# A RFID System for Recognizing Activity Using Radio Patterns

**Shwetha R[1], Sushmitha P[2], Swathi MS[3], Poonam Kumari[4]**

*[1] BE Student, CSE, RRCE, Karnataka, India*
*[2] BE Student, CSE, RRCE, Karnataka, India*
*[3] BE Student, CSE, RRCE, Karnataka, India*
*[4] Assistant Professor, CSE, RRCE, Karnataka, India*

## ABSTRACT

The activity recognition system aims at determining the activities of a person or a group of persons based on sensor data. Activity recognition plays an important role in many applications. One of such many applications is elderly care that is supported by activity recognition systems. In this paper, we make use of radio frequency identification system (RFID) that aims at providing high detection coverage. We develop a prototype system which consists of a RFID system and a smartphone to demonstrate the working principles.

**Keyword:** - *Activity recognition, RFID, Sensors*

## 1. INTRODUCTION

As an enabling technology, activity recognition systems have an important role in many applications. One such critical application that involves much of crucial interest is elderly care due to the increase in growing number of elderly people around the world. Research shows that steady decline in cognitive, visual and physical functions caused by different age-related diseases are experienced by aged persons. For the daily support of old age people with different degrees and types of impairments new applications are actively being developed. For example, Autominder is a cognitive orthotic system that aims towards elders with memory impairment to adapt to cognitive decline and continue the satisfactory performance in everyday activities, thereby potentially enabling them to remain in their own residence for longer, growing services like social networking, cloud computing and internet of things.

Building activity recognition systems for elderly people poses many challenges. **Ease-of-use:** Most of the systems are designed for personal usage environments where the user receives minimum supervision from the professionals and assistants. As a result, it is necessary to require minimum effort to configure and maintain the system, especially for elderlies with cognitive and physical impairments. **Coverage:** The system's working area should not be restricted to limits considering the mobility of a user. Tracking elderly's activity and mobility has shown to be a vital evidence for determining their quality of life. **Privacy Preserving:** The system should not be invasive to the user's privacy, especially for elderly users under long-term monitoring.

To provide an easy-to-use activity recognition system with high coverage, this paper proposes an approach that combines the benefits of both the sensor-based systems and the RF-based systems.

The following contributions are made by the paper. We propose a novel wearable activity sensing architecture involving both the passive RFID-tags and the reader which provides an easy-to-use system with high coverage suitable for applications such as elderly care. We implement the prototype system and carry out preliminary studies to demonstrate the feasibility of the proposed system for activity recognition.

## 2. EXISTING SYSTEM

Elderly care is one of the many applications supported by real-time activity recognition systems. The world's population is aging at a phenomenal rate. Certain types of cognitive decline, in particular some forms of memory impairment, occur much more frequently in the elderly. The existing approaches are limited due to ease-of-use, coverage, or privacy preserving issues. Disadvantage: As an enabling technology, real-time human activity recognition plays a central role in many applications. One of the critical applications attracts much research interest is elderly care because of the growing number of elderly people around the world. Studies show that aged persons experience steady decline in cognitive, visual and physical functions caused by different age-related diseases.

## 3. PROPOSED SYSTEM

Powerful sensors and there are many diverse incorporate nowadays in the new generation of smart cell phones and mobile devices are becoming increasingly sophisticated. These sensors include GPS sensors, vision sensors, audio sensors, light sensors, temperature sensors, direction sensors and acceleration sensors. We use node MCU with heart rate sensor, temperature sensor, gas sensor and GPS sensor, to detect heart rate, temperature, air quality and location. RFID tag number is matched with the RFID reader. Tag placement strategies and RFID reader are used in this system. A RFID reader is activated sequentially to detect tags within their reading ranges. A dwell time for each tag and the time to complete an inventory cycle are set. We choose values such that it achieves a balance between reading agility and stability. The transmission power level of the RFID reader is a key parameter in our system, and it influences the system's performance on both recognition accuracy and battery consumption. Advantages: Easy-to-use solution with high detection coverage to support applications like elderly care. The prototype system is used and extensive experiments are conducted using data collected in a realistic setting. The experiment results show that the proposed system can perform to achieve the highest recognition accuracy.

