DEVELOPMENT OF AUTOMATED GUIDED VEHICLE FOR WAREHOUSES.

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ABSTRACT

This research is to study and create prototypes of vehicles following line for warehouse. The objectives are as following (1) Design System of automatic material conveying for a walk along the flow smoothly. To create prototypes of automatic material-based vehicles for warehouses. This research has studied about the operation of the electrical system, PID programming to control motor operation and application of infrared sensors to detect the light reflection from black-white paths.

Results of the research can applied the use of infrared sensors to detect the black-white paths. When the vehicles moving outside the black-white path, the infrared sensors will send an alert to the controller program. Then, this program will analyze the mistake from the path that the sensors detect and adapt the result to calculate the speed of each motor. All of these processes can help the prototype vehicle to move in warehouse smoothly.

Keyword: Automated Guided Vehicle, Line Following, PID, Automatic Warehouse

INTRODUCTION

Based on the study of technology trends in 2017, the most popular technology is IoT Platform and Smart Robot technology that is in a period of great growth. The Internet of Think Platform (IoT) is the connection of all operations via the internet by linking data or operating machinery and equipment with just one mobile device.
Smart Robot is to create a robot for specific tasks by automation.

The researcher has the idea to adapt to the warehouse that wants to develop an efficient work system. By using robots to work for humans and the introduction of the internet to connect to work in order to control multiple machines by just one worker.

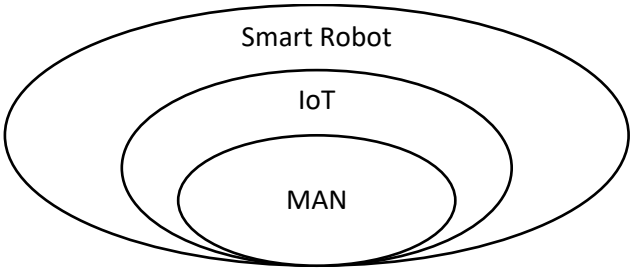


Figure 1 One man using internet control (IOT) to many Smart Robot

According to the study of warehouse operation system, there is a need to reduce work procedures, maximum space utilization and standard of operation. In Present, Warehouses are using technologies for help at work. Such as RFID, Handheld, Forklift, Conveyor and Crane, etc.

However, Technology has Big Change to Smart Bots and IOT work together to create new automatic for help working in the warehouse. Call this vehicle is Automated Guided Vehicle: AGV, which assists in warehouse operations in receiving goods and moving to storage points.

The initial development of AGV is to study the operation of the machine and create a small model of AGV in the initial stage. As a starting point for the step into Logistics 4.0 that brings technology and knowledge together. In this initial development, the goal was for the car to be able to move along a specified path, cornering, turning and straight direction smoothly.

OBJECTIVE

1. To design a system of Automated Guided Vehicle line following for the warehouse.
2. To create a prototype of Automated Guided Vehicle following line detection

METHODOLOGY

ECRS

The concept of reducing operational waste, also known as Waste, which is a cost incurred without creating any additional compensation or benefit to the organization, and in some cases may cause the operation to be slower than necessary.

E- Eliminate mean cutting unnecessary work processes in the process.

C - Combine mean the integration of working procedures to save time and labor.

R - Rearrange mean to solve problem for new solution in process plan.

S – Simplify mean reduce duplicate solution.

Take all of these principles into coding operation control reduce, combine and create new methods and reducing unnecessary steps.

PID controller

The proportional-integral-PID controller is a feedback control system. By using the error value in the operation as a calculator to reduce the error to the minimum by adjusting the input signal of the process by controlling the system into 3 types as follows

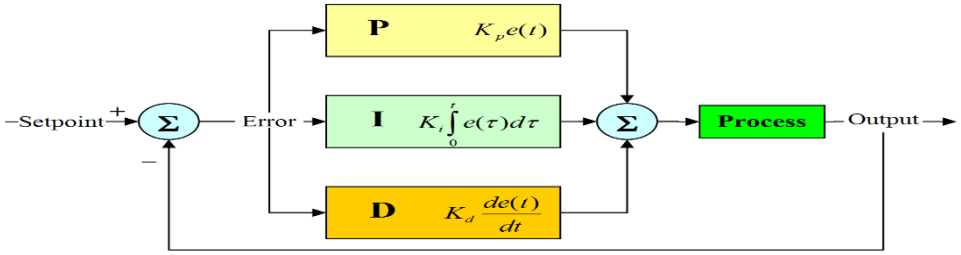


Figure 2. PID Control System

- Proportional Control or (P-Control) means control system by error signal detection.
- Integral Control or (I - Control) means control system by integrating the signal value.
- Derivative Control or D-Control means control system by Previous error value - Current error value.

