International Research Journal of Advanced Engineering and Science
ISSN (Online): 2455-9024

Electromagnetic Metal Collecting AGV

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***Abstract*— *Scrap is one of the leading wastes generated in manufacturing industries. Collection of scrap is a tedious work and requires more labor work and is also a time consuming one. Thus this project emphasis the importance of scrap collection and an AGV is designed to eliminate the manual scrap collection. In our project we are eliminating the need of manually collecting the scrap in heavy industries. For this purpose we are designing an automated electromagnetic scrap collecting AGV controlled by an Arduino mega 2560 controller. Of the available methods of scrap collection techniques, manpowered and fuel powered vehicles are used. In the near future, the fuel deposits in the world will be completely depleted. To avoid this situation of problems and to reduce manpower requirements we are in need of other type of technique called as 'battery operated automated electromagnetic scrap collecting AGV'. The Arduino mega 2560 controller is used to control the Vehicle path automatically. The rechargeable battery is supplying power to the automatic scrap collecting. The Vehicle is having the one electromagnetic arm which is used to collect the scrap automatically.*

***Keywords*— *Electromagnetic arm, Arduino AT Mega 2560 micro controller, Metal detector, Rechargable battery.*

I. INTRODUCTION

We are pleased in introducing our new project "Automated Metal Scrap Collecting AGV", which is equipped by micro controller (Arduino mega 2560), driving mechanism and battery.

The power stored in the battery is used to drive the DC motor that causes the driving movement. The speed of rotation of DC motor i.e., velocity of Vehicle is controlled by the arduino mega 2560 controller. In existing Vehicle, pallet trucks, trolley use petrol or diesel as fuel for running and for operating them we use requires manpower. These types of Vehicles consume liter of fuel for a period of one hour.

For overcoming this disadvantage we have designed a vehicle which draws power from the storage battery. The power stored in the battery is used to drive the DC motor that causes the movement. The speed of rotation of DC motor i.e., velocity of vehicle is controlled by the arduino mega 2560 controller.

Battery assembled on the vehicle is easily replaceable and detachable. Path programmed for the vehicle in an arduino mega 2560 controller can be reprogrammed when required. The Vehicle is having on electromagnetic arm which is used to collect the scrap automatically.

II. EXPERIMENTAL SETUP

System design comprises components such as Arduino Mega (2560), Electro magnet, Servo motor, DC Motor, IR Sensor.

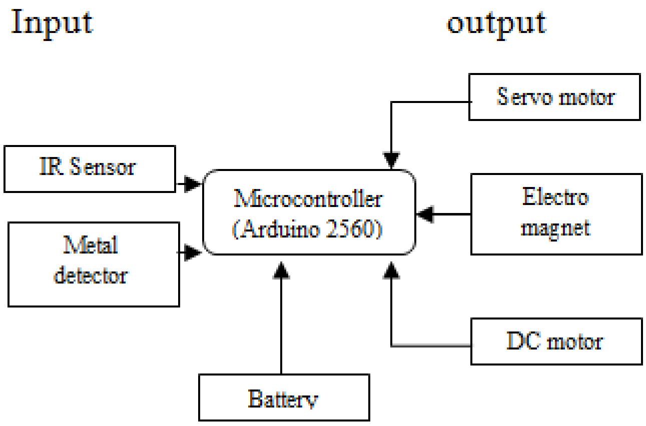

Fig. 1. System implementation design.

The above figure 1 describes the system implementation design where Arduino is the heart of the system because it controls the both input and output.

Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Diecimila.

The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

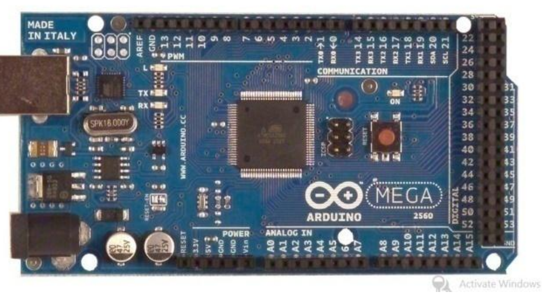

Fig. 2. Arduino mega 2560.

In this project we have used Arduino Mega 2560 (shown in figure 2) to control the input sensors and output such as

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motors, Electromagnet. The program for the project is coded using the Siemens software, which is downloaded in the hardware PLC. It has flexibility of changing the program whenever we want to made alterations in the conditions.

