Advanced Line Follower Material Handling Device

Tejas Ingle[1] Vikrant Katkar[2] Indrajeet Anandiprasadnarayan[3] Jitendra Choudhary[4] Abhishek Shivgan[5]

[1]Assistant Professor [2,3,4,5]Student

[1,2,3,4,5]Department of Mechanical Engineering

[1,2,3,4,5]S.S.J.C.O.E, India

Abstract— Advanced line follower material handling device is a combination of mechanical & electrical ideas. Here concepts from mechanical engineering provide rigidity as well as primary vertical motion by scissor mechanism to the device. Electrical stream provide required automation with the help of microcontroller and its output and input devices. Previously there are many ideas regarding to the topic such as Automated Guided Vehicle or Line follower robot with obstacle avoidance but here we merge various concepts to contribute to the final output. This device is a material handling system that uses independently operated self-propelled vehicle guided along defined pathways. The vehicles are powered by on-board batteries that allowed many hours of operation between recharging. A distinguishing feature of the "line follower material handling device" compared to rail guided vehicle system and most conveyor system is that the pathways are unobtrusive.

Keywords: Material handling, Line Follower, Scissor Mechanism, Conveyor system, Obstacle Avoidance, Arduino programming

I. INTRODUCTION

The term "automated line follower material handling device" is a general one that encompasses all transport system capable of functioning without driver operation. The term 'driverless' is often used in the context of automated guided vehicles to describe industrial trucks used primarily in manufacturing and distribution settings that would conventionally have been driver operated. The line follower material handling systems are not found in all types of industries with the only restriction on their use mainly resulting from the dimension of the goods to be transported for special consideration.

Now days, to reduce human efforts and ensure efficient automatic transport system line followers are becoming popular. Especially in industrial areas these are used in large number to be an ideal industrial element, these robot need to provide high efficiency at minimum cost. That is robot should have the ability to follow complex line and on the other hand, it have to be simple easy to operate an inexpensive. Beside all other things if we reduce the number of sensors that will reduce the complexity and cost. But if we reduce the sensor it become very difficult for a line follower to detect Critical Angle such as 90 degree bend T- junction and + junctions so to achieve high efficiency with lesson search we have to find an appropriate algorithm as well as we have to set sensors at appropriate positions.

With the Improvement in modern technologies of production and as the world has adopted the latest global trade potential of Industry 4.0. There should be an upgradation in latest technologies for material handling to save time as well as capital. Automated material handling equipment witnessed a higher demand owing to increase need for the automation industries such as e commerce automated food and beverages due to the reduced operational cost improve supply chain process and reduce labor cost. Due to advancement in technologies such as introduction of vision guided navigation technologies which allow the vehicle to follow the route without any human intervention as further strengthened the market growth for automated transport equipment.

II. PROBLEM DEFINITION

Today we are facing various major problems regarding to Material handling in Industry, some of the problems are mentioned below:

A. Delay Production time:

During production of any product there is certain plan should accomplished in a way to achieve needs of market. Hence forecasting is done to achieve the same motive.

But poor material handling leads to delay in forecasting which later results in failure in desire production.

B. Industry Hazards:

In Industry where heavy weight material is difficult to handling leads various hazards such as fall, Machine guarding, Lockout, Repetitive movement causes to trouble in production line. Sometimes it causes a heavy loss to the manufacture.

C. Uses of Automobile:

Most of industry uses automobile for material handling. It has its own advantages but certain disadvantages must be underlined such as Skilled worker is required to operate this device also it requires a wide path for transportation. Poor skilled worker leads to several accidents and mismanagement in production line

D. Fuel Crisis:

Certainly automobiles used in Industry for material handling purpose are run on a convention fuels. Fuels are costlier day by day. Also they have limited storage. Due to combustion by products they emit a harmful gas which leads to Pollution.

E. Lack of Automation:

India arrives with Industry stage 4.0., but handling is still manually operated. It cost Labors, Time.

III. COMPONENTS

A. IR Sensor:

The Infrared (IR) sensors consist of Infrared (IR) LED and Infrared (IR) photodiodes. The IR LED is called photo emitter and IR photodiode is called receiver. The IR light emitted by the LED strikes the surface and gets reflected back to the photodiode. Then the photodiode gives an output voltage which is proportional to the reflectance of the surface which will be high for a light surface and low for dark surface. Light colored objects reflect more IR light and dark colored objects reflect less IR light.