Microcontroller

Microcontroller is a small control device, which contains capabilities similar to a computer system. Inside the microcontroller is a combination of CPU, memory and ports. In this project, use the Arduino Uno as a control board to receive signals and control the speed of the motor

Figure 3. Microcontroller: Arduino Uno

Arduino is a microcontroller board. This board has open-source development and apply to control hardware. The Arduino board designed to be easy to use. Therefore, it is suitable for beginners who study. Users can connect external electronic circuits by I/O pins of the board and can be used to control different devices including infrared sensors, light sensors, magnetic sensors.

Motor Controller

Motor Controller is a module used to control the speed and direction of the motor, which must executed from the Arduino Board by writing the code into the control board and then command the motor to move fast - slow or control the direction of rotation of the motor.

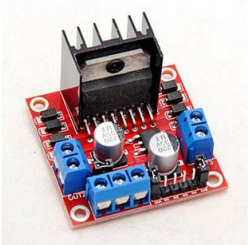


Figure 4. Motor Controller

Infrared sensors

IR Infrared Sensor Module. This module has a receiver and transmitter. The operation will send the light to impact the object, if the reflection of the light returns, will receive the signal value to 1 and if not reflect the light will show the value as 0

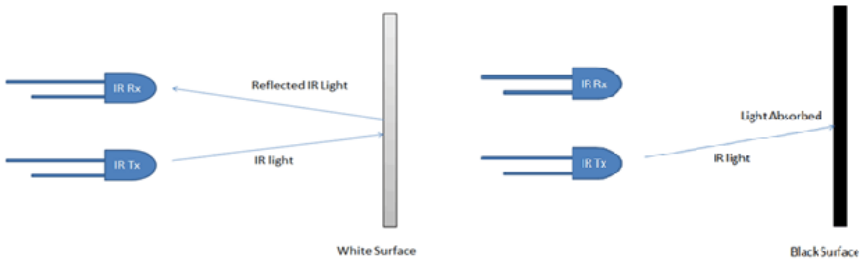


Figure 5. Infrared Sensors Operation

RESULTS

The study device, the researchers have guidelines to assemble a chassis that contains a plastic sensor 5-way Sensor Infrared Line Tracking Forum Motor Speed Control Motor Drive Shield dual L293D-board microcontroller's Arduino Uno R3 both. 4 DC motors, 4 gears at 1: 48 turns to help with the weight And a small power bank.

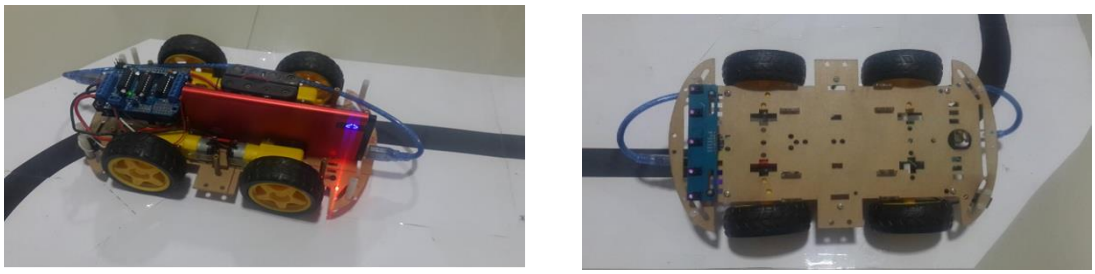


Figure 6. Structure Inside Automated Guided Vehicle: AGV Model

Figure 7. Automated Guided Vehicle: AGV Model Successfully Assembly

In the part, the researcher must understand the working principle of 5 sensors which are 2! X 2! X 2! X 2! X 2! equal 32 events. All of these events must be under the conditions of the bus routes

White Line = 1
Black Line = 0
White Line = 1

Figure 8. Display of Reading Reflection of road

From the operation of 5 sensors, the following events can occur.

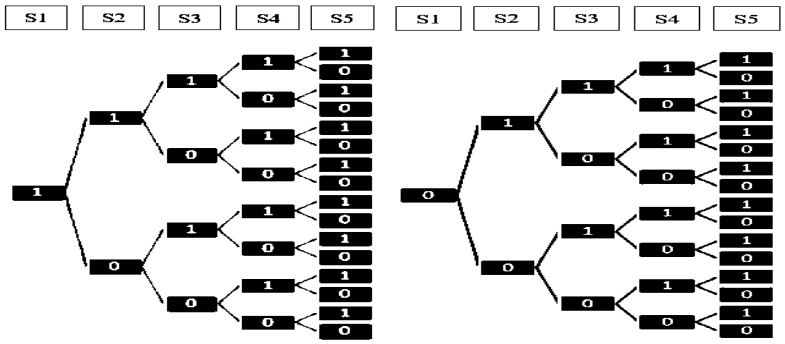


Figure 9. The possibility of occurrence of work 5 sensors.

