International Journal on Recent and Innovation Trends in Computing and Communication
Volume: 3 Issue: 6
ISSN: 2321-8169
3652 - 3655

Path Following Mobile Robot using Passive RFID Tags in Indoor Environment

Suvankar Barai, Buddhadeb Sau
Department of Mathematics
Jadavpur University
Kolkata- 700032, India
suvankar.barai@rediffmail.com

***Abstract*—**A Radio Frequency Identification (RFID) based tracking system becomes very important to our future world of pervasive computing, where information is all around us. Location finding is one of the most needed information for emerging and future applications. RFID tags may provide a new way of giving location information to mobile robot. Because of its small passive communication circuit and without an energy source, RFID tags can be embedded almost anywhere with any object. The Ultra High Frequency (UHF) RFID tags can stores location information which supply to any reader that is within a proximity range which can be up to approximately 15 meters. The robot senses all RFID tags using tags IDs which fall into reader's recognition area. Then the robot use Received Signal Strength Indicator (RSSI) technique to find the distance of RFID tags which is plotted in the ground. In this paper, we design a path which is build by putting passive RFID tags in serial format on the ground. After plotting all the tags, the mobile robot first tracking and navigating those tags, so that the next robots could follow through the path. In each divider of path breaker we use read/write RFID tags to avoid future problem. The RFID-based path following mobile robot which automatically navigate and moves source to destination accordingly in indoor environments without using directional antenna.

Keywords*-Localization using robot, Mobile Robot, Path Deployment, Path Following, RFID System, RFID Reader..*

*****

I. INTRODUCTION

An RFID reader can detect a signal received from an RFID tag which falls into the coverage area of the reader. This detected signal is called contiguous information. Positions of the tags may be computed from this contiguous information. Using successive contiguous information from the tags, the accuracy of the position estimation may be improved. The coverage area of the RFID reader varies depending on the communication medium between the RFID reader and the tags. Some localization schemes have been proposed to improve the accuracy of estimation [3]. In this paper, first we develop the path using passive RFID tags by plotting those tags on ground then we propose the method to follow the RFID tag's lane by the mobile robot. The distance between two tags must be within the sensing area of the RFID reader. A mobile robot, which has a RFID reader at the bottom, moves over the tags. The reader is adorned with a single antenna. When an RFID tag falls into the reader's recognition area, the mobile robot gets information and distance of RFID tag. The mobile robot only allows moving towards the tag if any the tag falls into reader's recognition area. Therefore, the distance between two tags must be less than the radius of the reader's sensing area. We show our method via computer simulation.

The rest of the paper is organized as follows. Section II describes related works. In Section III, we formally describe the used system model and problem of mobile robot movement. The proposed algorithm for tag localization is presented in Section IV. The experimental set up and the results of simulation of the proposed method are shown in Section V. Section VI includes our conclusion.

II. RELATED WORK

The automatic path following mobile robot based on paint line detection of computer vision used in many researches [4-10], Nguyen Xuan Dao, Bum-Jae You and Sang-Rok Oh in their paper "Visual navigation for indoor mobile robots Using a single camera" [11] propose a novel visual navigation method by combining visual localization with the extraction of valid planar region using only single video camera. They introduce a new method to findout landmark equations without theirs priori knowledge by combining with odometry data. After that, planar features can be findout and tracked. Using 2 pairs of features, a homography (is a projective transformation between the two projected points of two different image) could be computed while the least square method is adopted to refine to an optimal homography matrix optionally. The difference image between the image at a time t+dt and the transformed image at a time t by a homography matrix is used as a basic image. The difference image is converted into a binary image to distinguish desired planar regions from other objects. They adopt some labeling and filtering based on the size of each label to filter out undesired planar regions. It is shown how the proposed method implemented with two pairs of features can be obtained in real time. Finally, they show the feasibility and robustness of the method by experiments involving real data.

In this paper, we propose a describe a new method of robot movement to follow a path. We use low-cost Read Only passive RFID tags [12]. We calculate the distance between reader and tags using RSSI method. In the propose system, we do not use the directional antenna.

ISSN: 2321-8169
3652 - 3655

III. SYSTEM MODELING

Any RFID system consists of at least one interrogator (commonly known as reader) and at least one transponder (commonly known as tag). The readers use radio link to communicate with tags (Fig. 1). The reader is often (though not always) remains connected to a server through a network. The data collected by the reader will be sending to the server through the host network.