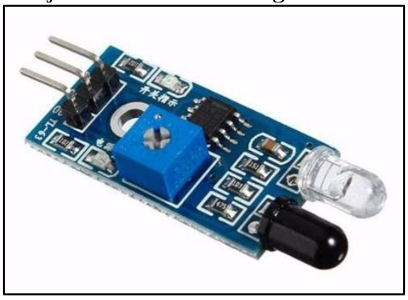

Fig. 3.1: IR Sensor

B. Ultrasonic Sensor:

Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to hear. They then wait for the sound to be reflected back, calculating distance based on the time required. This is similar to how radar measures the time it takes a radio wave to return after hitting an object.

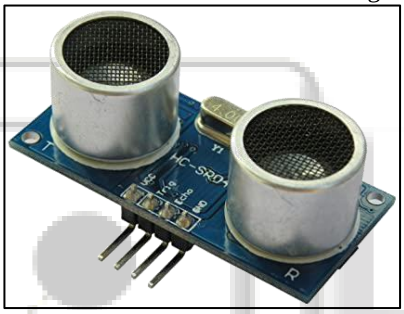

Fig. 3.2: Ultrasonic sensor

C. Arduino:

The Arduino Uno is an open-source microcontroller which has analog and digital board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

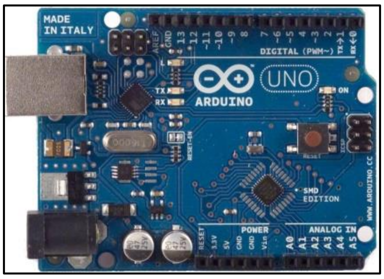

Fig. 3.3: Arduino

D. L298 Motor Driver:

The motor driver IC is an integrated circuit chip used as a motor controlling device in autonomous robots and embedded circuits. L298 is the most commonly used motor Driver IC that is used in simple robots and RC cars. A motor driver is undoubtedly something that makes the motor move as per the given instructions or the inputs (high and low). It listens to the low voltage from the controller/processor and control an actual motor which needs high input voltage. In simple words, a motor driver IC controls the direction of the motor based on the commands or instructions it receives from the controller.

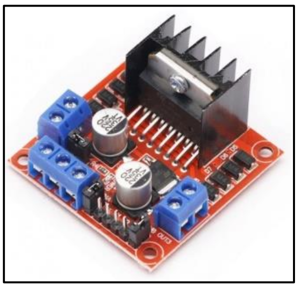

Fig. 3.4: Motor Driver

E. Motor:

High torque is required in this device since it has to carry load including its own. Hence we are using Planetary Motor of 50 Kg/cm of torque having 300 RPM and run at 12 Volt DC. Overall weight is act on shaft of motor hence we choose 8mm diameter having taper at one side for tightening purpose. It gives movement to the device or acts as a actuator which provides the motion. It also uses to actuate scissor mechanism in which rotary motion is converted into translation. In conveyer it will provide high torque to roll the roller which carries the load.

Fig. 3.5: Planetary motor.

F. Iron Strips:

Iron is a best material to be used in machine where several stresses such as shear and compressive stress are acted at same point. Hence galvanized iron strips are used in scissor mechanism. Also machining on this strips easy to align the precision that required in mechanism. These strips are easily available in a market and also economical as compare to the other material.

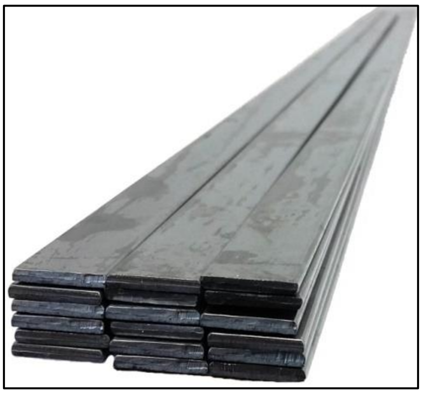

Fig. 3.6: Iron Strips

G. Conveyor:

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. They also have popular consumer applications, as they are often found in supermarkets and airports, constituting the final leg of item/ bag delivery to customers. Many kinds of conveying systems are available and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys.

Fig. 3.7: Conveyor

H. Sprocket and Chain:

A sprocket or sprocket-wheel is a profiled wheel with teeth, or cogs, that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.

Fig. 3.8: Sprocket

The roller chain design reduces friction compared to simpler designs, resulting in higher efficiency and less wear. The original power transmission chain varieties lacked rollers and bushings, with both the inner and outer plates held by pins which directly contacted the sprocket teeth; however this configuration exhibited extremely rapid wear of both the sprocket teeth, and the plates where they pivoted on the pins.

