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# Automatic Driverless Dust Dump Truck

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***ABSTRACT***

***The dust dumping vehicle designed here travels along the defined path and reaches dumping yard automatically. When the vehicle reaches to the dump yard, it itself finds Open place and the material inside the truck will be unloaded automatically. Since it is a driverless vehicle, lot of care has been taken while designing the Electronic Hardware. The whole circuitry including motors is designed to operate at 12V DC. For this purpose huge rating of Lead Acid rechargeable battery is used. This kind of vehicles can also be used for various applications in industries, factories like Cement Factories, Stone Crushers and Coalmines etc. Presently lot of manpower is utilized for loading as well as for dumping the materials. Therefore this vehicle is designed, which minimizes the manpower and saves time as well. The vehicle also can be used for dumping the waste material; hence this vehicle is quite suitable for municipality and other suitable sectors.***

***The vehicle is designed with three DC motors in which two motors are used to drive the vehicle and the third motor is used for lifting the dust container in one angle. Path sensing circuit as well as place finding circuit is designed with infrared sensors. Once the vehicle enters into the premises of the dumping yard, it immediately checks for open space to dump the dust. At the entrance of dump yard, an optical sensor is arranged and when the vehicle reaches near to it, the receiver over the vehicle will be activated and a signal is generated which is fed to the microcontroller for identifying the dust dump yard. After that place finding circuit identifies the open place automatically and the vehicle stops for a while for unloading the material. The empty truck returns to its destination for refilling the dust again. The loading process should be done manually.***

The primary design of this mobile robot is accomplished with the construction of basic chassis including drive system and wheel mechanism. The complete structure of the vehicle can be broadly viewed as consisting of following subsystems.

1. Path sensing
2. Zone identification
3. Open place sensing
4. Container lifting Mechanism
5. Body wheels with their driving system
6. Micro-controller unit
7. Battery with Charger.

Two Plastic Wheels with Grippers are used as back wheels and these are coupled to the shaft of DC motors individually. The front wheels are designed to rotate freely. The movement of the back wheels is precisely controlled with the help of DC motors. The motors used are of in-built reduction gear mechanism type. So a small motor will be able to drive higher loads.
The entire Electronic circuitry is placed on the body of the vehicle along with the micro-controller unit. The outputs of all the sensing circuits are interfaced to the micro-controller and based on this output the controller generate the necessary logical signals for driving the motors.

These kinds of mobile robots can be easily employed in numerous real time applications like Material handling, Office automation, in Hazardous, Slummy and inaccessible Environments. Also in places, which are uncomfortable or unpleasant for human workers. (Ex: in deserts, premises of nuclear stations etc.)

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## Literature Review

To reduce the human efforts on a mechanical maneuvering in the present worldDifferent types of robot automatic technologies are being developed.The machine is nothing but a Mobile Truck, which can be used for carrying the material in a specific route from the process units to dump yard. This kind of automatic dumping trucks can be used for various applications, for example Cement Factory. In cement factories huge quantities of processed material are available at the site of processing unit, this material can be carried up to dumping yards. Another example is coalmines; at the site of coal mine, coal is carried from inside mine to ground level through conveyor belt system and it is dumped at the other end of belt system, this area is called as coal collecting point. At these points lot of coal is accumulated and it is supposed to be lifted and carried up to the dump yards as earliest. Hence this kind of vehicle is quite suitable, which completes the job in less time.

There are three important topics that service robot must take into account which are the navigation strategy, control architecture, and sensory system.The selection of using which navigation method is based on the situation, environment and the budget for the particular robot.

Regarding to control software for the robot, there are standard software`s are available. Currently in this project work KEIL software is used to program the robot for object sorting. Some of the requirement of Electro-Mechanical Equipment`s for the project

- Reduction Gear Motions, DC Motors, IR Sensors.
- Limit Switches, PCB(Printed Circuit Board).

