

LIGHT REFLECTIVE SYSTEM TO MONITOR MOVEMENT IN ROOM

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ABSTRACT

Systems to monitor the activity and patterns of behavior of people in a room would enable detection of certain behaviors for which an alert for help should be issued, such as a prolonged condition of having fallen down. Many different types of sensing systems could be used to monitor activity, but each has limitations. This project is developing a system using orthogonal photo emitting and detecting sensors to locate opaque objects, such as a human in a room. A scaled down model of a room is being developed and tested. The location of opaque objects can be detected and indicated on a grid of LEDs. Though the preliminary results appear promising, further development and testing is required to access usability of the system to monitor movement in a room for detection of conditions, such as episodes of falling.

Keywords

retro reflective, photo switch, LED matrix, microcontroller, old age, balance, falling, alert

1. INTRODUCTION

Monitoring human motion within a room has many beneficial applications, including detection of certain behaviors, such as falling that may need medical attention. The risk of falling increases with old age due to declining balance, sensory input, and response time, as well as increased risk for medical conditions related to stroke, cardiovascular or respiratory diseases. The risk of injury as a result of a fall also increases with old age, partially related to increased frailty of bones. Older people often live alone and may need medical attention after a fall, but be unable to make the call for help by themselves. A longer delay following injury before help arrives worsens prognosis for recovery.

Commercially available methods to call for help after a fall include the Life Alert device, but the device will not help if the person cannot reach or utilize the device after the fall. Camera systems could be used, but would be complex, expensive, and may be considered intrusive. A room monitoring system would be beneficial to monitor and detect changes in behavior, such as falling that would indicate need for medical attention.

This project is developing a system to monitor body position and movement in a room using a series of orthogonal reflective light sensors. The system can monitor movement and location of opaque objects in a room such as the human body. Such a system would be useful for detecting abnormal behavior, such as falls, especially if used in conjunction with other sensing methods.

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2. MATERIALS AND METHODS

For development of sensor, circuit and software modules, a prototype of a scaled down model of a room is being designed and tested. Figure 1 shows the layout of the sensor system in the model room. The photo switches (42SMU-7001 retro reflective, Allen-Bradley, Rockwell Automation, Milwaukee, WI, USA) were mounted on two of the four walls of the room (Figure 1). The photo switches emit an infrared beam that reflects off the opposite wall due to reflectors. The location that the orthogonal infrared beams intersect is a detectable location.

A microcontroller module (MSP430 Launchpad, Texas Instruments, Austin, TX, USA) functions as the digital control. The microcontroller looks at which pairs have emitted light reflected back to determines the location of blocking objects. Shift registers (SN74HC595, Texas Instruments) are utilized to map the digital signals.

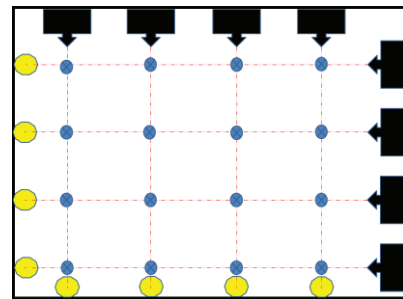


Figure 1: Layout for a scaled down model of a room, including the light emitting and sensing modules (four each on right wall and top wall), and light reflectors on opposite walls. With no opaque objects in the way, the transmitted light is reflected back to the sensor. An opaque object would block the light, preventing return to the sensor, and allow detection of location.

The microcontroller indicates the location of detected objects using a 4x4 matrix of LEDs. Figure 2 shows a system diagram.

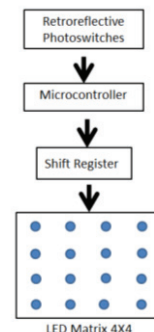


Figure 2: System diagram.

3. RESULTS

After building and testing our sensor system we have discovered the following results. First, we realized that our system is not ideal and cannot be used until the errors in the system are solved. For example, one of the flaws of our system was that if either photo switch at the ends of the room were to break, the system would not be able to distinguish between the two ends of the room, especially if more than one person is in the room.

Our original goal was to develop a way to have an alarm sound when one or more intersections of the sensors detect a person(s) in the room. We were able to get the system to the point where an alarm would sound if the sensor detected a person in only one intersection. Unfortunately, we were not able to get the alarm system to work for more than one intersection, like our original goal was.

4. CONCLUSIONS

Based on the results of our sensor model we have made the following conclusions. Our scaled down model of the room sensing system was able to detect opaque objects that were blocking the reflected light of the sensor? Our system would then identify the timing and location of the object or person.

Further development and testing of the system will be required to make a full scale model. After the completion of further testing, our system would ideally supplement another monitory system to provide redundant checking of the detected behaviors to improve accuracy and robustness. A system like ours that would detect episodes of falling and issue an alert for help would improve the prognoses for patients' injury, recovery and overall quality of life.

4.1 RELATED WORK

Currently there are many systems related to ours that are designed to track movement and episodes of falling. For example, there are alarm bracelets and necklaces that require a button to be pushed for help. However, there are many new ideas under development to help ensure the safety of the elderly. For instance, in the United Kingdom there is a new electrical sensor under development that would be able to detect heart beats and bodily movements. This way, the sensors would be able to detect a heart attack or a fall. This detection system would passively detect when there seems to be something wrong with the patient and immediately issue an alert for assistance. This new sensor system is based on electrocardiograms (EKG), which is the system used to monitor heart beats.

Another sensor also under development in the United Kingdom uses sensitive electrodes that determine the effect of the patient on the electric fields in the room. If there is a disturbance, the system would be able to detect if the patient has fallen or had a heart attack.

Another system that is currently available has also incorporated the idea of an Android app. This system called iFall uses data collected from the accelerometer and is evaluated using algorithms and positioning information. The fascinating detail about this system is that the threshold is adjustable based on user parameters such as weight, heights, and amount of activity. The versatility of this system will allow for faster medical attention and better patient prognoses. The developers are also interested in adding a blue tooth feature to their system so that any information from the microsensors on articles of clothing could also be a factor when determining if the patient has fallen.

4.2 FUTURE DIRECTIONS

After completion of this sensing model to detect episodes of falling, we decided that a Thermo Imaging system would also benefit this concept.

Using Thermo Imaging technology we would be able to detect when a person has walked into a room and track their motion throughout the house. Ideally, we would use an Electric Potential Sensor (EPS), which can detect a heart beat a meter away, to locate the person(s) in the room. Then, we would install Force Sensors onto the floor. The purpose of these sensors is so that we can distinguish between footsteps in the room and furniture that is set in place. Using accelerometers we could detect the presence of a person falling and also be able to calculate exactly how fast he or she fell. These results will give us an idea of how badly injured the person is to allow for faster response time.

We are also very interested in creating an Android app so that you would be able to check on the status of your elderly friend or family member while you are away. All of the data needed to ensure the status of your friend or relative will be sent to the app and you will be notified if anything has happened while you were away. This use of technology will greatly increase response time of medical attention and a better prognosis for the patient.

To make sure the entire system is communicating with each other we decided to use LabView. This way, all of the components of the system are connected and the system will work effectively.

The following is an example of how this system would benefit a fallen, elderly patient: If the Thermo Imaging camera saw Bob's grandfather fall, LabView would make sure that the accelerometer caught this action, as well as the floor Sensors, and also make sure that there was/is a heartbeat. This would set off an alarm. If the person does not respond within 5 minutes of the fall then the system would call for help, as well as let Bob know that his grandfather just had a fall going 10m/s^2 .