Servomotor:

Servos, are electro-mechanical devices most commonly found in radio controlled (R/C) airplanes, cars, and boats. However, as robotics becomes more popular, servo sales for robotics purposes account for an increasingly large percentage of the servo market share. Servos are small mechanical devices whose sole purpose is to rotate a tiny shaft extending from the top of the servo housing, Extending from the side of the servo is a thin cable comprised of three wires as shown in the figure 3. Two of the wires are used to send power to the servo's motors and one wire is used to send commands from the BX-24 to the servo.

Fig. 3. DC servo motor.

R/C hobbyists use servos to steer model airplanes, cars, or boats. Robotics use servos to drive the wheels of rovers and the legs of walking robots.

Motor drive:

Motor Drivers are circuits which allow control of your motors. You need them because you can't power a motor with just a microcontroller's supply. Motor Drivers are available in IC form, implemented in the form of an "*LM293D*". They allow you to switch on and off a motor using an output from a microcontroller, and the best feature is they allow you to run the motor in both forward and reverse! This means each motor has 2 dedicated inputs from a microcontroller, one for direction control and one as an ON-OFF switch. If you're using PWM (we are!) you need a pin capable of producing a PWM output to control the ON-OFF switch. The direction control can be connected to any other normal pin. You need not require the programming of the motors in reverse. If so, remember not to leave the direction control pin 'floating', and connect it to ground or high depending on your direction. Motor Drivers are available in both IC form as well as a 'module' or 'breakout board'. The breakout boards are handy, as the pins would have been extracted out for easy access. It's worth the little extra to keep the circuit on your robot clean! The inputs and outputs have neat screw holders too! Motor Drivers get extremely hot sometimes, and proper dissipation is necessary. Notice the large 'heat sink' in the module above. Another important factor many overlook is the maximum current the motor driver IC allows to pass through it. It should be high if we need more current to drive our motors. This physical limitation of the IC can also result in the slow movement of your bot. Remember to allow for ample current in your motors, and select a module/IC which has a motor driver capable of handling that current. We used IC is l293D, which allows for 500mA of current for each motor.

DC Motor:

DC motors are widely used, inexpensive, small and powerful for their size. Reduction gearboxes are often required to reduce the speed and increase the torque output of the motor. Unfortunately more sophisticated control algorithms are required to achieve accurate control over the axial rotation of these motors. Although recent developments in stepper motor technologies have come a long way, the benefits offered by smooth control and high levels of acceleration with DC motors far outweigh any disadvantages. Several characteristics are important when selecting DC motors and these can be split into two specific categories. The first category is associated with the input ratings of the motor and specifies its electrical requirements, like operating voltage and current. The second category is related to the motor's output characteristics and specifies the physical limitations of the motor in terms of speed, torque and power. As noticed, the torque provided can hardly move 30gm of weight around with wheel diameter of about 2cm. This is a fairly a huge drawback as the robot could easily weigh about a kg. This is accomplished by gears which reduce the speed (2400 rpm is highly impractical) and effectively increase the torque. If the speed is reduced by using a gear system by a factor of ρ then the torque is increased by the same factor. For example, if the speed is reduced from 2400 rpm, to 30 rpm, then the torque is increased by a factor of (2400/30 = 80) in other words the torque becomes 30 80 2400 gm-cm or 2.4 kg-cm which is more than sufficient.

TABLE 1. Characteristic.

Characteristic	Value
Operating Voltage	6V to 12V
Operating Current	2A Max. (Stall)
Speed	2400 rpm
Torque	30 gm-cm

Electromagnet

Use electricity to create a magnetic field. They can be controlled (turned on and off). Their force or strength of field can be controlled certain materials found in nature exhibit a tendency to attract or repeal each other. These materials, called *magnets*, are also called *ferromagnetic* because they include the element iron as one of their constituting elements. Magnets always have two poles: one called *north*; the other called *south*. Two north poles always repel each other, as do two south poles. However, north and south poles always attract each other. A *magnetic field* is defined as a physical field established between two poles. Its intensity and direction determine the forces of attraction or repulsion existing between the two magnets. Typical representations of two interacting magnetic poles as shown in figure 5, and the

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magnetic field established between them. Magnets are found in nature in all sorts of shapes and chemical constitution. Magnets used in industry are artificially made. Magnets that sustain their magnetism for long periods of time are denominated “permanent magnets.” These are widely used in several types of electric rotating machines, including synchronous machines.