Worm Gear mechanism,
Microcontroller(ATMEL89C52).

## FUNCTIONAL DESCRIPTION OF THE PROJECT:

The overall function of this project is to create a robot that will follow a specific color of line, reaches to its destination carrying the material (dust) dumped into it and reach the destination (dump yard) to unload the material sensing it and again reach the home position for loading the material for dumping. To achieve this, a step-by-step systematic approach is essential to get good results. The first step is to design the reference points where the material will be loaded (home) and where it should be unloaded i.e., dump yard. So this section is designed using IR sensors to transmit the information about the home position and dump yard. After the vehicle coming to the home position, by pressing the start button, the vehicle movement following the path will be started to dump the dust in the dump yard.

So one autonomous robot, which follows the line is designed to carry the material. A line following robot is a precursor to other autonomous robots not confined to following a line. Line follower is a machine that can follow a path. The path can be visible like a black line on a white surface (or vice-versa) or it can be invisible like a magnetic field. These robots can be used to explore places too dangerous or otherwise impossible for humans to go. This robot is designed with a sensor array, controlling circuitry, and motors working together to follow a black line and sense the destination point to dump the material.

The sensor array is designed with two sets of optical sensors; these sensors are arranged below the vehicle at front side. The main function of these sensors is to detect the black line, if any deviation is there in the vehicle movement, that information is fed to the microcontroller. Path sensing with optical sensors is interesting subject, therefore detailed description of this is provided in following chapters. Depending up on the information produced by the sensors, the microcontroller controls the vehicle motors through the ‘H’-bridge IC and reaches the destination point which is detected through the IR sensor. The *navigator* plans a path to the destination to dump the material and follows the same path to return to the home position through one more set of sensors at the back of the vehicle. The program sends steering and drive commands to the trolley to move it along the planned path.

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This line follower is designed using 89C51 microcontroller, IR sensors, Motor Driver (LM293D) and DC motors. At the bottom, it has line sensor array to detect the line and send signal to microcontroller for accurate control and steering of motors. Microcontroller AT89C51 and motor driver L293D are used to control the motors.

**Basic operations for line following robot are as follows:**

1) Capture the black line with the help of mounted sensors on the vehicle front and back while moving forward and backward respectively. The sensors used are optical i.e. they consisting of transmitting and receiving LED's.
2) Steer the vehicle to track the line with differential steering method. This is achieved by using two DC geared motors.
3) Sense the home, destination and vacant points through the IR sensors.
4) Dump the material at the destination point and move to the home position.

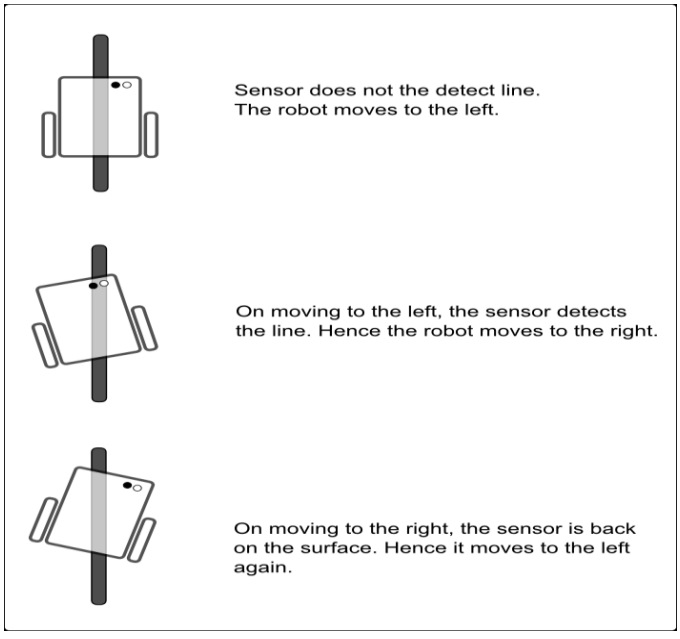
### 3.2 Line Following & material Dumping Structure

Structure of the line following vehicle can be divided into several parts as follows.