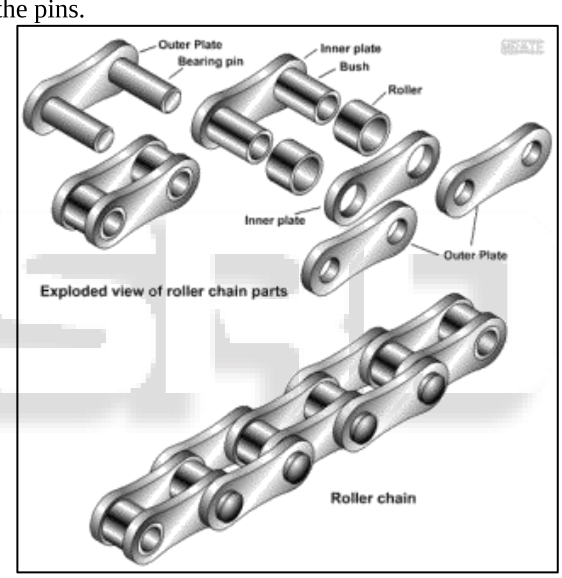

Fig. 3.8: Roller Chain

IV. PROGRAMME CODE

```
void setup() {
  Serial.begin(9600);
  pinMode(2,INPUT);
  pinMode(3,INPUT);
  pinMode(4,INPUT);
  pinMode(5,INPUT);
  pinMode(6,INPUT);
  pinMode(7,INPUT);
  pinMode(8,INPUT);
  pinMode(9,INPUT);
  pinMode(10, OUTPUT);
  pinMode(11, OUTPUT);
  pinMode(12, OUTPUT);
  pinMode(13, OUTPUT);
  analogWrite(10, 150);
  analogWrite(11, 150);
}
void loop() {
```



```
// Serial.print("1: ");
// Serial.println(digitalRead(2));
// Serial.print("2: ");
// Serial.println(digitalRead(3));
// Serial.print("3: ");
// Serial.println(digitalRead(4));
// Serial.print("4: ");
// Serial.println(digitalRead(5));
// Serial.print("5: ");
// Serial.println(digitalRead(6));
// Serial.print("6: ");
// Serial.println(digitalRead(7));
// Serial.print("7: ");
// Serial.println(digitalRead(8));
// Serial.print("8: ");
// Serial.println(digitalRead(9));
// delay(250);
//
/* ********************** *sensor */
// if(digitalRead(2) == LOW && digitalRead(3) == LOW
&& digitalRead(4) == LOW && digitalRead(5) == LOW
&& digitalRead(6) == LOW && digitalRead(7) == LOW
&& digitalRead(8) == LOW && digitalRead(9) == LOW){
//  digitalWrite(12, HIGH);
//  digitalWrite(13, LOW);
//  delay(100);
//  digitalWrite(12, LOW);
//  digitalWrite(13, HIGH);
// }
 if(digitalRead(2) == HIGH && digitalRead(3) == LOW
&& digitalRead(4) == LOW && digitalRead(5) == LOW
&& digitalRead(6) == LOW && digitalRead(7) == LOW
&& digitalRead(8) == LOW && digitalRead(9) == LOW){
digitalWrite(12, HIGH);
digitalWrite(13, LOW);
  }

if(digitalRead(2) == LOW && digitalRead(3) == HIGH
&& digitalRead(4) == LOW && digitalRead(5) == LOW
&& digitalRead(6) == LOW && digitalRead(7) == LOW
&& digitalRead(8) == LOW && digitalRead(9) == LOW){
digitalWrite(12, HIGH);
digitalWrite(13, LOW);
}
if(digitalRead(2) == LOW && digitalRead(3) == LOW &&
digitalRead(4) == HIGH && digitalRead(5) == LOW &&
digitalRead(6) == LOW && digitalRead(7) == LOW &&
digitalRead(8) == LOW && digitalRead(9) == LOW){
digitalWrite(12, HIGH);
digitalWrite(13, LOW);
  }
if(digitalRead(2) == LOW && digitalRead(3) == LOW &&
digitalRead(4) == LOW && digitalRead(5) == HIGH &&
digitalRead(6) == LOW && digitalRead(7) == LOW &&
digitalRead(8) == LOW && digitalRead(9) == LOW){
digitalWrite(12, HIGH);
digitalWrite(13, LOW);
  }
 if(digitalRead(2) == LOW && digitalRead(3) == LOW
&& digitalRead(4) == LOW && digitalRead(5) == LOW
&& digitalRead(6) == HIGH && digitalRead(7) == LOW
&& digitalRead(8) == LOW && digitalRead(9) == LOW){
digitalWrite(12, LOW);
digitalWrite(13, HIGH);
}
if(digitalRead(2) == LOW && digitalRead(3) == LOW &&
digitalRead(4) == LOW && digitalRead(5) == LOW &&
digitalRead(6) == LOW && digitalRead(7) == HIGH &&
digitalRead(8) == LOW && digitalRead(9) == LOW){
digitalWrite(12, LOW);
digitalWrite(13, HIGH);
}
if(digitalRead(2) == LOW && digitalRead(3) == LOW &&
digitalRead(4) == LOW && digitalRead(5) == LOW &&
digitalRead(6) == LOW && digitalRead(7) == LOW &&
digitalRead(8) == HIGH && digitalRead(9) == LOW){
digitalWrite(12, LOW);
digitalWrite(13, HIGH);
}
if(digitalRead(2) == LOW && digitalRead(3) == LOW &&
digitalRead(4) == LOW && digitalRead(5) == LOW &&
digitalRead(6) == LOW && digitalRead(7) == LOW &&
digitalRead(8) == LOW && digitalRead(9) == HIGH){
digitalWrite(12, LOW);
digitalWrite(13, HIGH);
  }

/* ********************* */
```

