Automated Guided Vehicle For Chirr Pine Collection

Project Submitted to
University Of Petroleum And Energy Studies
In partial fulfilment of the requirement
For the award of the degree

Bachelor Of Technology
In
Automotive Design Engineering

Project work carried out at

Energy Acres, Bidholi

UPES Dehradun

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Submitted To :Dr. Pankaj Kumar Sharma

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Dehradun, Uttarakhand 2012-2013

CERTIFICATE

This is to certify that the project work on "**Automated Guided Vehicle-For Chirr Pine Collection**" submitted to the University of Petroleum & Energy Studies, Dehradun, by **Mr. Jagjeet Singh Sehgal, Vishal Sharma , Rajat Rathi** as major project in Automotive Design Engineering during Academic session 2012-2013 is a bonafide work carried out by him under my supervision and guidance.

Signature of Project Guide:

Name: Dr. Pankaj Kumar Sharma

Designation: Assistant Professor (SG)

Declaration

'Project Title: Automated Guided Vehicle – For Chirr Pine Collection'

The Project Dissertation is submitted in partial fulfilment of academic requirements for B.Tech. This major project is a result of my own investigation. All sections of the text and results, which has been obtained from other sources, are fully referenced. I understand that cheating and plagiarism constitute a breach of University regulations and will be dealt with accordingly.

Signature:

Name of the Student: **Jagjeet Singh Sehgal, Vishal Sharma, Rajat Rathi.**

Date: **26-April-2013**

Acknowledgement

We express our deep sense of gratitude and indebtedness to Prof. Pankaj Kumar Sharma, Assistant Professor (SG), Department of Mechanical Engineering for his valuable advice, constant encouragement and constructive criticism during the course of the project and also during the preparation of this manuscript. We place on record the valuable suggestions and numerous constructive comments rendered by Prof Deepak Bharadwaj, Assistant Professor, Department of Mechanical Engineering and for being our internal guide in the design and implementation of our project.

We are highly indebted to all the staff members of Mechanical Department for their wholehearted support and co-operation.

We also express our sincere thanks to all the classmates for their support and co-operation in completing the project work.

Above all, we should express our supreme gratitude to almighty God for making this project a reality.

Abstract

An AGV is an Automated Guided Vehicle that generally follows a line, a matrix or a laser to complete a task. We will be fabricating an AGV that has the potential to collect pine leaves from a rough surface at an incline of 60 degrees. Therefore, we cannot use a line or matrix for the AGV to follow since the surface will be very irregular. So, instead of using simple Artificial Intelligence, we will be using DAI (Distributed Artificial Intelligence) which is a much more advanced form of Artificial Intelligence.

We will start with the base design that is, deciding the various parameters required, which depend upon the type of terrain we will be using the vehicle on. The parameters include the basic dimensions and various payloads. After the parameters have been decided, we will convert our hypothesis into a CAD model followed by its analysis. This will be followed by the fabrication of the prototype. Testing and presentation of the report will be done after the completion of fabrication.

An AGV with an independent suspension system is the best suited vehicle for hilly terrains. The efficiency of the vehicle is not very high but it has a productivity increasing feature due to its flexibility of path, central control and ability to add sensors to detect the payload conditions. But it has some disadvantages; it should be recharged periodically, and has high initial cost. The Advantages of the AGV far shadow over the disadvantages and hence it is concluded that this is the best suitable mean for collecting chirr pines.

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List Of Nomenclature

a	= Acceleration (m/s^2)
F	= Force (N)
N	=Speed (RPM)
CG	=Centre of Gravity
W	=Track width (m)

List of Figures

Chapter 1 – Introduction

The project is based on developing a prototype that can climb a hill i.e (All Terrain vehicle) and collecting of chirpine leaves.This veichle should be so intelligent enough so that it can take its own decision during barrier or any obstacles that comes across d vehicle .By the help of this vehicle, forest fire can be avoided and these chirpine can be further used to generate electricity.

This project is totally based on robotics For that, we need to understand what a robot is. It is a system that contains sensors, actuators, control systems, manipulators, power supplies etc. combined together to perform a specific task. The use of robots in the industries is continuously increasing and a graph has been provided to support the statement.

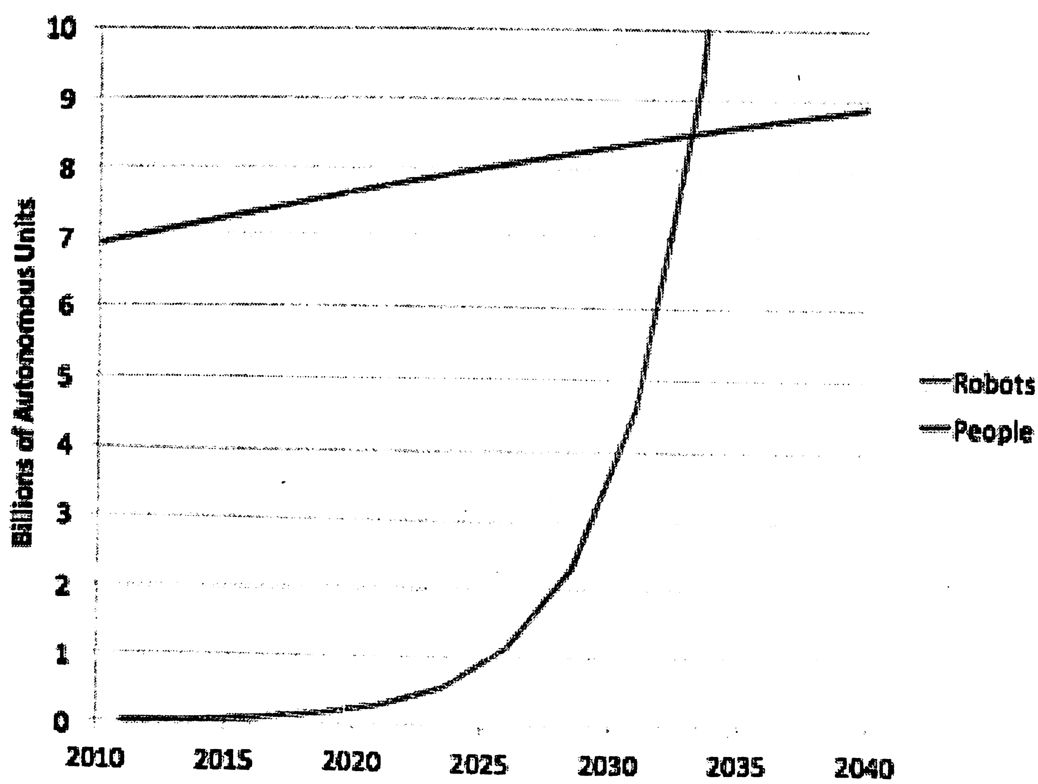


FIG-1.1

Our project comprises the use of robotics and mechanics to make an automatic guided vehicle. Let us begin with an introduction to Automatic Guided Vehicles commonly known as AGVs. The concept of AGVs came way back in the 1950s. The first actual AGV was developed in 1953.

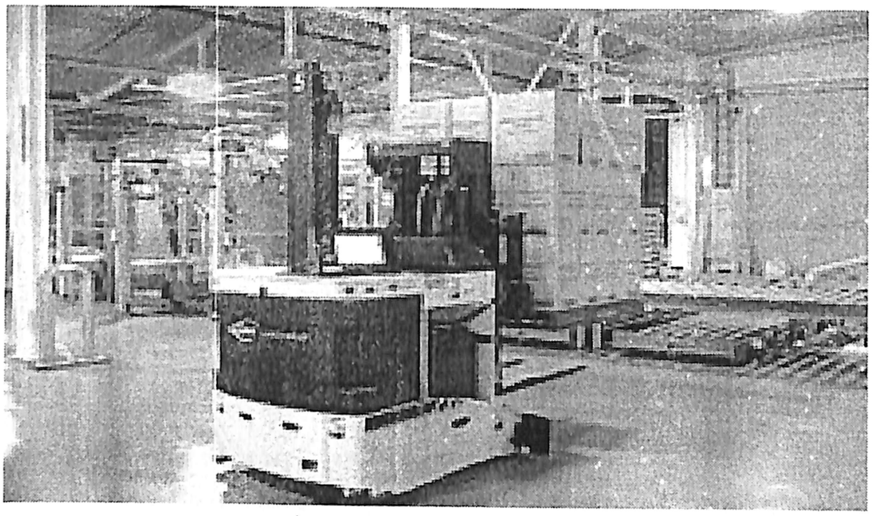


FIG-1.2

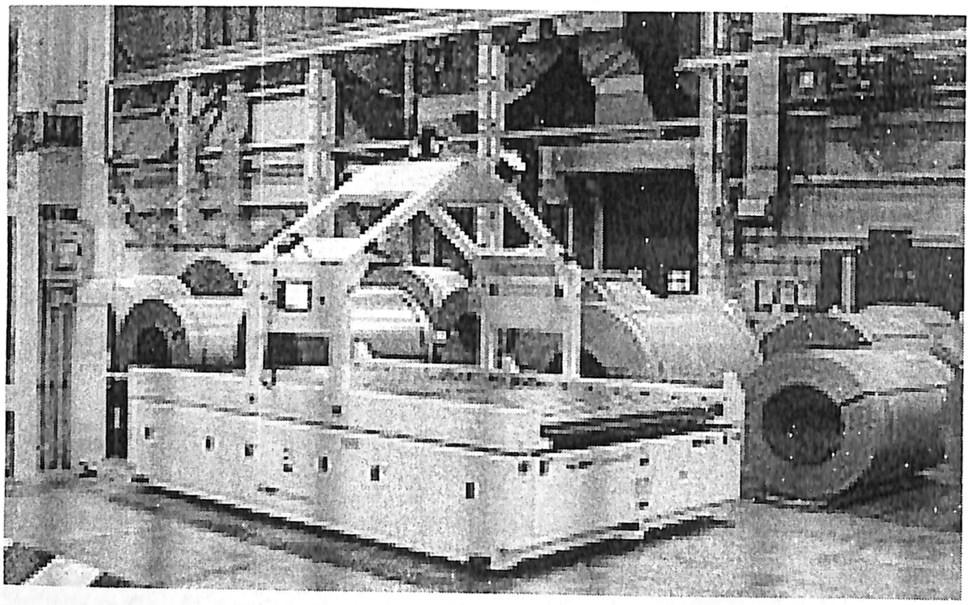


FIG-1.3

The AGVs shown above are used in various industries like Pharmaceuticals, Baking industries, Civil and Infrastructure industries, construction sites, Automotive industries, etc.