## 4. SYSTEM ARCHITECTURE

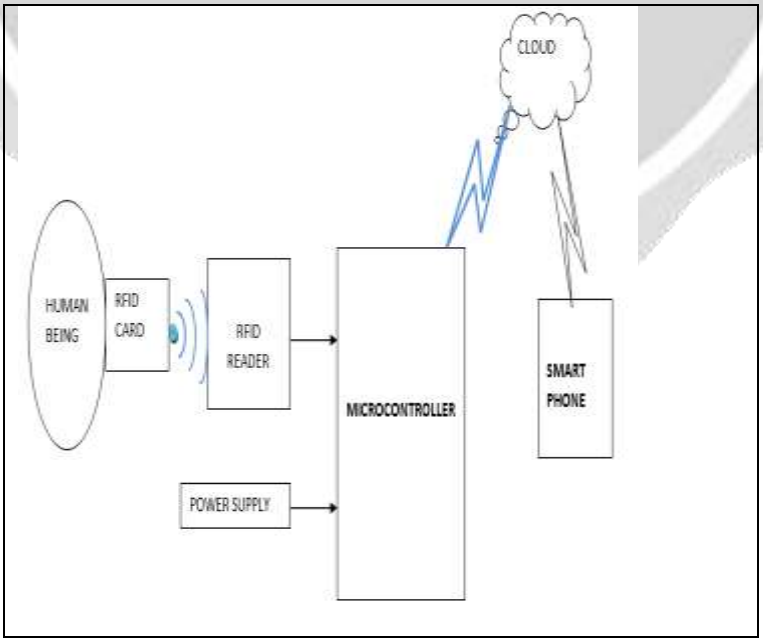


Fig-1: Block diagram of RFID system

Our system consists of components such as RFID card, RFID reader, microcontroller and a smartphone. Sensors, RFID cards and tags are initialized with respective identification values. RFID tag captures radio patterns for different activities. Tag id is matched with the reader. Reader collects the sensor values and uploads the data to cloud. These values are compared with the threshold value. Whenever the value exceeds the threshold value a message is sent to the user's smartphone through the cloud. Node MCU is an open source IOT platform, it includes hardware which runs on the ESP8266 Wi-Fi soc, its power consumption, cost and memory size is less. A RFID system is made up of two parts a tag or label and a reader. We use softwares such as Arduino Programming Language, Aurdino IDE and IOT (osmosis/ubidot). Aurdino programming language supports C++. Aurdino IDE is an integrated development environment which makes it easy to write code and upload it to the cloud. IOT is inter networking of physical devices, vehicles buildings.

## 5. PERFORMANCE

In this experiment, we evaluate the system's performance with different antenna transmission power levels. The existing RFID reader module allows us to set the same power level for the antennas.

