

RFID based Intelligent Environment for Adaptation of a Robot

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The intelligent environment for supporting a robot to recognize surroundings and execute tasks in the real environment has growing interest over the last few decades. The robot has difficulty in adapting the dynamically changing environment such as our daily environment with the limitation of installed functionalities. But in the intelligent environment, the environment actively furnishes own detailed information to the robot, and robot can adapt to the environment without any other additional effort. To construct such an intelligent environment, developing suitable platforms that can be used in the environment and the way that robot handles the environment are needed. Radio Frequency Identification (RFID) system can sense the unique identifier and other information without the need for a direct line of sight using the small RF tags affixed to objects, it can be used as the platform that senses and stores the environmental information in the intelligent environment.

The information of an object is composed of three parts, inherent information, spatial information, and status information. If robot uses a current RFID based object sensing system, the robot can acquire the inherent information, such as name, shape, color, size, etc. But RFID system can't offer the spatial and status information, so other additional functions are needed to the current RFID system. For this purpose, I proposed a location sensing active RFID reader and a sensor affixed controllable active RF transponder. The current RF tags are extremely low functionality devices that communicate with readers only and unable to detect the communications with other tags. The proposed transponder senses and stores the environmental status using installed sensors and communicates with other transponders and then performs a small scale sensor network environment. The reader joins to the sensor network and controls the transponder then it acquires the environmental status and handles the environment. Additionally, the reader determines the location of transponders with the loop antenna and signal strength detector.

Until now, I have developed the location sensing active RFID reader. This system is based on very simple electromagnetic theory. When electromagnetic wave is transmitted from the transponders, a voltage is induced in the loop antenna. The voltage strength is absolute sin of the angle between wave plane and loop antenna. Then we can know the direction to the transponder using the signal receiving pattern. The exact position is determined by triangulation technique. To validate the efficiency of the proposed system, I made a prototype 315 MHz RFID reader for location awareness and installed this system to mobile robot. Electrically small loop antenna and additional signal strength detector is used in the RFID reader. The sensing distance is above 10 m, and robot can find the location of transponder within max 50 cm error. The accuracy of the overall system fell within the reasonable range as we expected for indoor localization.

A future of my work includes the improving the accuracy of the system with the multi-axis array antenna and developing the controllable active RF transponder to build the intelligent environment.

The research result.

2004

ROBOMECH 2004 (Domestic) 6.18 ~ 6.20 (Nagoya)

H.P. : <http://www.toyota.nitech.ac.jp/robomec04/>

Title of paper : 3-D Localization Using a 3-Axis Orthogonal Antenna

INSS 2004 (International) 6.22~23 (Tokyo)

H.P. : <http://www.conferences.jp/inss2004/>

Title of paper : A 3-axis Orthogonal Antenna for Indoor Localization

ISRA 2004 (International) 8.25~27 (Mexico)

H.P. : <http://www.mecamex.net/isra/>

Title of paper : Object Location Sensing Using Active RFID Systems

2005

ROBOMECH 2005 (Domestic) submitted 6.9 ~ 6.11 (Kobe)

H.P. http://www.rescuesystem.org/robomec2005/japanese_index.html

Title of paper : Location sensing algorithms for active RFID

ICCAS 2005 (International) submitted 6.2 ~ 6.5 (Seoul, Korea)

H.P. : <http://2005.iccas.org/>

Title of Paper : RF Power Detector for Location Sensing

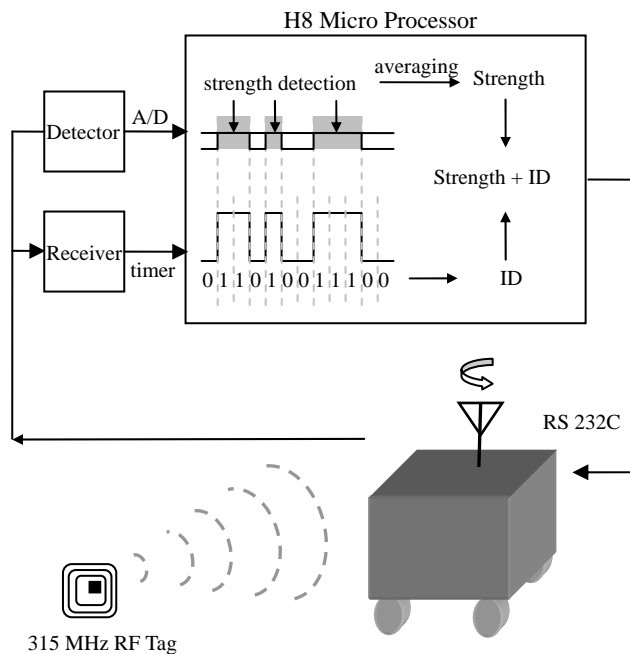
IROS 2005 (International) submitted 8.2 ~ 8.6 (Canada)

H.P. : <http://www.iros2005.org/>

Title of Paper : Toward RF-based Mobile Robot Localization

The developed system

The location sensing active RFID reader for mobile robot.



The proposed RF-based mobile robot localization system