Software is used to interface the elements with each other. The main motive of the project is to provide a protective ride and also to decrease the death rate.



Transmitter Block Diagram



Receiver Block Diagram



BLOCK DIAGRAM DESCRIPTION

In the block diagram there are different modules such as sensor section, controller section, power supply, Zigbee Transceiver, LCD display etc.

Power supply: block is used to provide power to the Arduino UNO (controller). The 230 volt AC supply is converted to 5 volt DC supply suitable for the controller.

Accelerometer: The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ). Heart Beat: A sensor is a device equipped with an IR-sensitive element that measures the heart beat of a body or a liquid against a diaphragm made of stainless steel, silicon, etc., and converts the measured value into an electrical signal as an output.

ZigBee: It operates in the unlicensed radio frequency (RF) bands – 868, 915 and 2400 MHz These three bands provide a total of 27 channels with RF data rates of 20, 40 and 250kbps, respectively. ZigBee protocols are use in embedded applications requiring low data rates and low power consumption. ZIGBEE'S purpose is to define a general-purpose, inexpensive, self-organizing mesh network that can be used for industrial control, embedded sensing, medical data collection, smoke and intruder warning, building automation, home automation, etc.

MAX232: The MAX232 is a hardware layer protocol converter IC manufactured by the Maxim Corporation. Commonly known as a RS-232 Transceiver, it consists of a pair of drivers and a pair of receivers. At a very basic level, the driver converts TTL and CMOS voltage levels to TIA/EIA-232-E levels, which are compatible for serial port communications. The receiver performs the reverse conversion.

4. IMPLEMENTATION DETAILS

The proposed fall detection is a part of an indoor and outdoor fall monitoring system designed for elderly people living alone. The system consists of two stations: the proposed fall detection transmitter and a remote station. The remote base station is a PC installed in the user's house. It can wirelessly receive a signal from the proposed fall detection and relay the signal to the remote center via the wireless communications network. Additionally, the base station can flash a light and beep to remind the user to cancel a false alarm. When the remote service center receives the alarm, a medical monitoring group can contact the user, and then decide whether to send assistance.

Moreover, the proposed fall detection can also alert the remote monitoring center to send technicians to replace the battery when it runs low, and the user can know the battery status of the proposed fall detection by using a flashing colored LED on the device.

Common body locations to wear a fall detector are the waist, wrist, or neck (on a lanyard). Waist-worn fall detectors have achieved the highest accuracy among the three locations, but it is the least comfortable location for prolonged use, and this location is not convenient when sleeping or changing clothes. Even though a wrist-worn version is more comfortable and aesthetically pleasing, its sensitivity and specificity are poor because large accelerations at the wrist during normal activities involving the arm are easily confused with the free fall or impact of a fall. Furthermore, more frequent triggering of the fall detection program for a wrist-worn device will reduce the battery life.

4.1. PROPOSED HARDWARE

The hardware of the proposed system includes a Arduino UNO microcontroller (Atmega 328), a digital accelerometer (ADXL335), a RFID Module (125KHz RFID Module), a Zigbee transceiver (CC2500), a MAX232, a voltage regulator (Power Supply-7805), a pushbutton, several LEDs and a 5 V, 1 Ah power supply. The figure shows a prototype of the proposed fall detection.

A number of hardware design approaches were used to reduce the overall power consumption of the proposed fall detection. Firstly, we applied voltage scaling (under volting). This is a hardware based power-saving technique specifically targeted at the microcontroller, whose supply current varies linearly with input voltage. Therefore, reducing the input voltage will reduce power consumption.

Secondly, we selected a microcontroller with an ultra-low power mode feature. The selected microcontroller utilizes EEPROM, and as a result its memory access speeds are 100 times faster than microcontrollers using flash memory. In this way, memory access is completed quickly allowing a longer time in ultralow-power mode, therefore reducing the active duty cycle and increasing energy efficiency.

Thirdly, the selected accelerometer and pressure sensor are both analog sensors with the ability to generate interrupts to wake other devices, and have an internal first-in-first-out buffer (FIFO) for local storage of sampled data. In addition, appropriate use of the each sensor's FIFO and interrupt enables system-level power savings by enabling the microcontroller to sleep for extended periods of time while the sensors automatically collect data and internally compare them with preconfigured programmable thresholds. The microcontroller will only be woken up if the collected data exceeds a threshold or a sensor's FIFO is close to full. By contrast, if sensors without interrupts or FIFO are used, the microcontroller will need to retrieve all samples and process them, causing a long active period with high power consumption.

Fourthly, almost all major electronics (the microcontroller, the barometer, the accelerometer, the RTC, and the RF transceiver) have several working modes, each with a different level of power consumption, and the microcontroller can manage system-level power consumption by configuring working modes of the above components. For example, the RF transceiver, which has a very high peak current, is usually powered off, and is only triggered to transmit an alarm to the base station when the device detects a suspected fall.

4.2. FALL DETECTION PROGRAM

When a suspected fall happens, the proposed fall detection will execute the fall detection program, which is based on a threshold value, to distinguish between fall and non-fall activities. If the current event is classified as a fall, a signal will be sent out. After this fall detection program execution, the proposed fall detection will return to sleep until it is woken up by the next suspected fall event, and then it will execute the fall detection program again. In the fall detection program, each node of the tree is a binary screener based on the comparison between a feature and a predefined threshold (thr1, thr2, thr3 and thr4), or a flag from a hardware interrupt.

5. CONCLUSION

In this project, a low-power fall detector proposed fall detection and reduces its power consumption using both hardware- and firmware-based approaches. In the development of the firmware, human trials of simulated falls and real ADXLs were conducted by prototype, and the collected data sets were split into two parts for training and testing the fall classifier, respectively. Considering the pressure is the main power-consuming component in the proposed fall detection, future work will involve investigating methods of collecting and processing pressure data in a more energy-efficient manner. Moreover, coding efficiencies will be improved by replacing floating-point calculations with fix-point calculations. As mentioned in the discussion, the proposed fall detection has been developed and evaluated on data sets acquired from young volunteers rather than from an older cohort.

The flowchart of the fusion between the RFID sensors and the accelerometers that finally permitted the ability to locate and track the elders, recognize their activities, and detect fall cases. To end up, our challenge is to offer a usable system with maximum privacy within a reliable, efficient and affordable framework.

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