WORKING OF AGV

AGVs follow a line, a matrix or a laser on the floor to guide them to their destinations and perform the task. A program is fed into the memory of the vehicle and sensors and cameras are provided on the vehicle which act as the sensory organs and help the vehicle to see and judge with the aid of artificial intelligence (AI).

Coming to the specific area of our work, we are supposed to make an AGV that could collect pine leaves from an inclined surface. The basic step for which, involves the calculation of various parameters, designing a model and making an all terrain vehicle to check whether it can climb hilly terrain or not. If the test results are positive, the next step, to providing that vehicle, intelligence is taken for the completion of the vehicle.

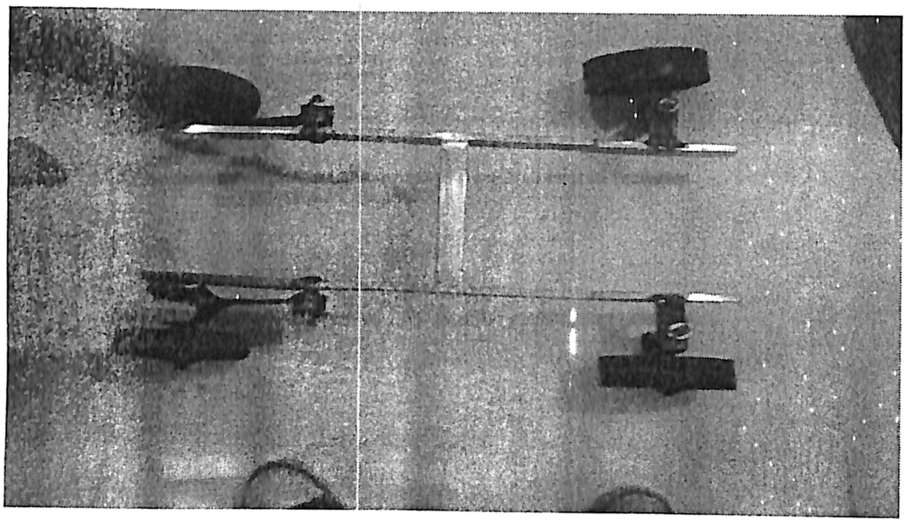


FIG-1.4

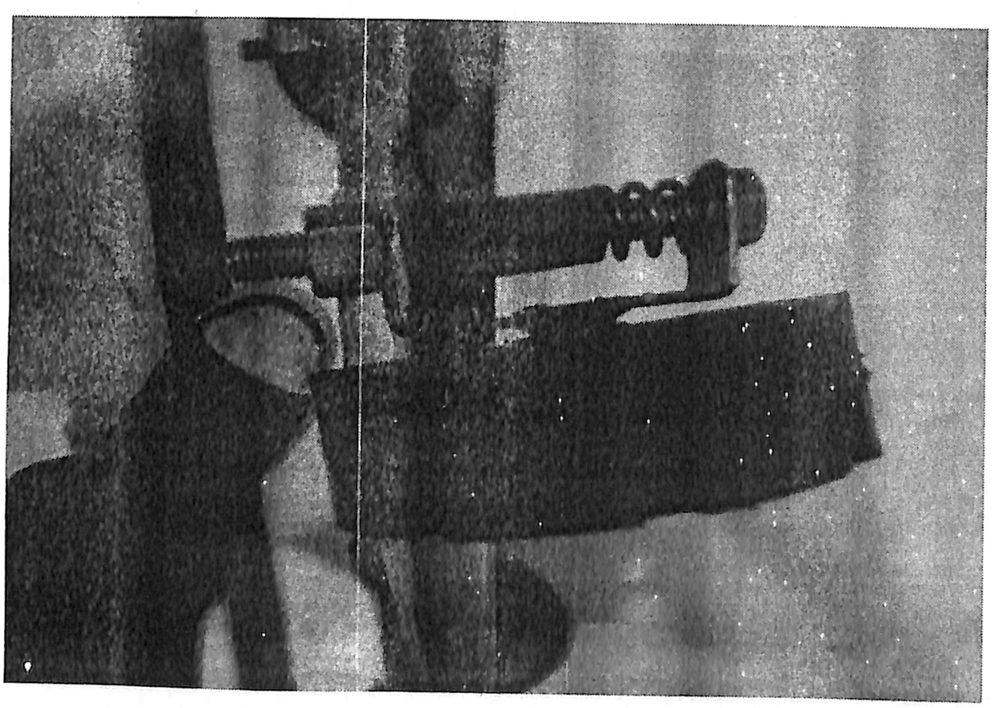


FIG-1.5

These figures shown above are of the actual model we made for testing the all terrain vehicle that was planned earlier.

Chapter 2 – Literature Review

One technological advancement that has made life easy and convenient, is Robots. They are human like machines capable of doing tasks they are programmed to do. They have shown significance in decreasing human work load especially in industries.

The industries have achieved a lot of benefits out of robotics. The company productivity rose which made businesses achieve more profits. The only drawback is that the emergence of industrial robots decreased employment. Since the former are truly effective machines, industries prefer utilizing them rather than employing humans. As a result, unemployment rate goes high. Many underprivileged people become poorer while company owners which are only a few get richer.

Robots are generally used in the automotive manufacturing industries. The errands are mostly repetitive and monotonous. Human nature is that when we are made to do the same thing for a long period of time we get bored and tired of what we do, so we do the job unwillingly. That is where the robots come in. Also, as human beings, we get tired, so the length of time that we can work is only limited. Robots can be set to function for a long span of time producing the same quality product all throughout the production process. This results in an increase in the number of manufactured products and decrease in the production of faulty products.

The brain of robots where they receive set of instructions already programmed into them is called artificial intelligence or AI.

Now coming to Automatic Guided Vehicles, as already explained above, came into existence in the 1950s, more specifically 1953 have become a significant part of any big industry.
An automated guided vehicle or automatic guided vehicle (AGV) is a mobile robot that follows markers or wires in the floor, or uses vision or lasers. They are most often used in industrial applications to move materials around a manufacturing facility or a warehouse. Applications of automatic guided vehicles has broadened during the late 20th century.

Automated guided vehicles (AGVs) increase efficiency and reduce costs by automating a manufacturing facility . The first AGV was invented by **Barrett Electronics** in 1953. The AGV can tow objects behind them in trailers. The objects can be placed on a set of conveyors and then pushed off by reversing them. The trailers can be used to move raw materials or finished product. AGVs are employed in nearly every industry, including metals, newspaper, pulp, paper, and general manufacturing. Transporting materials such as food, linen or medicine is also done.

An AGV can also be called a laser guided vehicle (LGV). In Germany the technology is also called **Fahrerlose Transportsysteme** (FTS) and in Sweden **förarlösa truckar**. Smaller versions of AGVs are often called Automated Guided Carts (AGCs) and are usually guided by magnetic tape.. The first AGV was brought, by Barrett Electronics of Northbrook, Illinois, and at the time it was simply a tow truck that followed a wire in the floor. AGCs are available in a variety of models and can be used to move products on an assembly line, transport goods throughout a plant or warehouse, and deliver loads.

Over the years the technology has become more sophisticated and today automated vehicles are mainly Laser navigated e.g. LGV (Laser Guided Vehicle). In an automated process, LGVs are programmed to communicate with other robots to ensure product is moved smoothly through the warehouse, whether it is being stored for future use or sent directly to shipping areas. Today, the AGV plays an important role in the design of new factories and warehouses, safely moving goods to their rightful destination.

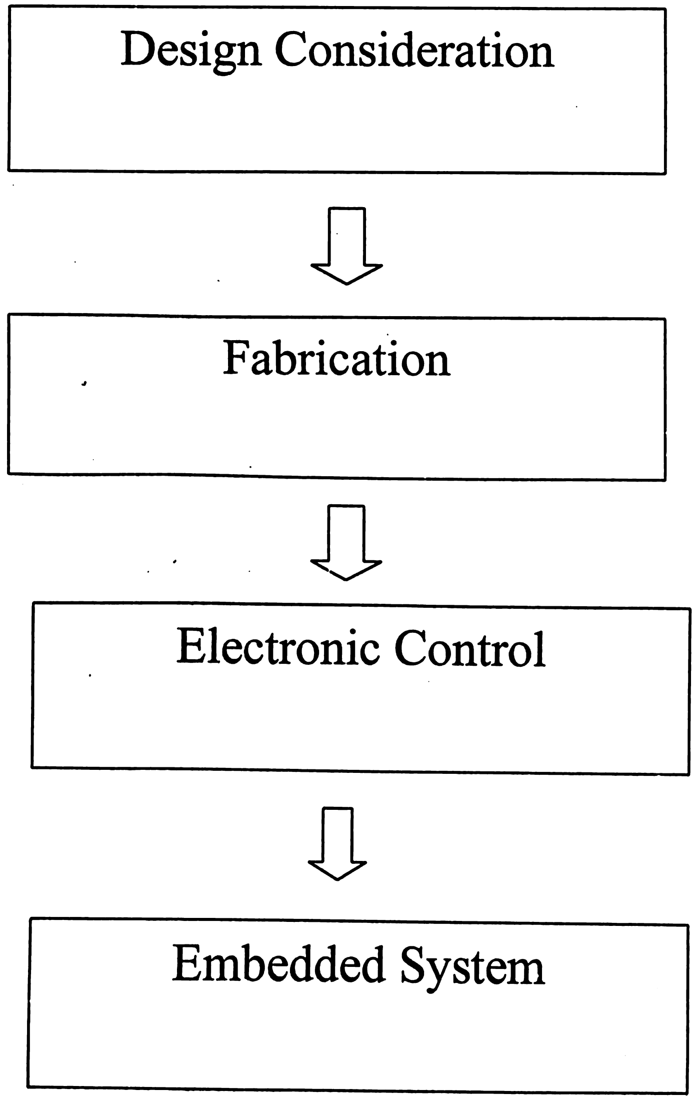
The first big development was the introduction of the unit load carrier in the 1970s. These came like a wave in the material handling sector because of their ability to serve several functions.

