INDOOR TRACKING AND MONITORING SYSTEM OF WALKING AID USAGE BY DEMENTIA AND ALZHEIMER PATIENTS USING RSS

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Abstract
Alzheimers disease and Dementia are the most common mental illnesses that affect the elderly population of the world. Elderly individuals affected by Dementia and Alzheimers tend to forget even their inability to walk without a walker. Constant monitoring of such an elderly is particularly difficult during the night. The implementation of a Radio Signal Strength(RSS) based system to specifically monitor whether the partially-disabled elderly affected by mental disabilities such as Alzheimers or Dementia always use their walking aid indoors has been outlined. The system will consist of a Bluetooth(BT) transmitter and receiver affixed separately to the elderly and their walking aid respectively. Based on the signal strength between the transmitter and receiver, an estimate of the distance between the elderly and their walking aid can be calculated with the help of a Raspberry Pi(Rpi) and an alert can be sent to a caretaker when the distance exceeds a safe threshold.
Keywords: Alzheimers Disease, Dementia, Elderly, Monitoring, Radio Signal Strength, Tracking, Walking aid.

I. INTRODUCTION

Dementia is the most common neuropsychiatric disorder that affects a large portion of the elderly population across the globe. It mainly affects cognitive functions and memory. Alzheimers disease is considered a more specific form of Dementia as it mainly affects the memory of the individual. Memory loss or forgetfulness are only few of the many symptoms that indicate the onset of Dementia or Alzheimers disease.[1]

A potential cause of injury to elderly individuals is the increased risk of falling. Falls at such an age cause fractures which can eventually to rapid degradation of health and even death in some cases. The most common cause is when an elderly who requires their walking aid forgets their aid when walking. The risk increases drastically when the elderly suffers from Dementia or Alzheimers.[2]

An elderly individual who is suffering from Dementia or Alzheimers disease will most likely be under the care of family or a home nurse in the case that the individual is at their own residence. Even in the case of old age homes, nurses are present to take care of the elderly. During the night time, it becomes difficult to monitor the activities of the elderly individual who may wake up to go to the restroom or may not have regular sleeping patterns. Elderly individuals suffering from Dementia or Alzheimers will be disoriented and confused when left alone. The chances of the individual forgetting their walking aid and tripping over in the dark is very high. A device that can address these issues is the need of the hour. Various devices already in existence utilize technologies that are either complicated or highly unreliable.[3]

The proposed system is aimed to be reliable and cost effective when compared to existing systems. The cost cutting is achieved using already existing software and hardware infrastructure and combining it to service our requirement in the most reliable way. The system will consist of a Raspberry Pi(RPi), Bluetooth (BT) Dongle, a Smartphone and a portable power supply unit for the Raspberry Pi.

II. EXISTING SYSTEMS

The design of the required system was to meet certain requirements in terms of cost and reliability. First, a suitable methodology of estimating the distance between two objects was to be identified. From the various tracking algorithms and distance estimation techniques mentioned in [4], a combination of a Radio Signal Strength(RSS) and Proximity sensing methodology was deemed the most suitable to the requirements, namely, cost and reliability. The decision to use an RSS based system was only reinforced by the system proposed in [5]. The design matrix provided a guide to the available alternatives for the proposed system. Each alternative was analyzed and their corresponding pros and cons evaluated.

Global Positioning System (GPS), Wi-Fi and cellular based systems were ruled out primarily due to cost and accuracy reasons. Near Field Communication (NFC) and Passive Radio Frequency Identification (RFID) were also deemed infeasible as they required a very short range (few centimeters) to work. Beyond which neither function at all.[6]

Using the system and information provided in [], it is understood that the proximity estimation is done initially with the help of a commercially available device that uses radio waves. The device consists of a radio transmitter and radio receiver which constantly communicates its RSS value to its receiver. The RSS value is compared with the threshold beyond which a buzzing sound is generated. The problem with this approach is that the elderly may be hard of hearing and may not hear the buzzing sound or even in some cases be confused by the sudden noise coming from their vicinity. Also, the caretaker will only be aware of the buzzing if they are in the relative vicinity to the elderly.

III. PROPOSED SYSTEM

The design of the proposed system has been inspired to recreate the same monitoring and alerting capability while providing ability to keep the family members and care taker updated on the activity of the elderly. The cost is kept low by providing a single function effectively instead of many functions leading to complications in maintenance and increase in cost.

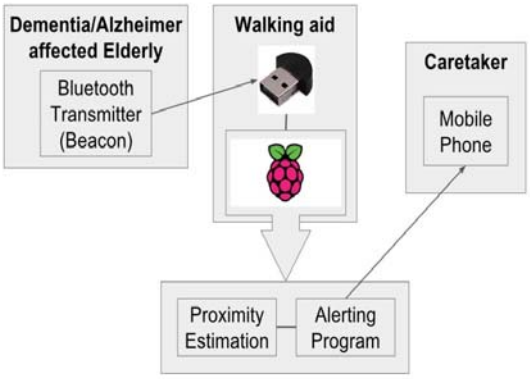

Fig. 1. System Architecture of proposed system.

The system can be broken down into three modules. They are Relay system, Proximity Estimation and Push-Alert.

The Relay system is essentially a Bluetooth transmitter and receiver setup. The transmitter is a Bluetooth enabled mobile phone. It will be carried by the elderly person and will be paired with the receiver. The receiver can also be a Bluetooth beacon, but a smartphone was chosen for simplicity of implementation and evaluation of the proposed system. The receiver is a commercially available generic Bluetooth Dongle. Both the transmitter and receiver are paired together eliminating the interference from other nearby devices. The Bluetooth receiver (Bluetooth dongle) will be present on the walking aid and will be interfaced with Raspberry Pi via USB.
The Raspberry Pi will be powered by a suitable power supply.