V. WORKING PRINCIPLE

Principle of our devices is distributed in several parts such as Line Following Principle, Obstacle detection principle & Principle of Scissor Mechanism. In line following we are using IR sensor which are equally distributed at the front end of device which detects the black line and send signals to the motor driver. In obstacle detection we preferred Ultrasonic sensors which has transmitter as well as receiver. It helps to avoid any disturbance in the path to pursuit harmless travel of device. And last principle is of Scissor mechanism which gives the vertical motion to the device.

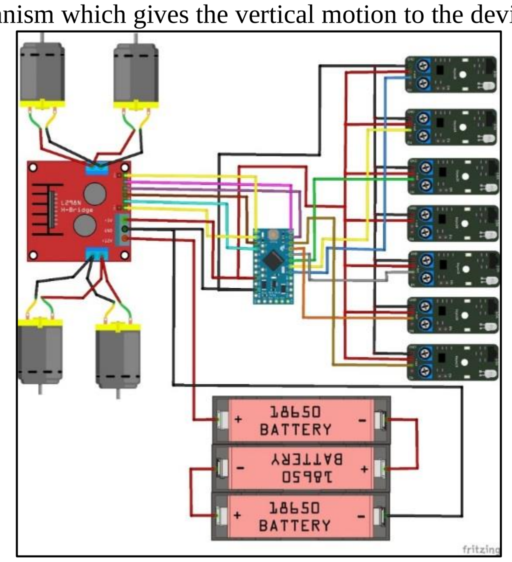

Fig. 5.1: Connections

The IR LED on getting proper biasing emits Infra-red light. This IR light is reflected in case of a white surface and the reflected IR light is incident on the photodiode. The resistance of the photodiode decreases, which leads to an increase in current through it and thus the voltage drop across it. The photodiode is connected to the base of the transistor and as a result of increased voltage across the photodiode, the transistor starts conducting and thus the motor connected to the collector of the transistor gets enough supply to start rotating. In case of a black color on the path encountered by one of the sensor arrangement, the IR light is not reflected and the photodiode offers more resistance, causing the transistor to stop conduction and eventually the motor stops rotating. Thus the whole system can be controlled using a simple LED-Photodiode-Transistor arrangement.

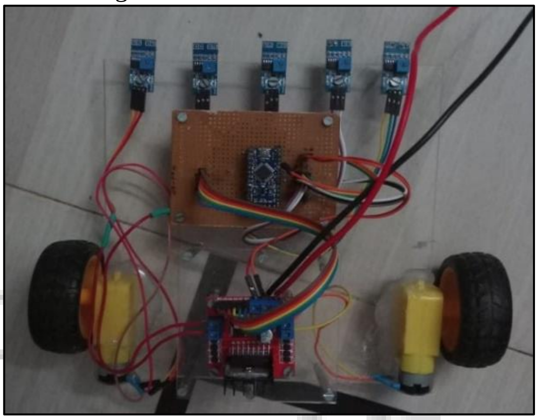

Fig. 5.2: Actual Demo

The ultrasonic sensor enables the robot to virtually see and recognize object, avoid obstacles, measure distance. The operating range of ultrasonic sensor is 10 cm to 30 cm. An optical sensor has a transmitter and receiver, whereas an ultrasonic / level sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic / level sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head. The ultrasonic sensor actually consists of two parts; the emitter which produces a 40 kHz sound wave and detector detects 40 kHz sound wave and sends electrical signal back to the microcontroller.