Since then, AGVs have evolved into complex material handling transport vehicles ranging from mail handling AGVs to highly automated automatic trailer loading AGVs using laser and natural target navigation technologies.

In fact, the technology has so developed now, that fully automated vehicles have been sent on planet Mars. NASA launched the Mars Exploration Rover on June 10, 2003 to see if the elements present on Mars and its existing conditions could support life in future or not.

The latest one that NASA sent on Mars was Curiosity, launched on November 26th, 2011.Their only motive being, to create such a machine that could function fully without human intervention, in short an Automatic Guided Vehicle. But since there were no tracks, no magnetic tapes, no wires for the vehicle to follow, the vehicle had to be so intelligent so as to judge things itself which brings us to the introduction of our project topic.

Chapter-3 Methodology



Various parameters were to be considered for creating a vehicle, starting with the base level, like :

- Stability
- Type of Drive
- Control mechanism
- Total Payload
- Weight balancing
- Size of tires
- Power of the battery
- Motor Rating
- Vacuum Cleaner Rating (for collection of leaves)
- Ground clearance and Centre of Gravity
- Suspensions
- Selection of material based on the payload

Inspiration Model

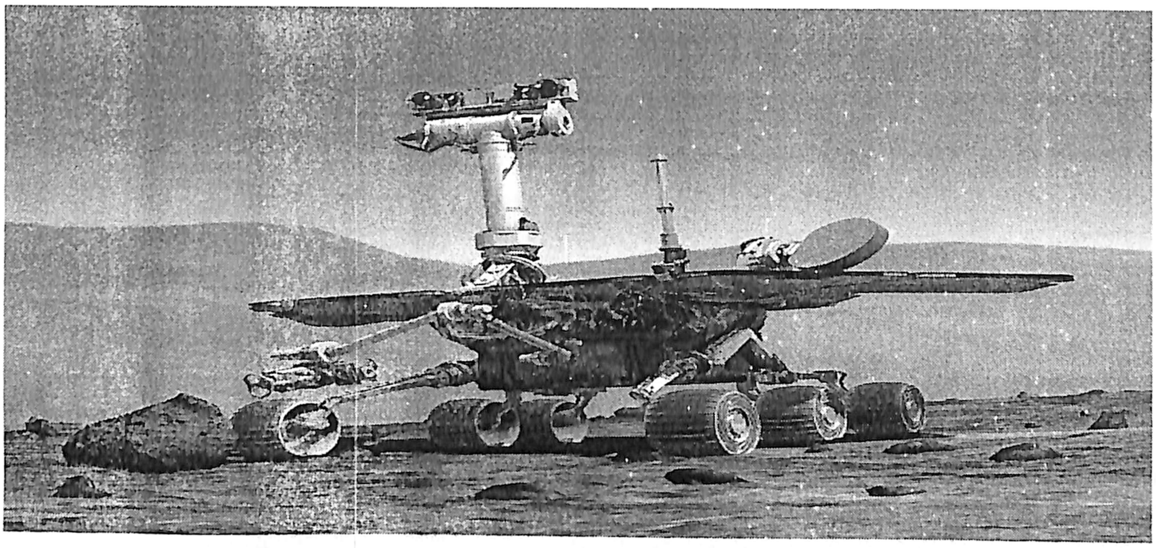


Fig1.6

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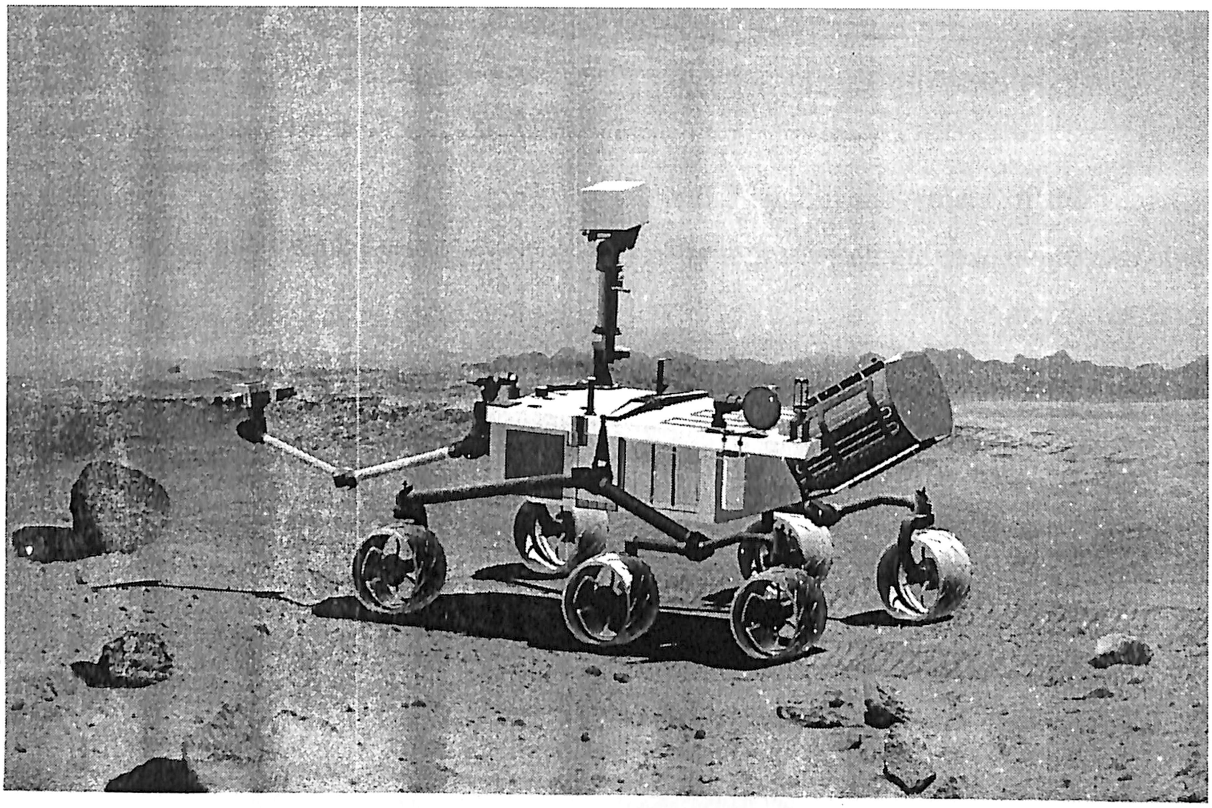


FIG-1.7

Curiosity Mars

We took our inspiration from these vehicles which operated on a rough terrain where there was no particular path to follow or a level ground. We were to make an AGV that could climb an incline and collect the Pine leaves from the ground. There has been no previous research done by other scientists on the topic we will be discussing now. This idea of collection of pine leaves from a rough inclined plane is quite new so all ideas and designs have come up from the root level.

Therefore, such a system was to be provided to the AGV that it could balance itself perfectly well even if one of its tires went over a bump or a pothole and the other tires should not get affected by that which gave us the idea of using independent suspensions on all the 4 wheels.

Basic Model Design

We came up with various designs to accommodate the above stated parameters. We began by considering the payload calculation and based on that decided various other parameters.

A concept for transferring weight during uphill and downhill movement of the vehicle was also to be introduced for which we provided a slot or a groove on the base board and placed a movable mass on that, shown in the figure below. This was our initial concept, but later we changed the chassis to a base made of mild steel pipes of 12mm thickness based on some research, which will be seen in the next figure.