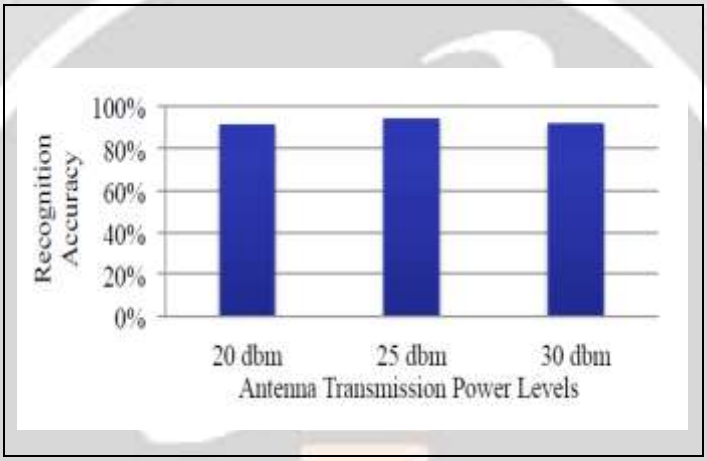


**Chart-1:** Accuracy under different transmission power levels

This result reveals that a higher transmission power level does not necessarily lead to higher recognition accuracy. It provides the best discriminative power for activity recognition. We measure the output current for the battery units of our reader and the recognition software system on the smartphone, respectively. During our data collection, we charged the battery during the night and collected data in the day. The system showed no sign of power shortage during the data collection. The current power consumption of the RFID reader is relatively high. This is because the device currently used is not optimized for our usage scenario. With the development of low-power, compact RFID readers, the power consumption of the RFID reader will not be a significant issue in the future. One advantage of our radio-based approach is that it favors the most discriminative transmission power level which is often relatively lower than data-based approaches.

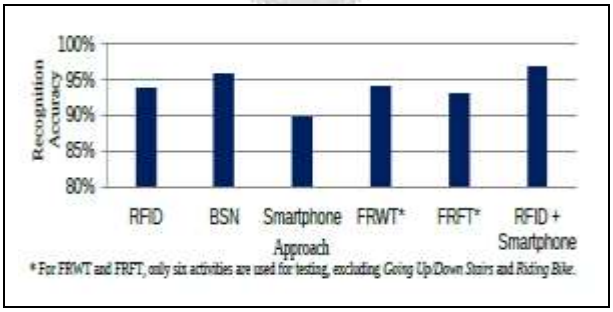


**Chart-2:** Comparison of different approaches

We compare the performance of the proposed approach with the BSN-based, smartphone-based approaches, and with two different setups of RFID-based systems. In the BSN-based approach, data transmission is done in real-time in full power. In smartphone-based approach, the readings from the on-board accelerometer are used as input. Two alternatives of RFID-based approaches are implemented to compare with the proposed system, namely the Fix Reader Wear Tag (FRWT) and Fix Reader Fix Tag (FRFT) approaches. For the FRWT approach, we use the same devices as the proposed system. However, in this approach, we fix the RFID reader and antennas on a shelf facing the detection area. For the FRFT approach, we follow the RF-Care system. The RFID reader and antennas are fixed on a shelf facing an array of tags attached to a wall. Activities are performed by a subject located between the antennas and the tags without any device attached to him. As shown in the figure, the recognition accuracy of both the proposed RFID- and BSN-based approaches is above 90%. The recognition accuracy of the BSN-based approach is 95.8%, which is slightly higher than the proposed approach. We can also observe in some cases that our system slightly outperforms the BSN-based system, suggesting our solution is comparable with the BSN-based system. Most importantly, our system requires less maintenance effort than BSN. The smartphone-based approach reaches the lowest recognition accuracy of 89.8%. For the two alternative RFID-based approaches, the recognition accuracy of the FRWT and the FRFT approaches are 94% and 93.1%, respectively. Considering the randomness in the validation process, this result suggests all RFID-based systems achieve comparable recognition accuracy. To further extend the above experiments, since our system already uses a smartphone for data collection, we combine the proposed RFID-based approach with the smartphone-based approach. Experiment result shows that by fusing RFID and smartphone sensing data, the recognition accuracy is improved to 96.8%, outperforming all the above approaches.