The Proximity Estimation is a program running on the Raspberry Pi. The Bluetooth manager software is called through a shell program that will be running once the system is set up. Using that program the RSS value of the connected transmitter can be retrieved.[7]

Fig. 2. Smartphone used as a Bluetooth transmitter.

Fig. 3. Raspberry pi with a Bluetooth dongle acting as the receiver.

The Push-Alert consists of two programs. One is a notification program called Ntfy, that supports multiple back ends for pushing notifications to mobile devices. The second program is android application called Pushbullet that will be installed on the family members or caretakers smartphone. The application will receive messages sent from the Raspberry Pi through the Ntfy program. The programs can be configured such that multiple devices can be notified of the elderlys activity.

The Proximity Estimation and Push-Alert systems are handled using a shell program. It handles the monitoring of the RSS and sends a push notification when the RSS value is below the safe threshold.

IV. TESTING AND OBSERVATIONS

The system was set up and configured. The smartphone was paired to the Raspberry Pi using the Bluetooth Dongle.
The shell program was startup and connections were checked.

The program would proceed to connect to the device and poll for a RSS reading at regular 0.1 second intervals. The RSS readings could be classified into 3 positive, zero and negative. Positive values indicated that the transmitter was very close to the receiver (around 1 10 centimeters). If the RSS value was zero, it indicated that the transmitter was in the general vicinity of the receiver (around a foot or two). When the values were negative, the transmitter was at a distance from the receiver. The values corresponded to the trials that were conducted and referenced from [7]. And hence the push notifications were sent when the RSS values changed to negative for a set period.

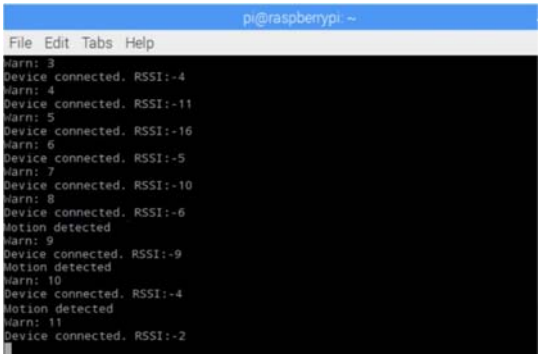

Fig. 4. RSS readings retrieved from the transmitter.

When tested, the RSS values changed to positive when the transmitter was brought closer to the receiver and went below zero when taken away from the receiver. It was also observed that the RSS values varied dramatically in the negative range when held at distance from the receiver. This prevented us from calculating the distance from the transmitter and receiver accurately. But the values of RSS were consistently negative when the transmitter was at a distance from the receiver.

The other issue that was observed was that if there was a line of sight between the transmitter and receiver, the RSS value would be constant at zero until the transmitter was moved away more than 10 feet. An ingenious solution helped solve this issue by placing the transmitter around the neck of the wearer. When placed in such a position, the line of sight is broken every time the wearer moves away from the receiver.

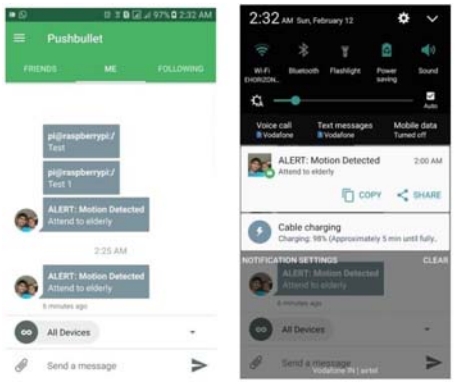

Fig. 5. Push notifications successfully received on the caretaker's smartphone.

When comparing the cost of the entire system with the already existing systems, it was comparatively lower. The cost of the entire system came to around 7500 Rupees or 115 Dollars. If the person is willing to use an old

smartphone the cost can be further reduced to 4500 Rupees or 70 Dollars.

V. CONCLUSION

Thus, the proposed system has been implemented and tested for proficiency. Upon evaluations in a test environment it was found to work as per requirements. The system would constantly monitor the RSS values from the transmitter and send a push notification when the RSS values fell below the threshold value for a set duration. Cost of the system was kept to a minimum and has been identified to be comparatively cheaper than the currently available systems.

In the future, the system can be further improved by using better algorithms to accurately determine the RSS value of the transmitter. The movement of the elderly individual can be tracked throughout the day and analyzed for patterns in the time of day that they are most likely to forget their walker. This could be done with the help of Artificial intelligence.

REFERENCES

[1] H. E. Team, "Dementia and alzheimer's: What are the differences? with alarm system," 2016.

[2] Alzbrain.org, "Prevention of falls in the dementia patient."

[3] J. Tilly, DrPH, and P. Reed, "Falls, wandering, and physical restraints: Interventions for residents with dementia in assisted living and nursing homes," 2006.

[4] D. Dardari, P. Closas, and P. M. D. C, "Indoor tracking: Theory, methods, and technologies.," *IEEE Transactions on Vehicular Technology.*, vol. 64 , April 2015.

[5] R. O'Connell, "Elderly fall prevention: Alert system and cadence walker," 2014.

[6] P. Bellavista, A. Kupper, and S. Helal, "Location-based services: Back to the future," *IEEE Pervasive Computing*, vol. 7, April-June 2008.

[7] S. Liu, Y. Jiang, and A. Striegel, "Face-to-face proximity estimation using bluetooth on smartphones," *IEEE Transactions on Mobile Computing*, vol. 13, March 2014.