However, due to mechanical, as well as operational reasons, permanent magnets in synchronous machines are restricted to those with ratings much lower than large turbine-driven generators, which is the subject of this book. Turbine-driven generators (for short: turbo generators) take advantage of the fact that magnetic fields can be created by the flow of electric currents in conductors. Schematic representation of a magnetic field created by the flow of current in a conductor. The direction of the *lines of force* is given by the “law of the screwdriver”: mentally follow the movement of a screw

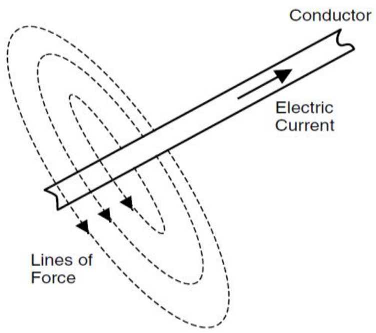

Fig. 4. Principle of electro magnet.

As it is screwed in the same direction as that of the current; the lines of force will then follow the circular direction of the head of the screw. The magnetic lines of force are perpendicular to the direction of current as shown in Figure 4. A very useful phenomenon is that, forming the conductor into the shape of a coil can augment the intensity of the magnetic field created by the flow of current through the conductor. In this manner, as more turns are added to the coil, the same current produces larger and larger magnetic fields. For practical reasons all magnetic fields created by current in a machine are generated in coils.

Metal Detector:

In this work, we depend on metal detector, because we need to decide object is metallic or non-metallic. A metal detector is a device which takes advantage of the electric and magnetic properties of metals (Eddy currents) to detect metals. Eddy currents are electric currents induced within conductors by a changing magnetic field in the conductor. The metal detector generates electromagnetic fields by passing an electrical current through the coil. The magnetic field surrounds the coil. If the object has a magnetic field, the magnetic field will create the current. As a result, the metal generates a magnetic field of its own, and the detector senses this field and detects metal. Metal detectors are used for security and industrial purposes. They are also used for the detection of treasures.

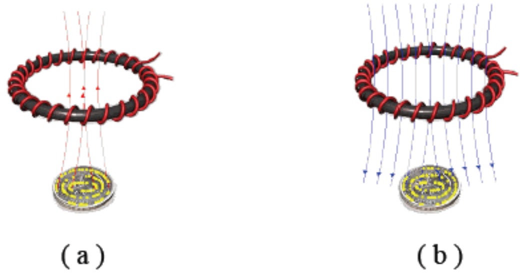

Fig. 5. Metal detector working.

A metal detector consists of simple sections, which are as follows: a) Search coil, which is the main section of the device. It is used in the metal detector and is sometimes called the detection head. b) LED indicators light up when the detection detects metallic object. The metal detector is placed in front of vehicle. When the vehicle moves, the metal detector is turned on to detect a metallic object. In case if the metal detector detects a metallic object, the vehicle will stop, because there are two wires are taken from the LED, which is exist in metal detector’s circuit, and they are connected with the amplifier’s circuit to receive a signal from metal detector. The amplifier’s circuit is responsible to send a signal to Arduino Mega, which controls the movement of the vehicle when it obtains the signal.

IR Sensor:

The IR Sensor-Single is a general purpose proximity sensor. Here we use it for collision detection. The module consists of an IR emitter and IR receiver pair. The high precision IR receiver always detects an IR signal. The module consists of 358 comparator IC. The output of sensor is high whenever it IR frequency and low otherwise. The on-board LED indicator helps user to check status of the sensor without using any additional hardware. The power consumption of this module is low. It gives a digital output. The following table gives its pin description.

TABLE 2. IR Connection.

