Multi Automated Guided Vehicle (AGV) cardboard

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Multi Automated Guided Vehicle (AGV) cardboard carrier using wireless communication

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Abstract. This paper presents Automated Guided Vehicle (AGV) to move cardboard from one place to another using modul communication method as communication medium between AGV. In previous agv usage agv operation is done automatically with human monitoring to allow agv to operate within its working area and no accident occurs between agv. In this study, the input signal value of the received signal strength indicator (RSSI) method is used to control and regulate the alternate workspace. The test results show that the use of the received signal strength indicator (RSSI) method can optimize AGV work with work orders that are run interchangeably when some agv go to the same point. Furthermore, Line Follower system can accelerate the operation of Automated Guided Vehicle (AGV) on the determination of the operation path.

Keywords: *Automated Guided Vehicle, Received Signal Strength Indicator, NRF24l01*

1. Introduction

In the modern era, technological developments are getting increasingly advanced in various fields of industry. In the industrial world robotics technology is used to help solve existing problems. Today's technology, automatic vehicle to vehicle communication and vehicle to infrastructure communication using nrf24l01 module [1], has illustrated how to measure the distance between Automated Guided Vehicle (AGV) using NRF24l01 as a module. In this research, it is about how to find the distance using value received signal strength indicator (RSSI) to communicate between agv. Currently the application of control theory becomes more frequent to solve real problems.

Rusdinar et al [2] reduced the disruption of vehicle that was vertically measured from horizontal view using extended Kalman filter and artificial landmark on ceiling. This research discusses the movement control algorithm of weighted vehicle by trolley using Fuzzy Inference System [3]. Sensing and tracking of a moving object/human by a robot is an important topic of research in the field of robotics and automation for enabling collaborative work environments [4]. Jaiganesh et al entitled Automated Guided Vehicle with Robotic Logistics System[5] measured the distance between two nodes (we used NodeMCU as sensor node). The NodeMCU is an Arduino type board which runs on ESP8266 module

[6] indoor positioning is an interesting topic and an enabler in several fields of application, and consequently subject to a significant number of research activities [7]. Vehicle intelligent position systems based on Received Signal Strength Indicator (RSSI) in Wireless Sensor Networks (WSNs) are efficiently utilized [8]. Received Signal Strength Indicator (RSSI) location algorithm is a range based localization algorithm. It uses the connection between communication distances and the received signal strength to calculate the coordinates of unknown node [9].

Various techniques have been proposed in recent years, Broadbent et al [10] proposed the shortest time path planning problem without collision; MinLv et al [11] proposed a multi-AGV path planning algorithm based on directed graph. The biggest advantage of this algorithm is its efficiency. However, the shortcomings are obvious. It is only applicable to the directed map, making map utilization low. QiSun et al [12] used the improved Dijkstra algorithm to achieve global path planning. There are many guidance systems available and the selections are based on need, application, and environmental constraints. It is better to have guidance system which can be modified at low cost than high cost of modifying fixed-path equipment. Many researchers, tried to implement different methods in guiding the AGV on the production area such as magnetic sensor [13], On-board Camera [14][15]. Changing the values of RSSI due to the transmitters and receivers non idealities [16] and the influence the variability and accuracy of RSSI measurements. The device used as a wireless transmission medium that is on the wireless sensor network can be regarded as a transceiver module. Transceiver module utilizes radio frequency in digital data transmission. Examples of transceiver modules include nRF24L01, Xbee and Wifi Module ESP2866.[17].

In this research, we proposed an RSSI modification with the NRFl2401 module to control communication between AGVs. This study was conducted to overcome accidents and goods in the form of cardboard. We changed the speed by determining the direction and velocity caused by the creation of instability motion. Movement instability directly affects the related items. Motor speed is moving to make the vehicle move steadily. Input from the system results from ultrasonic motion. The selection of the sensors is placed on the location of the vehicle, which is outside the room. Because it is very susceptible to disturbances such as light, nrfl240 communication modem is used. The module becomes the best choice because it can be connected with AGV of this result and then into system input. Data input is processed in Primary Control System. The output is motor speed and parameter for PID controller.