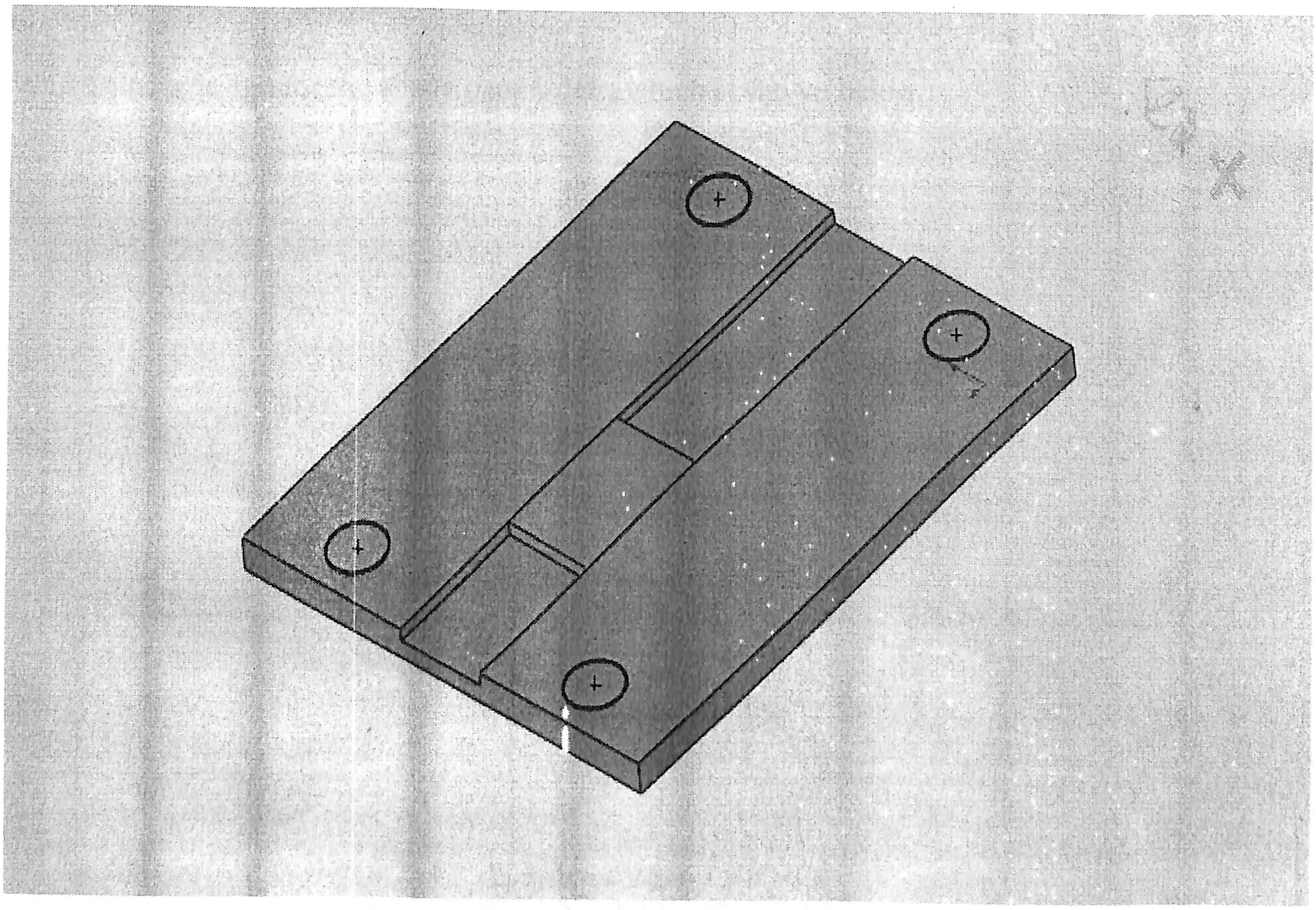


FIG-1.8

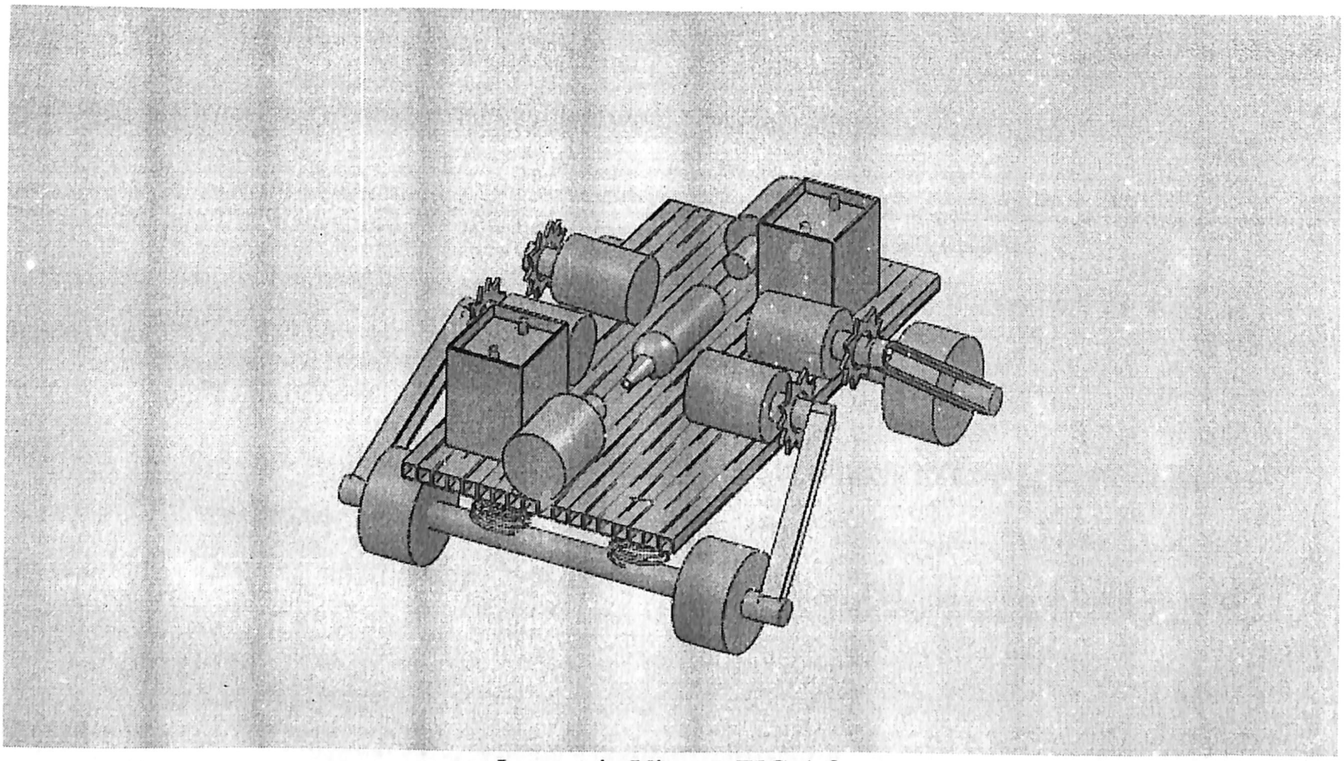
After this, we came up with the idea of introducing chain drives combined with wheels propelled by motors. Sprockets would be provided on the motors for chains, on both, the chassis and the wheels.

Suspensions would be provided from the axle to the chassis to accommodate any bumps and motors would be provided to control the height of suspensions, electronically.

Two batteries would be provided to supply power to motors for wheels as well as suspensions.

Vacuum cleaner would also be battery operated.

We created a design for the above parameters, which is shown below :



Isometric View FIG-1.9

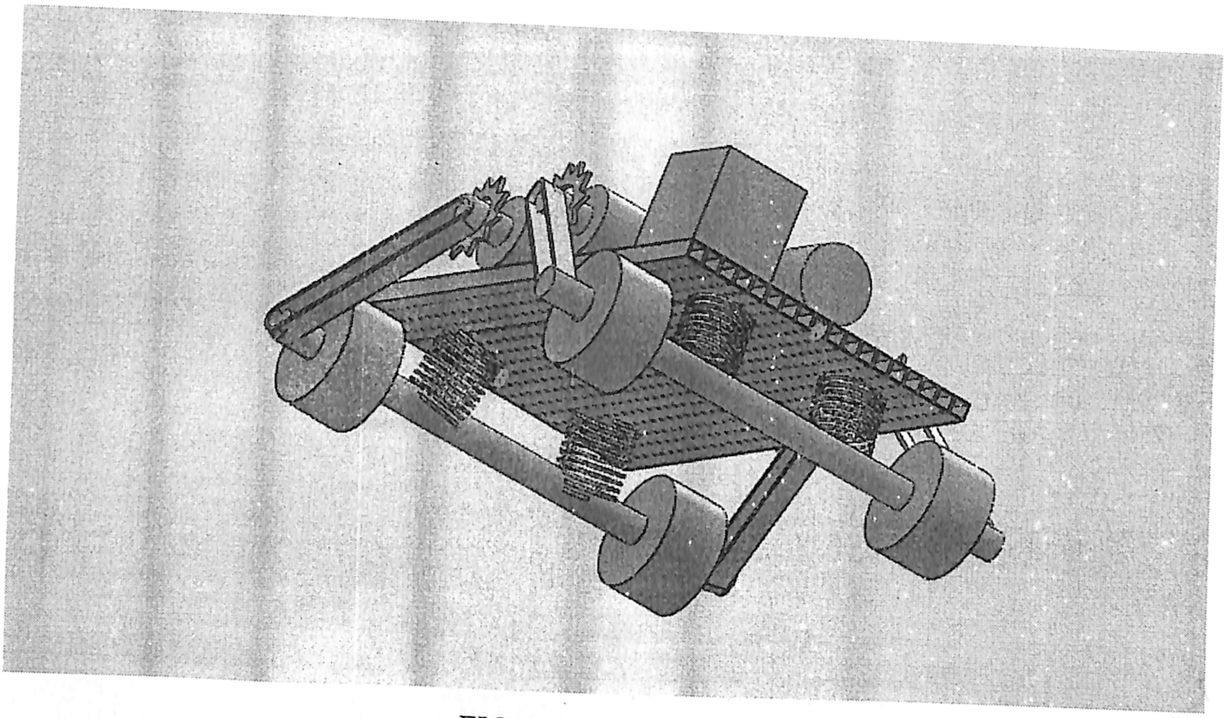


FIG-1.10

In the above figures, we can see a chassis made of 12mm thick Mild Steel pipes, which is connected to the axles, by suspensions which would be electronically controlled.

We can also see the placement of batteries, motors, sprockets, vacuum cleaner.
The vehicle would be remote controlled, both for wheels, i.e., for movement as well as suspensions

.