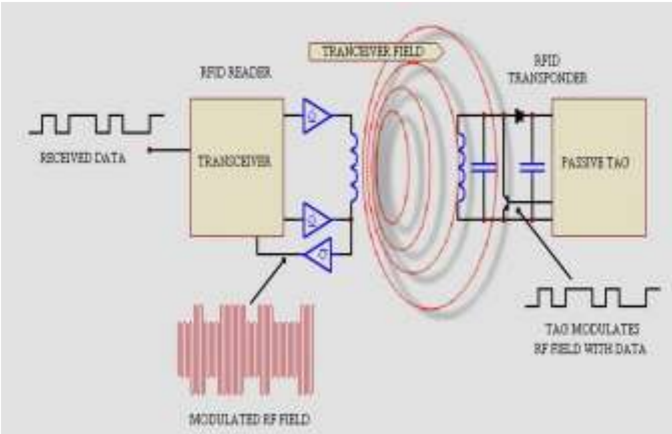

Figure. 1. Example of RFID System [8]

The passive RFID tags have the heart of microchip do not require any power source of their own and instead get the power from the RFID reader's electromagnetic field. Whenever the RFID tag fall into the generated RF field it is able to gain enough power from the field to access its internal memory data and transmit its all stored information. When the transponder RFID tag gain power in this way the resultant interaction of the RF fields causes the voltage at the transceiver antenna to drop in value. This effect is utilised by the RFID tag to communicate its information to the RFID reader. The RFID tag is able to control the amount of power gain from the field and by doing so it can modulate the voltage sensed at the transceiver according to the binary pattern it wishes to transmit [8].

RSSI values collected by the mobile robot are measure of the power received by the RFID tag from a transmitter and provide information as to location of the subject carrying it. The received signal receive by the reader in backscattering reflection of electromagnetic waves. In indoor environments, RSSI values are requested to follow the easy to find out by model expression.

$$RSSI=A+ B.\log(d) \ [2]$$

Where, d indicates the distance between the transmitter and the tag, and A, B are parameters to be estimated. At ideal conditions without the existence of any reflections, diffraction's, and scattering, the distance of the tag to the three transmitters, hence the location of the tag, can be find out from Equation (1), when A, B are known. However, in this application, this above formula does not provide to proper positioning and this application calls for incorporation of statistical methods [2].

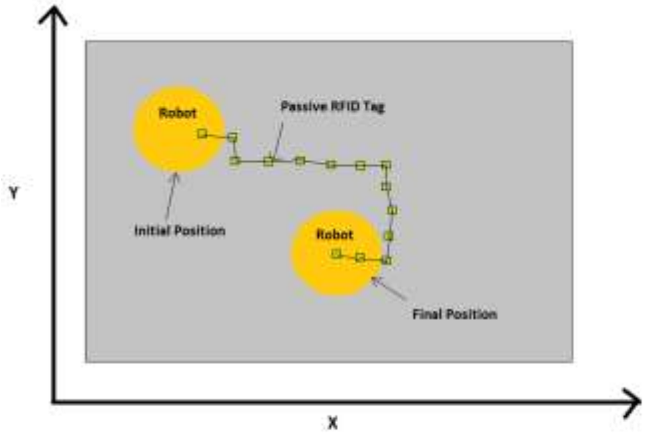

Figure. 2. Example of path following mobile robot

In RFID system there are several limitations due to the constituent hardware. Therefore, we consider the model for the RFID system as follows:

1) *The reader's recognition area is a circular disk. The current position of the reader is the centre of this disk.*
2) *The tags are plotted in the ground in serial format.*
3) *All tags are working fine, there are no dead tags.*
4) *There is no obstacle in the scan area.*
5) *Each tag contains a unique identifying number.*

IV. PASSIVE TAG TRACKING

We assume that all the RFID tags are plotted in serially within a certain distance and the distance between two tags is less the radius of the reader's recognition area. Initially, mobile robot starts from a particular position. Then robot finds the next nearby tags and moves towards it unless the distance becomes minimum, between the tag and reader.

Let, initial co-ordinate is (x_n, y_n) and the next tag's co-ordinate is (x_{n+1},y_{n+1}) and the distance between two tags is d_n. the radius of sensing area is r then,

$$d_n=abs\{(x_n,y_n)-(x_{n+1},y_{n+1})\}$$

$$r>d_n$$

Algorithm 1. Robot move towards the RFID tags

Data: X , Y , N , i
Result: Robot calculate the location of the tag
if hitTest(Robot) = true **then**
    for i=1 to N //search upto number of node

```
                //moves right side
                while X<TagX[i] do
                        X=X+1;
                end
                //moves left side
                while X>TagX[i] do
                        X=X-1;
                end
                //moves upwards
                while Y<TagY[i] do
                        Y=Y+1;
                end
                //moves downwards
                while Y>TagY[i]  do
                        Y=Y-1;
                end
        end for
end
```

V. SIMULATION STUDY

To verify the propose method, simulation studies are carried out using C-Programming. The robots starts from a particular point and move forward through the path as said in previous section. In the Figure 3 the red dots are indicate the RFID tags which is plotted in the ground in a form of a path. The green dots are indicate that those tags fall in the recognition or sensing area of the RFID reader. We will show the path fork simulation in our next work where robot decided which way to go.