In this paper, an innovative concept about a robot chain for cardboard carrier based on wireless communication has been presented. The multiple robots which coordinate and cooperate as a team is called robot swarm. There are a lot of related studied about robot swarm, such as aggregation collective behavior, pattern formation collective behavior, chain formation collective behavior, and self-assembly collective behavior [18], [19].

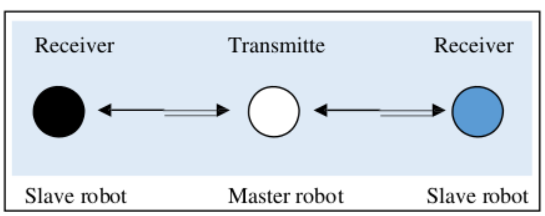

Figure 1. Master-slave-based robot chain wireless communication

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2. Methodolgy

2.1. Hardware design (Automated Guided Vehicle)

The purpose of this research is to identify In hardware parts which have arduino as control system to run automated guided vehicle, to carry the cardboard using gripper in motion using servo motor and at the bottom there is a color sensor to detect the track path with the propulsion using 12v dc motor. In this system, communication wireless is used to find signal so communication between automated guided vehicle can occur.

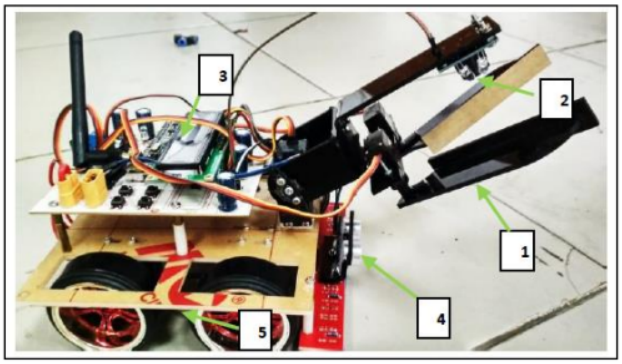

Figure 2. Hardware design system

Caption :

1. Gripper
2. Color sensor TCS3200
3. Main Control
4. Ultrasonic sensor
5. 12v DC Motor

2.2. Software – hardware integration

- Prepare materials and equipment to be created
- Prepare the required software install
- Construct the photodiode and other required hardware
- Open the arduino software and program the hardware to be created
- Incorporating the program on the master Robot and on the Slave Robot 1 and Slave Robot 2
- Construct the required track path
- Running Master Robot, Slave Robot 1 and Slave Robot 2.
- Data received by the photodiode which then runs according to the predetermined route
- The master robot meets the slave robot 1 and slave robot 2. Then the signal data from the master robot using communication wireless is sent to the slave robot 1 and slave robot 2.
- In master robot, the data is processed by communication wireless that produces signal with output of distance accepted by slave robot 1 and slave robot 2.
- After the slave robot 1 and the slave robot 2 receive the signal data from the master robot, the slave robot 1 and the slave robot 2 walk out the track and stop
- The master robot moves the item according to the color to the destination