But there was one flaw in this design, i.e., the connection of wheels to axle was not flexible, it was rigid, in which case, if a huge bump was encountered, there might be chances of the axle breaking. Though, small bumps would not be a problem, but big ones would. So, to overcome this, we will be providing a flexible link between the tires and the axle.

We then considered a ladder frame, whose weight would also be less than a full chassis and introduced suspensions, as shown below :

This is the working model which we created, which shows the suspensions and other parts of the vehicle, which at the moment is only an ATV (All Terrain Vehicle).

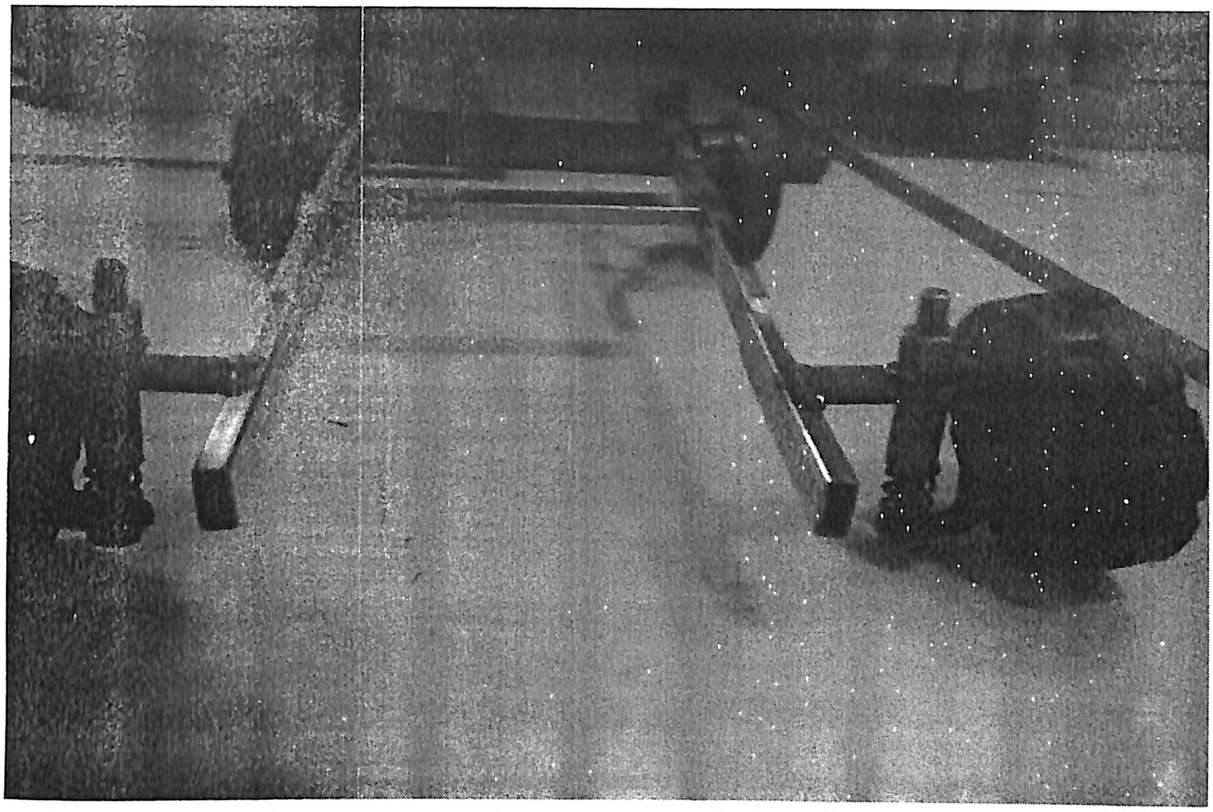


FIG-1.11

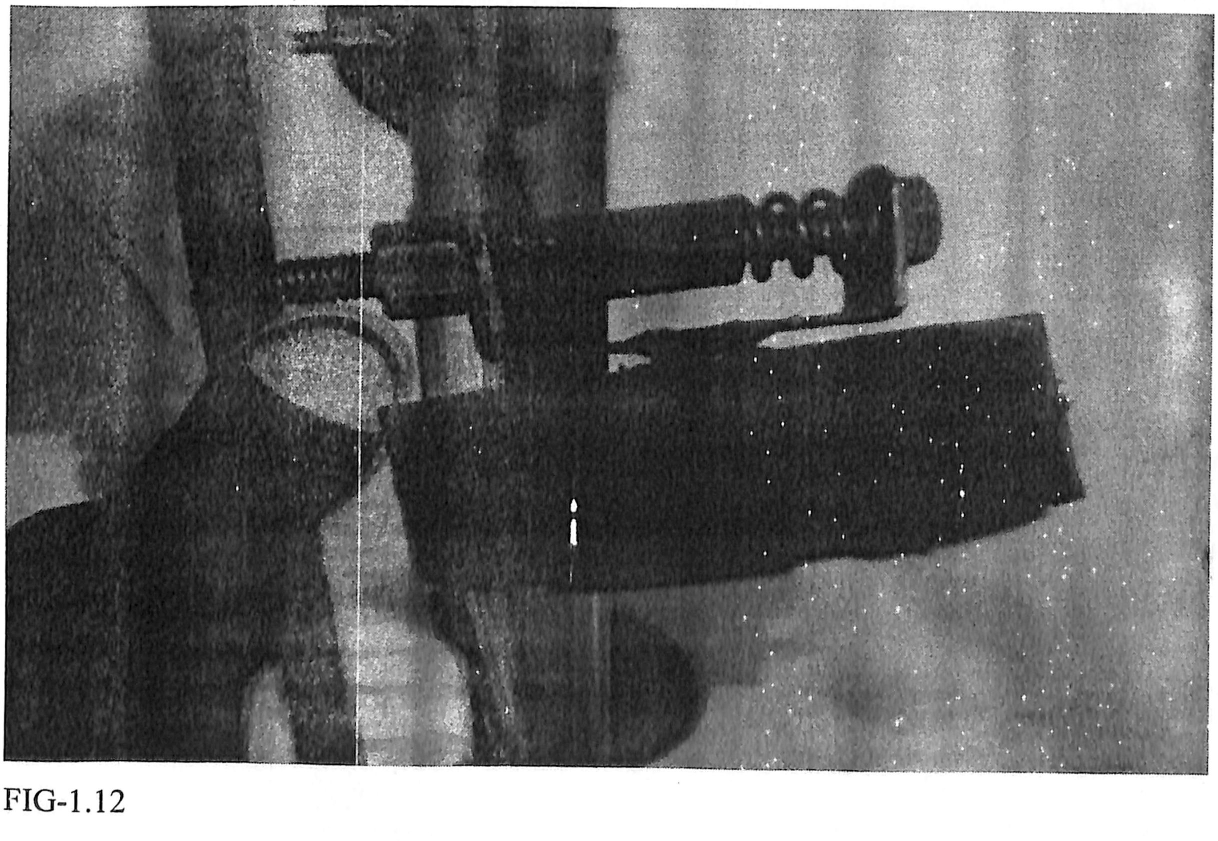


FIG-1.12

PROPOSED MLODEL [ATV]

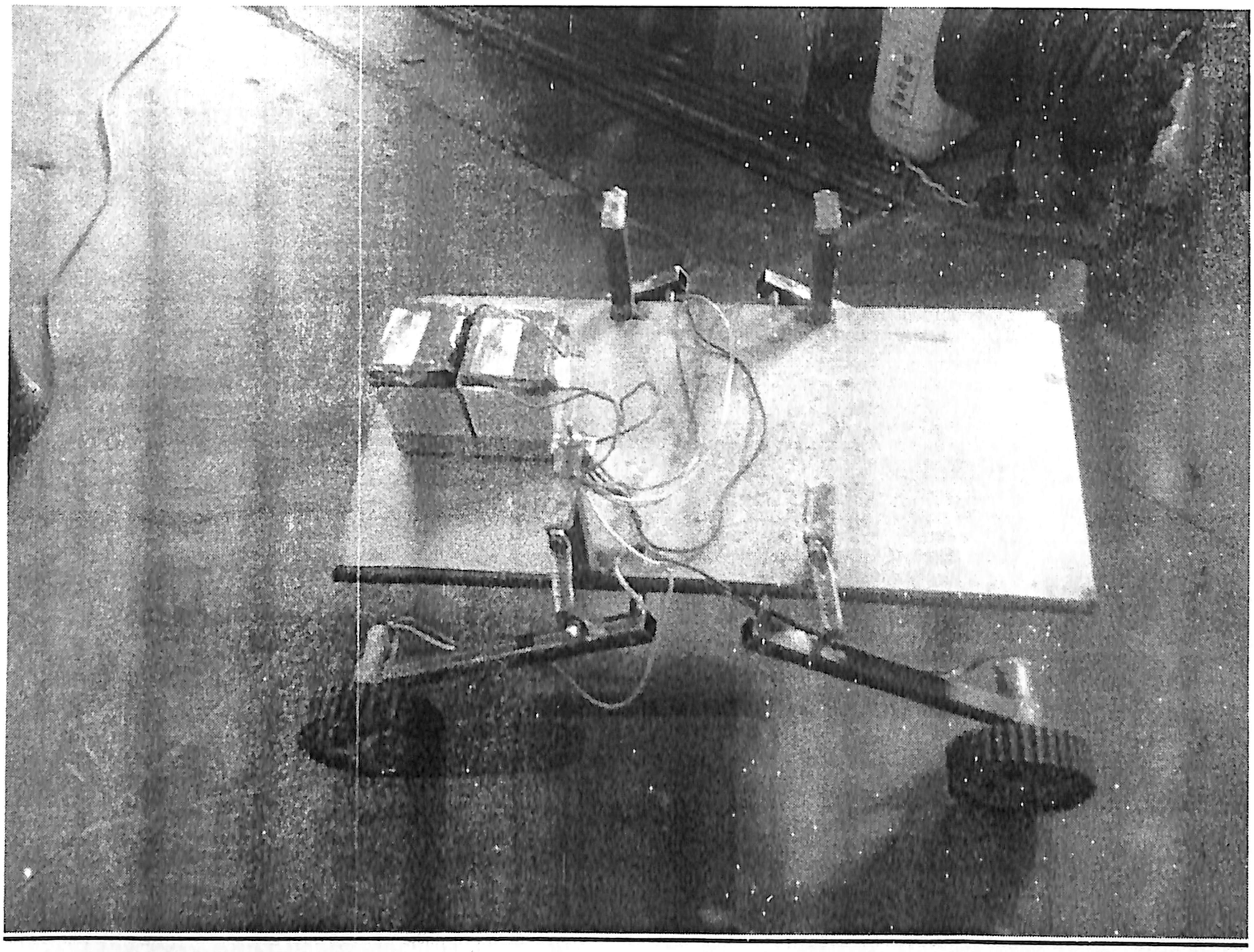


FIG-1.13

WORKING MODEL

Now this the model which have suspension that can accommodate itself as per the barrages that come across its way .Two batteries that have been installed on the vehicle to run the four motors , motors have a specification of 150 rpm that can run the tyre without any consideration of weight .