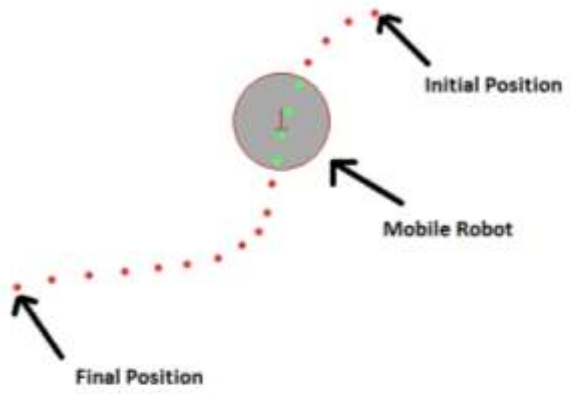

Figure. 3. Robot moves through the path of RFID tags.

VI. CONCLUSION AND FUTURE WORK

This paper proposes a passive RFID based tracking system which is a part of a navigation of mobile robot. The robot is program to follow the path. The path is design by serially plotted passive RFID tags. The drawback of this work that there is only one single mobile robot which is follow the path and if the path is fork it will follow the nearest RFID tag's path. We still not design to follow the destination path yet.

The future goal of our research work to implement swarm robots to follow the path and can follow the destination where to go. It will be a great challenge when multiple robots are moves because there will arise lots of problem like collision of robots, shortest root finding and recovery of faulting issue. Also to test in outdoor environment where the size of robot is big which can even carry people or heavy materials.

ACKNOWLEDGMENT

The first author would like to thank Jadavpur University for giving a formal platform to carry his research work.

REFERENCES

[1] http://en.wikipedia.org/wiki/Radiofrequency_identification.

[2] Rusen Oktem, Elif Uray Aydin and Nergiz Ercil Cagiltay , “An RFID Based Location Finding and Tracking with Guidance”, IEEE 2008.

[3] Suvankar Barai, Buddhadeb Sau, Krishnendu Mukhopadhyaya, “Localization and Mapping of Passive RFID Tags using Recognition Area of an RFID Reader”, page 194-199, 9th International Conference on Microwaves, Antenna Propagation and Remote Sensing ICMARS-2013, Jodhpur, INDIA, 11th-14th December, 2013.

[4] M Ayoub Khan, Manoj Sharma, Brahmanandha Prabhu R, “A Survey of RFID Tags” ,International Journal of Recent Trends in Engineering, Vol 1, No.4, May 2009.

[5] Z. Hai-bo, Y. Kui, L. Jin-dong, “A Fast and Robust Vision System for Autonomous Mobile Robots,” in Proceeding of IEEE International Conference on Robotics, Intelligent Systems and Signal Processing, Oct. 2003, pp. 60-65.

[6] Q. Fang and C. Xie, "A Study on Intelligent Path Following and Control for Vision-based Automated Guided Vehicle," in Proceedings of the 5th World Congress on Intelligent Control and Automation, June 15-19, 2004, Hangzhou. P.R. China, 2004 IEEE.

[7] Masashi Sugano, Tomonori Kawazoe, Yoshikazu Ohta, Masayuki Murata, Target, Vol538 (050), 2006.

[8] http://www.priority1design.com.au/rfid_design.html

[9] Y. Xu, K. Li, Yingma, Yuanyi, Wanjian, Chenjun, and Z Yufan, "General Design of the Lateral Control System Based on Monocular Vision on THASV-I," 2004 IEEE Intelligent Vehicles Symposium, University of Parma. Parma, Italy June 14-17, 2004.

[10] X. jiang, y motai, x. Zhu, "Prediction Fuzzy Logic Controller for Trajectory Tracking for Mobile Robot," 2005 IEEE Mid-Summer Workshop on Soft Computing in Industrial Applications, Helsinki University of Technology, Espoo, Finland, June 28-30, 2005.

[11] J-B. Coulaud, G. Campion, G. Bastin, and M. De Wan, "Stability Analysis of a Vision-Based Control Design for an Autonomous Mobile Robot," IEEE trans. on Robotics, vol. 22, no. 5, pp. 1062-1069, Oct. 2006.

[12] R. Martinez, A. Rodriguez, O. Castillo, L.T. Aguilar, "Fuzzy Logic Controllers Optimization Using Genetic Algoritms and

Particle Swarm Optimization," in Proceedings of the 9th Mexican International Conference on Artificial Intelligence, 2010, pp. 475-486.

[13] O. Castillo, P. Melin, F. Valdez, R. Martinez-Marroquin, "Handbook of Swarm Intelligence Adaptation, Learning, and Optimization," Handbook of Swarm Intelligence Adaptation, vol.8, no.3, pp. 389-417, 2010.

[14] Shang-Wei Wanga, Wun-Hwa Chenb, Chorng- Shyong Onga, Li Liuc and Yun-Wen Chuangb, "RFID applications in hospitals: a case study on a demonstration RFID project in a Taiwan hospital", Hawaii International Conference on System Sciences, IEEE 2006.

[15] Travis Deyle, Charles C. Kemp, and Matthew S. Reynolds, "Probabilistic UHF RFID tag pose estimation with multiple antennas and a multipath RF propagation model", IEEE/RSJ International Conference on Intelligent Robots and Systems, Acropolis Convention Center Nice, France, Sept. 22-26, 2008