2.3. System design control

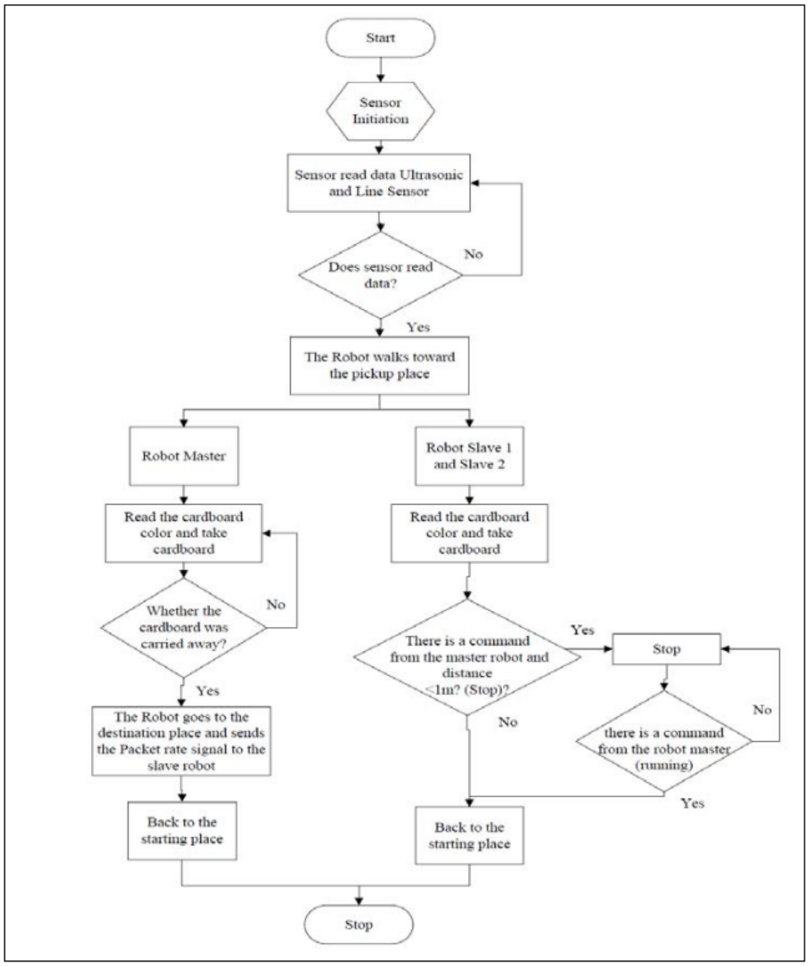

Figure 3. System Design Control

The picture above shows the system design of robot movement Automated Guided Vehicle (AGV) Master and Slave from the beginning to the end position. The system is continuous so when the robot has reached the destination, it is re-positioned again. Here the sensor is used to help the robot to be able to run well on its track and deliver the goods in accordance with the specified color, and the line sensor is used as a marker of the destination point of the robot and as a counter. Here the robot will start running when the goods have been received by the sensor, once it is read, the robot will walk to the location addressed by bringing goods according to color and send the RSSI signal to the slave robot, and then the slave robot will stop. The master robot and the slave robot will return to the original position when the task is fulfilled.

2.4. RSSI-based reliable communication

RSSI is a parameter indicating the power assigned to the channel frequency shown. This research is used to search for the strongest value and to communicate with the robots. In our proposed method, each agv robot is equipped with only a 2.4-2.5 GHz NRF24L01 module for communication

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between robots, which is also used for estimating the short distance between the robot and other adjacent robot. The robot can act separately and independently from each other. Each robot owns its unique channel of 2.4 GHz band. Only by using RSSI, it is possible to estimate the distance between a transmitter and a receiver of robot.

RSSI is an important parameter for the transmitter. It can be calculated using the measured transmission signal power and the path loss of microwave, just as follows:

$$RSSI(dB) = P_i(db) + G_i + G_r - L_{bf}(dB) \quad (1)$$

Where L_{bf} is the path loss of transmission, P_i denotes the transmission signal power, G_i and G_r is the antenna gain of transmitter and the receiver, respectively.

To estimate the path loss of the received signal (RSSI), a classic mode of received signal power can be defined as follows:

$$P(d_i)(db) = P(d_o)(db) + 10\gamma 10 \log_{10} \left(\frac{d_i}{d_o}\right) + N(0, \sigma) \quad (2)$$

Where $P(di)(dB)$ is the received signal power at distance di, $P(do)(dB)$ is the reference received signal power at distance di. γ denotes the parameter of transmission path loss, Moreover, $N(0, \sigma)$ represents a Gaussian random noise with zero mean and standard deviation parameter of σ. In our previous research, a NRF24L01 based communication system was developed for continuously generating and transmitting in 2.4 GHz band.