The car can carry upto 20 to 25 kg of weight and can climb a hill upto or an angle of 50 to 60degree

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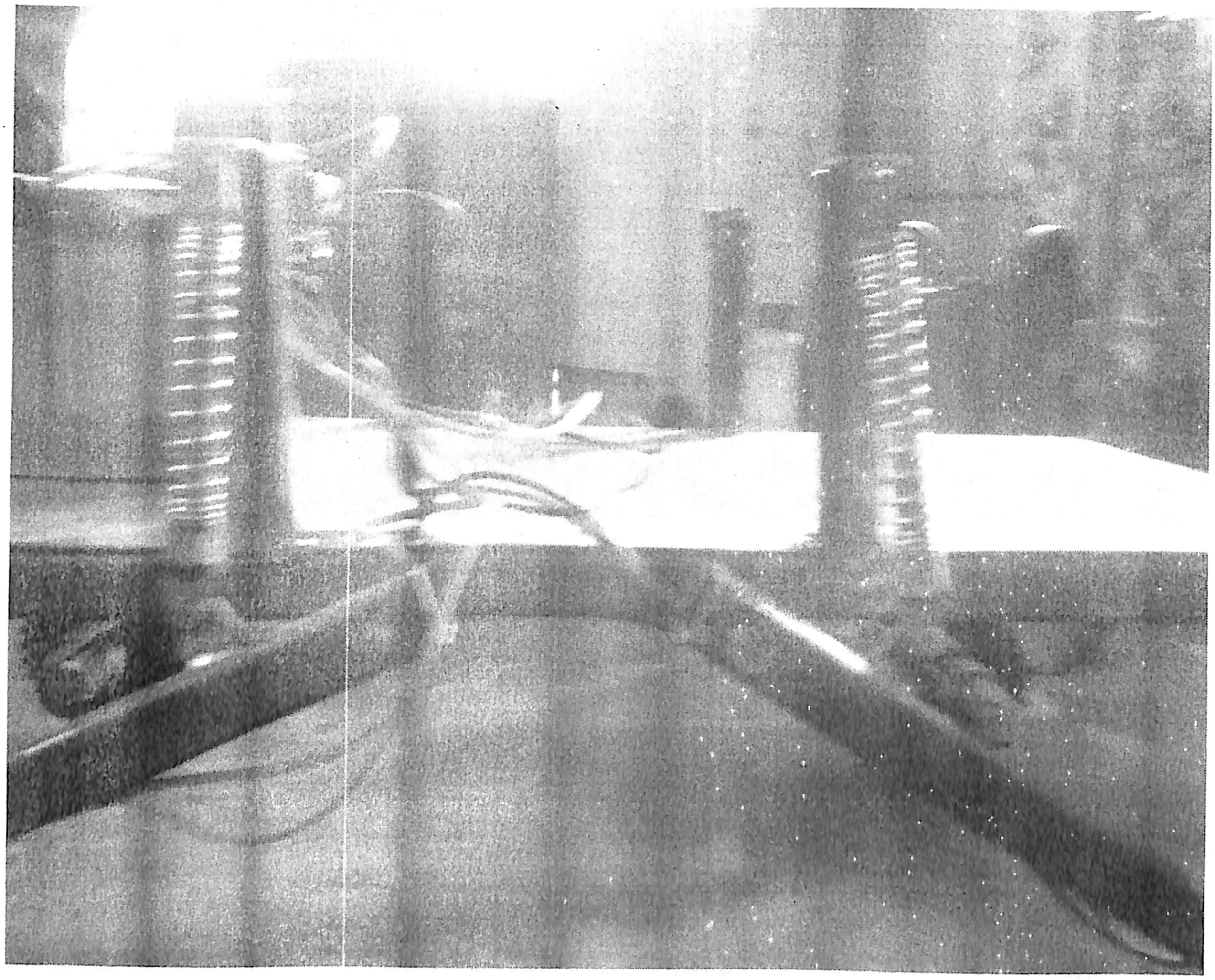