- DC geared motors
- Motor Drivers
- AT89C51 microcontroller
- Chassis and body structure

### 3.3 Path sensing block

The path-sensing block is designed with four sets of IR LED's arranged at the bottom of the vehicle, in which two are at the front and two are the back of the vehicle. Each set contains IR signal transmitting LED and IR signal detector. Both the LED's are arranged side by side with a distance of 1cm approximately. As long as the transmitting LED is over the black tape, the IR signal is not reflected; hence the receiving LED doesn't receive any IR signal. If there is any deviation, in that condition the transmitting LED is out of track, there by the signal is reflected by the normal floor and this reflected signal is detected through IR signal detector. The output of the detector is amplified through a transistor and is fed to micro controller through NOT gates. These NOT gates are used to generate a perfect logic output, which is essential for the microcontroller. Likewise the controller receives different logic signals from these two pairs of IR LED's. These two sets of sensors are denoted as left sensor and right sensor and these sensors are arranged below the vehicle at front side and back side of the vehicle to navigate in both the directions. The controller program is prepared such that, as long as it doesn't receive any signals from both the sensors, the controller drives both the motors simultaneously, there by the vehicle moves in forward direction in straight line. It means both the sensors are located exactly parallel to the path. For example: if the controller receives signal from the left side sensor, that indicates the vehicle is not exactly parallel to the path, it has deviated to the left side. Sensing this, immediately the controller stops the right motor and because already the left motor is in motion, automatically the vehicle reaches to its path. Similarly the controller also senses the right set of sensors for the deviation. The main activity of this block is for sensing the presence/ absence, deviation or turnings of the route i.e., the path.




Line Following with Only One Sensor Pair

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## RESULTS:

The project work "Automatic driver less dust dump truck" describes about design and development. For the demonstration purpose prototype module is constructed with the involvement of various fields like electrical, electronics and mechanical. The subsequent relation of these three fields was made creating this machine, therefore the subject can be called as Mechatronics. To make the machine "Autonomous", software is also included in this project work. The machine is designed to dump the material at dump yards; it can be utilized for various other applications also.

The machine is nothing but a Mobile Truck, which can be used for carrying the material in a specific route from the process units to dump yard. Dumping process is automatic, as mentioned in the abstract, when the truck reaches to the dump yard along with its path; automatically it senses empty space for dumping the material. This kind of automatic dumping trucks can be used for various applications, for example Cement Factory. In cement factories huge quantities of processed material are available at the site of processing unit, this material can be carried up to dumping yards. Another example is coalmines; at the site of coal mine, coal is carried from inside mine to ground level through conveyor belt system and it is dumped at the other end of belt system, this area is called as coal collecting point. At these points lot of coal is accumulated and it is supposed to be lifted and carried up to the dump yards as earliest. Hence this kind of vehicle is quite suitable, which completes the job in less time.

## CONCLUSIONS:

The project work designed and developed successfully, for the demonstration purpose prototype module is constructed and results are found to be satisfactory. We have given lot of importance for the mechanical structure; for this purpose lot of mechatronics books related to the electromechanical structures are referred, and a good-looking robust mechanical structure is designed. All electronic hardware including mechanical transmission section is mounted to this structure. Heavy-duty battery is also accommodated over the structure. Three small DC motors with built in reduction gear mechanism are used to drive the line following vehicle and dump the material at the destination. Same way one DC motor is used at the home position to lift the container and dump material into the vehicle container through worm gear mechanism.

The major and critical task is preparing the software for performing the tasks depending on the inputs. The performance of the machine purely depends on the software (code) we define in the controller. The technology utilized here is for developing the prototype module only; it has to be enhanced to develop it into a real working system.

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