Fig. 5.3: Final Design

VI. ADVANTAGES

A. *Cost effective*

An AGV solution is highly cost-effective when multiple Pick & Deposit locations are required. Direct cost savings include labor savings, elimination of the costs related to product and plant damage caused by material handling, and saving the costs associated with fork trucks (e.g. training, maintenance, vehicle purchases/leases, etc.). The indirect cost savings include improved safety, increased efficiency, and improved product track recording.

B. *Flexible*

Easy to adjust to changing transport needs and capable of handling any load from standard pallets to paper reels, tote boxes and car bodies.

C. *Safe*

AGVs are probably the safest and most reliable means of transport available within industrial plants. The vehicle safety features must strictly apply to the safety standard EN1525:"Safety of industrial trucks – Driverless trucks and their systems".

D. *Expansion & Changes*

Adding extra routes or vehicles to meet new layout and performance requirements is easily implemented without production loss.

E. *24 Hour Service*

Battery power and automatic charging ensure continuous, reliable operation.

VII. ESTIMATE OF PROJECT

Sr.No.	Name of object	Cost
1	Base Robot chassis and supporting components	1105
2	Planetary Motor	6000
3	Battery	1500
4	Wheels	300
5	IR Sensor	40
6	Ultrasonic Sensor	160
7	Arduino UNO	335
8	Strips	500
9	Conveyor	2200
10	Sprocket & Chain	650
11	Labor & Machining Charges	600
12	Miscellaneous Charges	845
TOTAL COST		13,735/-

Table 7.1: Project Estimate

VIII. CONCLUSION

Advanced line follower material handling device is capable of taking industrial challenges with fulfilling the demands of growing automation. We constantly think and design the better aspects of material handling should done without depend on human being. During this process we come across many constructions, assumptions out of we select the method which is more economical as well as time convenient.

Our device is a combination of modern technology in electronics and classical mechanism given by stream of mechanical engineering. Hence it can be robust in construction but flexible in application.

We take challenge to our design to exact details of construction, combination and arrangement of parts as herein illustrated and described, but may be modified for better performance & ease of manufacturing.

Finally we conclude that it had been an outright delectation for us to get a chance to work such an interesting project, which we refer to as the most exciting, enriching and challenging experience in our curriculum. It created team spirit and help in united decision making.

The device is consisting of sensors, micro-controller, scissor mechanism & conveyor indicates such a beautiful merge of Mechanical & Electrical Theory.

IX. FUTURE SCOPE

There are several possible directions for further research; we can improve the line follower type handling device utilizing better navigation technique. It can be adopted any environment and economical among autonomous robot. There is significant amount of difference between theoretical and practical work cycle value of time, which can be optimized by adopting different methodology. In addition, one could think of the material handling devices so can multiple devices can operate in single floor efficiently. If they turn too sharply or drift the device should recover its track. It can be improvise by using more effective Arduino programming.

REFERENCES

[1] Natalia Hornakova, Lukas Jurik, Henrieta Chavnoca, Dagmar Caganova, " AHP method application in selection of appropriate material handling equipment in selected industrial enterprise" Springer Science Business Media 2019.
[2] Abhijeet Pathak, Refat Khan Pathan, Amaz Uddin Tutul, Nishant Tashin Tousi, Afsari Sultana Rubaba, "Line Follower Robot for Industrial Manufacturing Process" International Journal of Engineering Inventions Volume 06 Issue October 2017.
[3] Joanna Marie M. Baroro, Michael Lawrence T. Haung, Angelo A. Beltran Jr.(2014), "Automation of Packaging and Material Handling" Volume 06 Issue October 2014.
[4] Deepak Tarbada, Chaitanya Upadhya, Jay Patel "Study On Material Handling System" International Journal for Research in Technological Studies (IJRTS) Volume 4 Issue 3, February 2014.
[5] Mr.Subrata Talapatra, Md.Fashan, Md. Shah ali MohlaAshwini , (2013), "An Approach for Layout Improvement Of Production Floor Based On Material Handling Cost". Volume 06 Issue October 2013.