Pin No.	Connection	Description
1	Output	Digital output (High or Low)
2	VCC	Connected to circuit supply
3	Ground	Connected to circuit ground

The sensitivity of the IR Sensor is tuned using the potentiometer. The potentiometer is tune able in both the directions. Initially tune the potentiometer in clockwise direction such that the Indicator LED starts glowing. Once that is achieved, turn the potentiometer just enough in anti-clockwise direction to turn off the Indicator LED. At this point the sensitivity of the receiver is maximum Thus; its sensing distance is maximum at this point. If the sensing distance (i.e., Sensitivity) of the receiver is needed to be reduced, then one can tune the potentiometer in the anti-clockwise direction from this point. Further, if the orientation of both Tx and Rx LED’s is parallel to each other, such that both are facing outwards, then their sensitivity is maximum. If they are moved away from each other, such that they are inclined to each other at their soldered end, then their sensitivity reduces. Tuned sensitivity of the sensors is limited to the surroundings. Once

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tuned for a particular surrounding, they will work perfectly until the IR illumination conditions of that region nearly constant. For example, if the potentiometer is tuned inside room/building for maximum sensitivity and then taken out in open sunlight, it will require retuning, since sun's rays also contain Infrared (IR) frequencies, thus acting as an IR source (transmitter). This will disturb the receiver's sensing capacity. Hence it needs to be returned to work perfectly in the new surroundings. The output of IR receiver goes low when it receives IR signal. Hence the output pin is normally low because, though the IR LED is continuously transmitting, due to no obstacle, nothing is reflected back to the IR receiver. The indication LED is off. When an obstacle is encountered, the output of IR receiver goes low; IR signal is reflected from the obstacle surface. This drives the output of the comparator low. This output is connected to the cathode of the LED, which then turns ON.

III. WORKING

1) *Algorithm*

The general algorithm "Figure 6" has main steps to accomplish the general tasks, which are tart, travel, stop, drop, pickup, and end. The program will begin with start step; through this step the Arduino Mega will run and check for pins and then go to the next step, which is travel. During this step, the robot moves and utilizes both the metal detector and IR sensor to check for any passing object. In case the detector or IR sensor finds an object, the robot will go to stop step and then pickup step to pick the object up. After that, the robot will check if the object is metallic object or not through passing it over the metal detector.

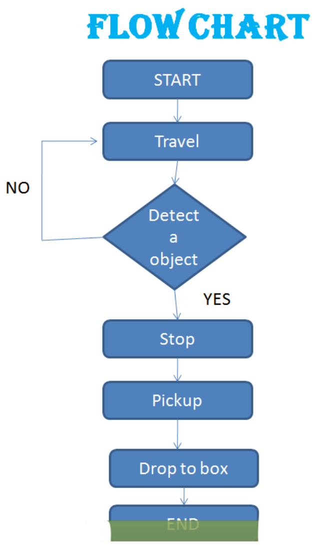

Fig. 6. Flow graph.

In case if the object was metallic the robot will go to drop step and drop it in box 2 with increment the Metallic counter then check for the limit of metallic object counter. In case if metallic counter equal to the limit of metallic object counter, the robot will go to end step. Otherwise, the robot will return to the travel step till it finds another object. On the other hand, if object was not metallic, the robot will go to drop step and drop it in box 1 with Increment the non-metallic object counter then check for the limit of non-metallic counter. In case if non-metallic counters equal to the limit of non-metallic object counter, the robot will go to end step. Otherwise, the robot will return to the travel path.

a) Obstacle avoidance

First of all, the robot starts with reading and determines the path free of obstacles. In the case of the readings being less than or equal

To the allowable distance limit, the robot will stop and go back to find another path. In the other case, if reading was greater than distance limit the robot will continue to move.

b) Detection

This task depends on metal detector and IR sensor. The robot obtains a signal from both metal detector and IR sensor when it finds any metallic or non-metallic object; the robot will stop and pick it up. In case, if metal detector does not detect a metallic object the robot will still depend on IR sensor to check if there is any non-metallic object stuck in bulldozer.

c) Arm movement

As we mentioned in Lynx5 robotic arm subsection, the robot's arm has six servomotors and each of them can move from 0 to 180 degree. In this work, we depend on inverse and forward kinematics to calculate angles for all these servomotors. This challenge is to operate the arm smoothly. First, we ranged the arm's angles for all servomotors. Second, we designed our method to move this arm smoothly to pickup any metallic or non-metallic object and drop it in proper box.

IV. CONCLUSION

Our goal was to build a robot that can discover and collect metallic object in an industry. We used Arduino mega microcontroller with motor shield to control this robot. We demonstrated the working of this robotic system using a set of experiments that are monitor to the actual environment. Finally, this modular system can be extended to handle waste in the all industry.

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