## 6. DATAFLOW DIAGRAM

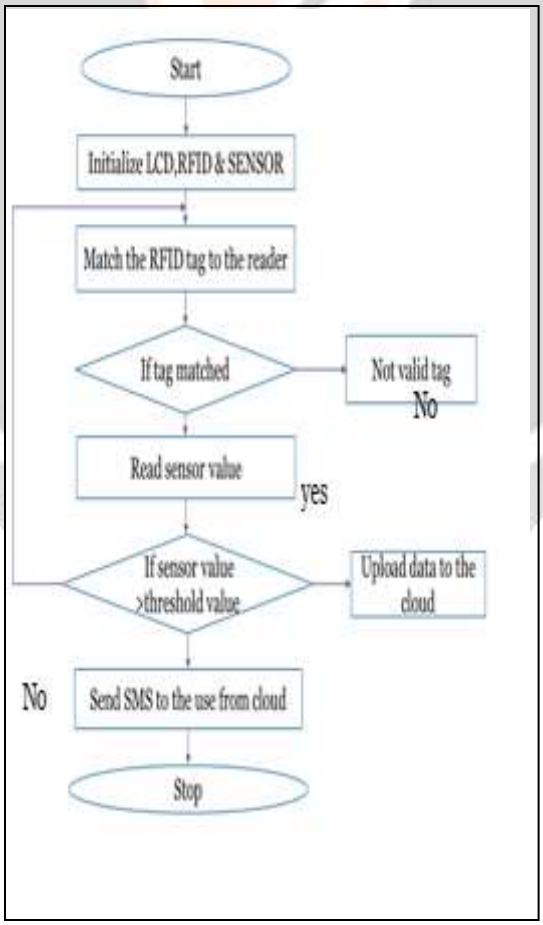


**Fig-2:** Data flow diagram of RFID system

The RFID, Sensor, LCD are initialized to some threshold value. RFID tag is matched to the reader. Whenever the RFID tag is matched, the sensor value is read else displays as an invalid tag. If the sensor value is greater than the threshold value, the data is uploaded to the cloud, else the reader continue reading the values. Once the data is uploaded to the cloud the message is sent to the user from the cloud.

## 7. EXPECTED OUTCOME

Easy-to-use solution with high detection coverage to support applications like elderly care. When the sensor value is greater than the threshold value sends SMS to the user from the cloud. The proposed antenna and tag selection strategy suffices to achieve high recognition accuracy.

## 8. CONCLUSION

The experiment results show that the proposed system can perform real-time recognition and achieve the highest recognition accuracy. The number of tags can be read by a RFID reader during a scan is limited. Tag placement strategies and RFID reader are used in this system. A RFID reader is activated sequentially to detect tags within their reading ranges. A dwell time for each tag and the time to complete an inventory cycle are set. The proposed system suffices.

## 9. REFRENCES

[1] M. E. Pollack, L. Brown, D. Colbry, C. E. McCarthy, C. Orosz, B. Peintner, S. Ramakrishnan, and I. Tsamardinos, "Autominder: An intelligent cognitive orthotic system for people with memory impairment," Robotics and Autonomous Systems, vol. 44, no. 3, pp. 273–282, 2003.

[2] A. E. Stuck, J. M. Walthert, T. Nikolaus, C. J. B¨ula, C. Hohmann, and J. C. Beck, "Risk factors for functional status decline in communityliving elderly people: a systematic literature review," Social Science & Medicine, vol. 48, no. 4, pp. 445–469, 1999.

[3] T. Lee and A. Mihailidis, "An intelligent emergency response system: preliminary development and testing of automated fall detection," Journal of Telemedicine and Telecare, vol. 11, no. 4, pp. 194–198, 2005.

[4] A. M. Khan, Y.-K. Lee, S. Lee, and T.-S.Kim, "Accelerometers position independent physical activity recognition system for long-term activity monitoring in the elderly," Medical & Biological Engineering & Computing, vol. 48, no. 12, pp. 1271–1279, 2010.

[5] M. Hirvensalo, T. Rantanen, and E. Heikkinen, "Mobility difficulties and physical activity as predictors of mortality and loss of independence in the community-living older population," Journal of the American Geriatrics Society, vol. 48, no. 5, pp. 493–498, 2000.

[6] A. Avci, S. Bosch, M. Marin-Perianu, R. Marin-Perianu, and P. Havinga, "Activity recognition using inertial sensing for healthcare, wellbeing and sports applications: A survey," in 23rd International Conference on Architecture of Computing Systems. VDE, 2010, pp. 1–10.

[7] T. Gu, L. Wang, Z. Wu, X. Tao, and J. Lu, "A Pattern Mining Approach to Sensor-based Human Activity Recognition," IEEE Transactions on Knowledge and Data Engineering (TKDE), 2010.

[8] J. R. Kwapisz, G. M. Weiss, and S. A. Moore, "Activity recognition using cell phone accelerometers," ACM SigKDDExplorations Newsletter, vol. 12, no. 2, pp. 74–82, 2011.