FIG-1.14

TOP VIEW OF PROPOSED MODEL

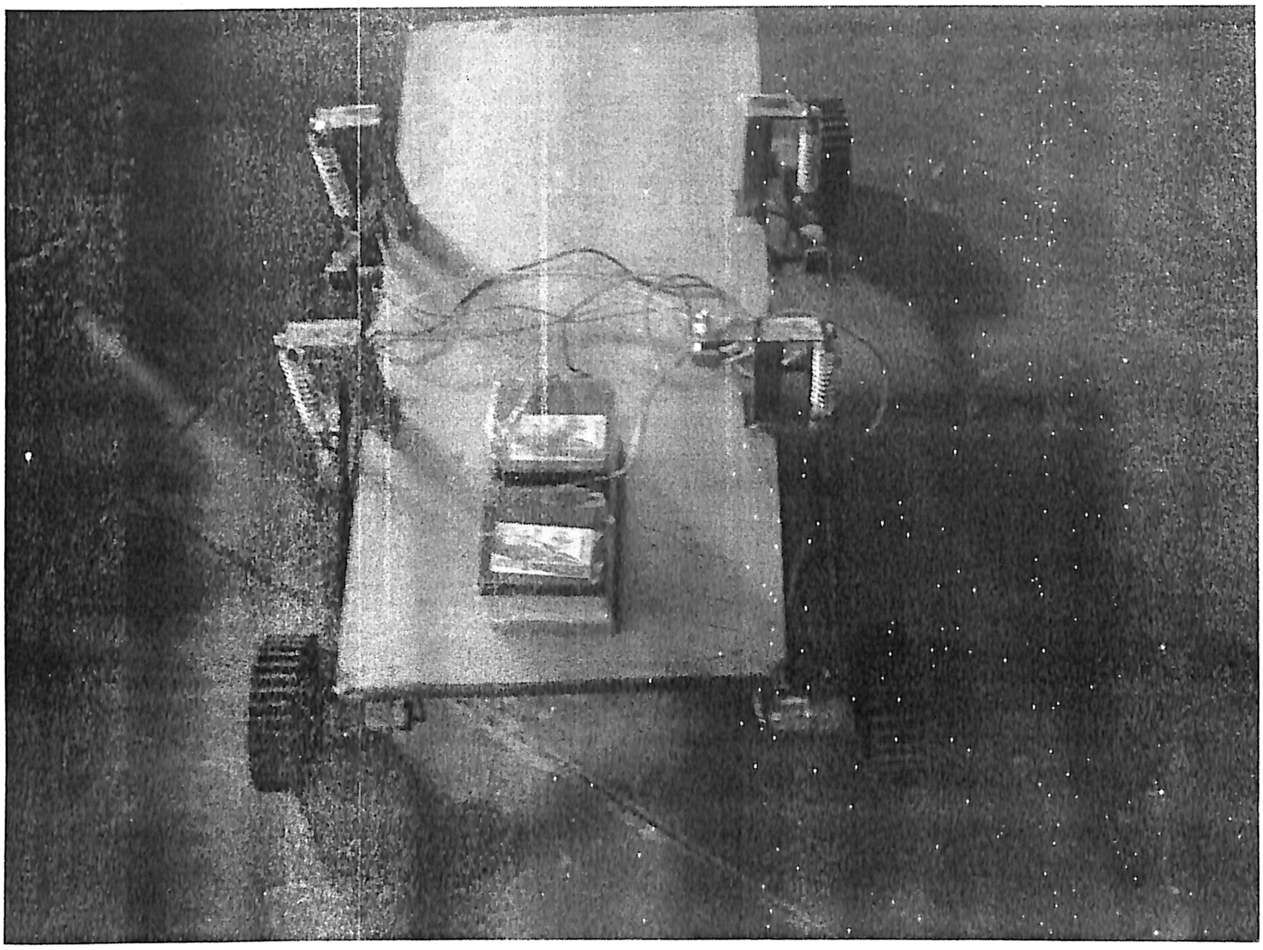


Fig1.15

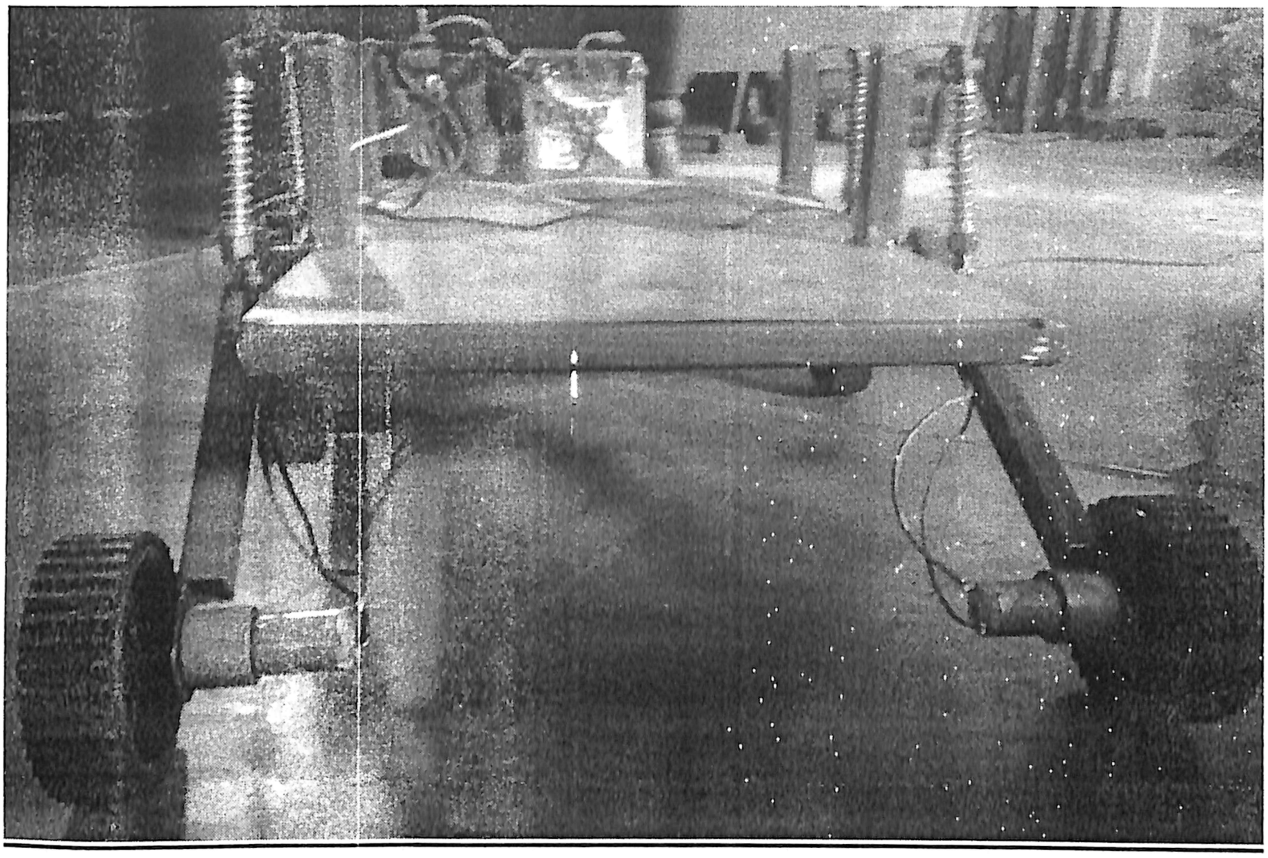


FIG-1.16

Chapter 4 – Problem Definition

As already told, we were making an AGV that could climb an incline and collect pine leaves from a rough surface, we made a model already shown above. A few problems were encountered, that'll be listed below.

The model we made had the following problems:

- The Ground Clearance was too low.
- The play in the suspensions was less
- There was no flexible link between the tires and the axle, which could have resulted in the breaking of the axle.

Our priority objectives now, are to rectify the above problems by increasing the ground clearance which would depend upon the flexibility of the tire-axle link. Our first aim is to provide the tire- axle link following which we would adjust the suspension play and the ground clearance. Increase in ground clearance can also be achieved by increasing the tire size considering the parameter of tire-axle link.

Chapter 5 – Model Construction and Solution

Model Design and Analysis

The AGV was supposed to grade steep inclined terrains which are rough and mountainous. It had to carry the payload and the weight of its various components like battery, motors, platform and the electrical system. Thus we had to bring together both mechanics and electronics to get the desired output. This has been further discussed in detail in the following section.

Components of an AGV:

Mechanical

- Chassis
- Suspension
- Steering system
- Axle
- Wheels

Electronic

- Development board
- Remote
- Receiver

Electrical

- Servo Motor
- Battery
- Relay
- Power switch
- Charger

MECHANICAL COMPONENTS

Chassis

The chassis was made by using steel pipes. Rectangular cross section was used for the pipes. Grade 225 steel was used over other metals to ensure light weight and high power to weight ratio. TIG welding was used to join the steel pipes.

Steels are ALLOYS of Fe & C, in which C is between 0.008 to 2.0 Percent. Commercial steels always contain some amount of other elements. If these elements are accidently present without any intention, they are called IMPURITIES. If they are added purposely, they are called alloying elements.

S & P are most common impurities which come from the coke and are used in manufacture of steel. To overcome the undesirable effect of S, Mn is always added in some amount to steel. Many other elements are also present in small amounts, Steel with other elements in small amounts are called Plain carbon steels. Their structure and properties are discussed by help of Fe—C equilibrium diagram.

Independent Suspension

ATVs are generally known in the art as being large-tired vehicles suitable for off-road operation on uneven terrain. They have one or two front wheels and two rear wheels mounted on a solid rear axle. Conventional ATVs generally have large balloon tires containing low air pressure in order to obtain adequate traction on a variety of terrains. Current vehicles of this type generally have a rear axle assembly and swing arm to pivot as a unit about a transverse axis of the vehicle.

In addition, the rear link arms of conventional ATVs are positioned in a significantly upward direction and thereby impart a lifting or jacking effect to the ATV chassis when the ATV is accelerated and a lowering effect to the chassis when the ATV is decelerated. This jacking and lowering effect alters the height of the center of gravity in conventional ATVs.

The stiffness of the rear suspension of conventional ATVs is such that one or the other rear tire can leave the ground surface as the vehicle traverses uneven terrain or a curve, creating partial loss of traction and unbalanced drive forces. The solid rear axle of conventional ATVs combined with their rigid swing arms, present unique handling characteristics.

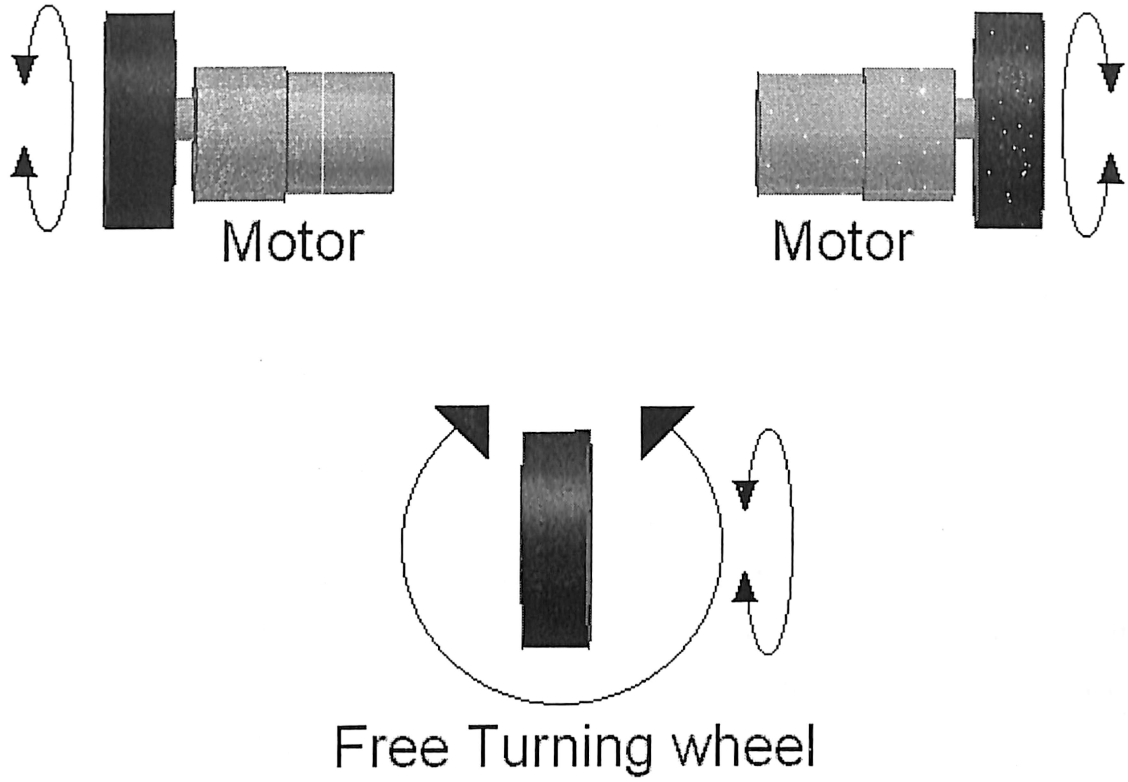
We used independent suspension for both front and rear wheels. This decision is directed to an ATV which satisfies the need referred to above. This invention comprises an ATV having a semi-independent suspension which allows the both axle to rotate both in pitch mode about a transverse axis of the ATV and in roll mode about a longitudinal axis of the ATV, thus giving improved operation and handling characteristics by keeping all tires on the ground during normal operation, giving improved traction on uneven terrain, providing for vehicle stability during cornering, preventing the sudden transition from under steer to over steer, and giving increased operator comfort and control.

This invention overcomes the shortcomings of conventional ATVs and provides an improvement over the prior art.