Direct Control

In this step, write a program to control the motor directly (Direct Control), which must consider all the possibilities of all events. From the above studies, there are 32 possible events. However, in writing motor control programs, all possibilities must depend on the conditions of the vehicle's movement space. Which has the main travel path in black, resulting in the control program writing to reduce all occurrences to only 14 events as follows.

Table 1. Events and motor commands under road conditions for road movement

Event	s1	s2	s3	s4	s5	Motor Control
1	0	1	1	1	1	L = Motor on the LEFT working
2	0	0	1	1	1	L = Motor on the LEFT working
3	0	0	0	1	1	L = Motor on the LEFT working
4	1	0	1	1	1	L = Motor on the LEFT working
5	1	0	0	1	1	L = Motor on the LEFT working
6	1	1	0	1	1	M = Motor on the left and right working
7	1	0	0	0	1	M = Motor on the left and right working
8	1	1	0	0	1	R = Motor on the RIGHT working
9	1	1	1	0	1	R = Motor on the RIGHT working
10	1	1	0	0	0	R = Motor on the RIGHT working
11	1	1	1	0	0	R = Motor on the RIGHT working
12	1	1	1	1	0	R = Motor on the RIGHT working
13	0	0	0	0	0	Stop
14	1	1	1	1	1	Finding Line

PID Control

In this step, the program is writing a turn control program by using PID Control method which must bring all 14 possible events from the procedure to write program to control the motor directly (Direct Control) converted to Error (Error) to create A program for analyzing turning errors (P Control), including taking all the errors that occur a lot to analyze (I Control) and removing the previous error values with the values All current errors (D Control) are analyzed to calculate the answer to the speed of each motor to balance the movement and to be smooth.

Table 2. Converting event results to error values

Event	s1	s2	s3	s4	s5	Error
1	0	1	1	1	1	-5
2	0	0	1	1	1	-4
3	0	0	0	1	1	-3
4	1	0	1	1	1	-2
5	1	0	0	1	1	-1

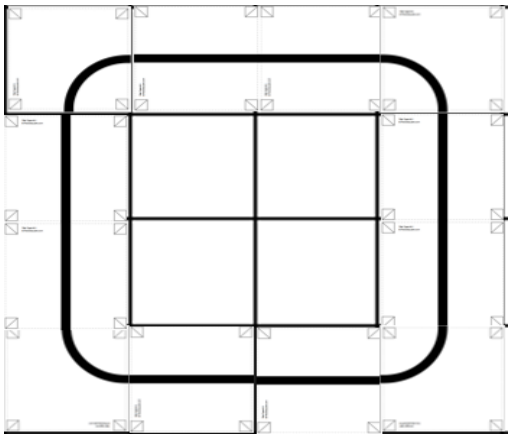
Event	s1	s2	s3	s4	s5	Error
6	1	1	0	1	1	0
7	1	0	0	0	1	0
8	1	1	0	0	1	1
9	1	1	1	0	1	2
10	1	1	0	0	0	3
11	1	1	1	0	0	4
12	1	1	1	1	0	5
13	0	0	0	0	0	Stop
14	1	1	1	1	1	Finding Line

In this process, a comparison of the performance of the motor control programming directly (Direct Control) with Proportional - Integral - Derivative (PID Control), with results as follows.

Table 2. Converting event results to error values

Test	**Direct Control** (sec)	**PID Control** (sec)
1	14.71	13.62
2	13.53	13.73
3	15.09	12.75
4	13.56	13.34
5	12.99	13.57
6	13.5	12.69
7	15.49	11.91
8	13.23	12.78
9	12.59	13.69
10	14.03	11.26

	SD (sec)	Slow (sec)	Mean (sec)	Fast (sec)
Direct Control	0.90	15.49	13.87	12.59
PID Control	0.76	13.69	12.91	11.26
Difference	-0.13	-1.80	-0.97	-1.33



Shows that the proportional-integral-derivative control (PID Control) is faster in movement than the direct control of the motor (Direct Control), both the slowest speed faster than 1.8 seconds, the average speed is faster than 0.97 seconds, the maximum speed is fast More than 1.33 seconds and with a variance less than 0.13 seconds

CONCLUSION AND FUTURE WORK

This research has studied to learning system of Automated Guided Vehicle Control. The objective of project to design a system of automated guided vehicle line following for the warehouse and create a prototype of line detection. Which the researcher has accomplished all objectives.

Construction of a prototype vehicle has studied from materials and equipment to find the equipment that meets the needs of the work. As a result, the vehicle has the proper equipment to work on building including a coding program to control the motor directly (Direct Control) and Proportional - Integral - Derivative (PID Control).

Comparative results of the program from the control Proportional - Integral - Derivative (PID Control) are quick movement over the motor control directly (Direct Control) both slow speeds far faster than 1.8 seconds. Average speed is faster than 0.97 seconds. Maximum speed is faster than 1.33 seconds and has a variance less than 0.13 seconds.

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