In wireless sensor network, a cell data device is radio device in which signal strength and signal quality are both measured in dBm(i.e. decibels relative to one milliwatt) and connected to the cellular tower. RSSI is a negative dBm value, values closer to 0 dBm are strong signals. Here we get an idea how and where the NodeMCU (NRF24L01) may be used in modern wireless technology.

$$P_{out} = 10^{\frac{dBm}{10}} \quad (3)$$

$$dBm = 10 \times log_{10}[\frac{P_{out}}{1mW}] \quad (4)$$

In this section, we discuss our methodologies to map the observed RSSI vector, $\mathbf{rv}[n]$, into the observation vector, $\mathbf{O}[n]$. *A. Distance Observations* To calculate distance, we employ one of the standard equations used in calculating the received power in a RF channel [20]:

$$\begin{aligned} P_{r,dBm} &= P_{t,dBm} + G_{dB} - \mathcal{L}_{ref} - 10\eta \log_{10} \frac{d^m[n]}{d_{ref}} + \psi \\ P^{ref}_{r,dBm} &= P_{t,dBm} + G_{dB} - \mathcal{L}_{ref} + \psi \\ \implies \frac{d^m[n]}{d_{ref}} &\approx 10^{\frac{(P^{ref}_{r,dBm} - P_{r,dBm})}{10 \cdot \eta}} \end{aligned} \quad (5)$$

where $Pr,dBm = avg\ \{\mathbf{rv}[n]\}$ is the average received power in our system, Pt,dBm is the transmitter power in dBm, GdB is the average antenna gain in dB, $\mathcal{L}ref$ is the path loss at the known reference distance $dref$ in dB, η is the path loss exponent, $dm[n]$ is the distance between the transmitter and receiver, $\psi$is the random shadowing and multipath fading noise in dB, and $Pref\ r,dBm$ is the pre- estimated received power at the reference distance ($dref$). More comprehensive details can be found in [21].

3. Testing and data analysis

The testing mechanisms include Collision Simulation, Tracking of the AGV cardboard carrier and simulating the distance between robots AGV by using RSSI to know the desired data analysis.

3.1. Collision simulation

Testing the whole system is done by using a sample of three prototypes, the scenario carried out in this experiment is simulated collision agv with colliding direction. The success parameter of this test is the occurrence of change in the position of the track by observing the distance and time of the experimental results. Then for parallel experiments it takes three prototypes that already have agv control circuit. The three prototypes will later be summed up as agv with different direction of movement as illustrated below:

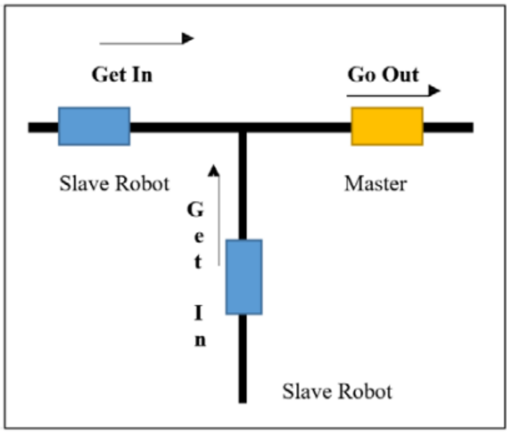

Figure 4. Testing of prototype collision simulation

The tests require a large enough space of up to 10 square meters, with slippery floor. The reference point used during the test is a reference point for movement in the Get In and Go Out areas. Further testing of the work response tool can be done by following the scenario according to the table below:

Table 1. Training data to find simulated collision testing scenarios

No	Prototype			Work Response
	Slave Robot 1	Slave Robot 2	Master Robot	
1	Get In	Get In	Get In	Work
2	Go Out	Go Out	Go Out	Not Work
3	Stop	Get In	Get In	Work
4	Stop	Get In	Go Out	Work
5	Stop	Go Out	Get In	Work
6	Stop	Go Out	Go Out	Work
7	Get In	Stop	Get In	Work
8	Get In	Stop	Go Out	Work
9	Go Out	Stop	Get In	Work
10	Go Out	Stop	Go Out	Work

3.2. Track of the AGV cardboard carrier

Overall testing by means of testing hardware that has been connected with another test is done by using the path and goods that have been determined. This test is intended to find the right program to be used on the robot in order to run as desired.

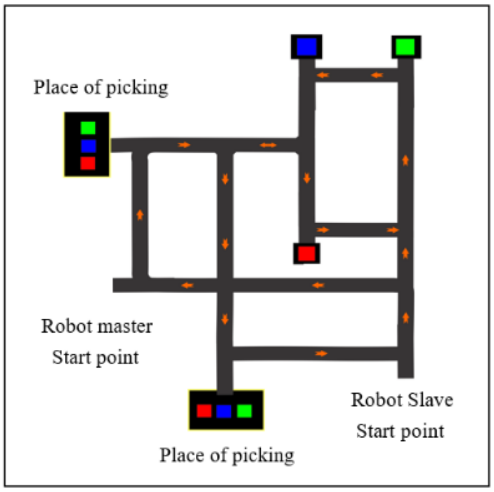

Figure 5. The path the robot passes through

In this experiment, the color sensor can capture the color. If the color sensor has not been able to capture the desired color, a darker similar color will be selected so that the goods carried is based on the color specified.

Table 2. Training data to find simulated appropriate color

No	Traveling time	Appropriate Color	%Error
1	21.47	Corresponding	20 %
2	20.62	Corresponding	
3	19.55	Corresponding	
4	21.06	Corresponding	
5	20.59	Corresponding	
6	Fail	Fail	
7	Fail	Fail	
8	20.66	Corresponding	
9	20.04	Corresponding	
10	20.22	Corresponding	

3.3. Simulating the distance packet rate between robots AGV using wireless communication
Testing simulation of distance between agv using rssi method is then used for communication between agv. Below is the graph obtained from the three agv and the result is a good or small data value.

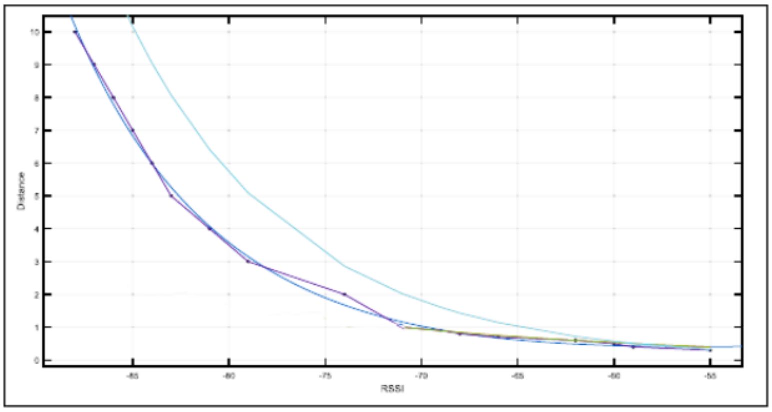

Figure 6. Compare between AGV estimated signal strength

4. Conclusion

We propose an AGV system of cardboard carriers and communication between wireless-based AGV, to autonomously communicate system between agv transmitter and receiver NRF24L01, and show our system performance and error statistics. However, there are many research questions that need to be addressed in our work in the future. First, we want to develop a carrier strategy with the right trade- off between Optimism and Pragmatism, which has the potential to improve performance. Second, we want to conduct a thorough evaluation of our system through a series of large-scale experiments. Lastly, we want to explore the domain of game theory to see if better or stronger predictions about the Leader's movement can improve performance.

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