Differential Steering System

If both the wheels are driven in the same direction and speed, the robot will go in a straight line. If both wheels are turned with equal speed in opposite directions, as is clear from the diagram shown, the robot will rotate about the central point of the axis. Otherwise, depending on the speed of rotation and its direction, the center of rotation may fall anywhere on the line defined by the two contact points of the tires. While the robot is traveling in a straight line, the center of rotation is an infinite distance from the robot. Since the direction of the robot is dependent on the rate and direction of rotation of the two driven wheels, these quantities should be sensed and controlled precisely.

A differentially steered robot is similar to the differential gears used in automobiles in that both the wheels can have different rates of rotations, but unlike the differential gearing system ,a differentially steered system will have both the wheels powered. Differential wheeled robots are used extensively in robotics, since their motion is easy to program and can be well controlled. Virtually all consumer robots on the market today use differential steering primarily for its low cost and simplicity.



Wheels and Movement

The AGV is propelled by four 150 R.P.M. D.C. gear head motors, which are attached to the tires. The tires are 10 inches in diameter and two inch wide. With the addition of the third castor, the majority of the vehicle's weight rested on the rear caster, and the tires were slipping. The AGV has an excellent turning radius as a result of the platform layout.

The wheels are directly powered by the DC motors. Since we were making an ATV, we gave less consideration to the turning radius and such criterion and more significance to the material of the tires. This was to ensure proper grip on the mountainous terrain they had to travel on.

Further, we also had to take note of the tire pressure. Being an ATV the pressure has to be kept less than normal to allow a self cushioning effect on the tires. They use the elastic property of the rubber for the same.

ELECTRONIC SYSTEMS

Development board (PCB)

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate. When the board has only copper tracks and features, and no circuit elements such as capacitors, resistors or active devices have been manufactured into the actual substrate of the board, it is more correctly referred to as printed wiring board (PWB) or etched wiring board. Use of the term PWB or printed wiring board although more accurate and distinct from what would be known as a true printed circuit board, has generally fallen by the wayside for many people as the distinction between circuit and wiring has become blurred. Today printed wiring (circuit) boards are used in virtually all but the simplest commercially produced electronic devices, and allow fully automated assembly processes that were not possible or practical in earlier era tag type circuit assembly processes.

Remote and Receiver (Wireless control)

We had to develop a wireless control for a miniature low-profile car comprising a chassis for supporting front and rear wheels, an all-wheel steering mechanism, a covered control circuit board, four drive motors and a battery. A shell miniature car body is attached to and substantially covers the chassis. The circuit board is positioned and secured atop a bottom panel of the chassis, while the battery is positioned and secured above the circuit board and at least partially within a central raised portion of the car body whereby the height of the central raised portion of the car body is substantially reduced. The differential steering is used in for the movement of the vehicle. The battery has been made rechargeable so that it is also permanently mounted within the chassis. Motors can be used to drive a car which uses differential turning mechanism. This is the simplest steering possible and is achieved by turning one motor on and the other motor off to achieve steering. The on and off controlling of the motors is done by using the remote control.

Driving the DC motors. Port pins p1.1 through p1.4 of the microcontroller drive four relays through a relay-driver circuitry comprising transistors T1 through T4. The four relays, in turn, control four motors of the car (Fig.5). Two relays control the forward and reverse rotations of a motor. The left two motors are connected in parallel and so are the two motors of the right. So two motors are controlled simultaneously using two relays.

Each of the four relays is 12V, single- changeover electromagnetic type to control the PMDC motor (12V, 50-rpm). The relays play an important role in isolating the controlling circuit and PMDC motors to protect the microcontroller and other low-current devices from the relatively high-current-driven motors. Basically, these are switches that connect or disconnect the motors from the 12V supply. Control signals from the microcontroller energize or de-energize the relays. That is, when a control signal makes a pin of P89V51RD2 high, the transistor connected to it conducts to energize the corresponding relay.

Here +12V terminal of the battery is connected to normally-open (N/O) contacts of all the relays and the ground terminal connected to normally-closed (N/C) contacts of the relays.

towards N/O contact. This connects +12V to the positive terminal of motor M2 on the left back of the car.

When Q3 output is high, transistors T3 conducts and relay RL3 energizes to make P shift toward N/O contact. This connects +12V to the positive terminal of motor M3 on the right front. When Q4 output is high, transistors T4 conducts and relay RL4 energizes to make P shift toward N/O contact. This connects +12V to the positive terminal of motor M4 on the right front.

When Q4 output is high, transistors T4 conducts and relay RL4 energizes to make P shift toward N/O contact. This connects +12V to the positive terminal of motor M4 on the right back.

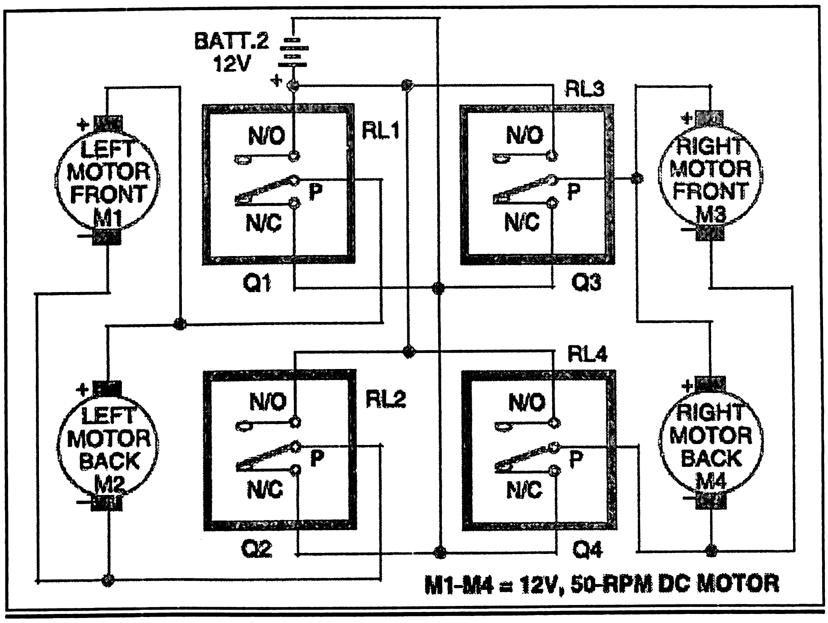


Fig1.17

ELECTRICAL SYSTEMS

DC Motor

Almost every mechanica l movement that we see around us is accomplished by an electric motor. Electric machines are a means of converting energy. Motors take electrical energy and produce mechanical energy. Electric motors are used to power hundreds of devices we use in everyday life. Motors come in various sizes. Huge motors that can take loads of 1000's of Horsepower are typically used in the industry. Some examples of large motor applications include elevators, electric trains, hoists, and heavy metal rolling mills. Examples of small motor applications include motors used in automobiles, robots, hand power tools and food blenders. Micro-machines are electric machines with parts the size of red blood cells, and find many applications in medicine.

Electric motors are broadly classified into two different categories: DC (Direct Current) and AC (Alternating Current). Within these categories are numerous types, each offering unique abilities that suit them well for specific applications. In most cases, regardless of type, electric motors consist of a stator (stationary field) and a rotor (the rotating field or armature) and operate through the interaction of magnetic flux and electric current to produce rotational speed and torque. DC motors are distinguished by their ability to operate from direct current. There are different kinds of D.C. motors, but they all work on the same principles.

Construction

DC motors consist of one set of coils, called armature winding, inside another set of coils or a set of permanent magnets, called the stator. Applying a voltage to the coils produces a torque in the armature, resulting in motion.

Stator

- The stator is the stationary outside part of a motor.
  - The stator of a permanent magnet dc motor is composed of two or more permanent magnet pole pieces.
  - The magnetic field can alternatively be created by an electromagnet. In this case, a DC coil (field winding) is wound around a magnetic material that forms part of the stator.

Rotor

- The rotor is the inner part which rotates.
- The rotor is composed of windings (called armature windings) which are connected to the external
- Circuit through a mechanical commutator.
- Both stator and rotor are made of ferromagnetic materials. The two are separated by air-gap.

Winding

A winding is made up of series or parallel connection of coils.

- Armature winding - The winding through which the voltage is applied or induced.
- Field winding - The winding through which a current is passed to produce flux (for the electromagnet) Windings are usually made of copper.

Principle of operation

Consider a coil in a magnetic field of flux density B . When the two ends of the coil are connected across a DC voltage source, current I flow through it. A force is exerted on the coil as a result of the interaction of magnetic field and electric current. The force on the two sides of the coil is such that the coil starts to move in the direction of force. In an actual DC motor, several such coils are wound on the rotor, all of which experience force, resulting in rotation. The greater the current in the wire, or the greater the magnetic field, the faster the wire moves because of the greater force created.

At the same time this torque is being produced, the conductors are moving in a magnetic field. At different positions, the flux linked with it changes, which causes an emf to be induced (e = d/dt) as shown in . This voltage is in opposition to the voltage that causes current flow through the conductor and is referred to as a counter-voltage or back emf. The value of current flowing through the armature is dependent upon the difference between the applied voltage and this counter-voltage. The current due to this counter-voltage tends to oppose the very cause for its production according to Lenz's law. It results in the rotor slowing down. Eventually, the rotor slows just enough so that the force created by the magnetic field (F = Bil) equals the load force applied on the shaft. Then the system moves at constant velocity.

A DC motor has two distinct circuits: Field circuit and armature circuit. The input is electrical power and the output is mechanical power. In this equivalent circuit, the field winding is supplied from a separate DC voltage source of voltage Vf. Rf and Lf represent the resistance and inductance of the field winding. The current If produced in the winding establishes the magnetic field necessary for motor operation. In the armature (rotor) circuit, VT is the voltage applied across the motor terminals, I is the current flowing in the armature circuit, Ra is the resistance of the armature winding, and E is the total voltage induced in the armature.

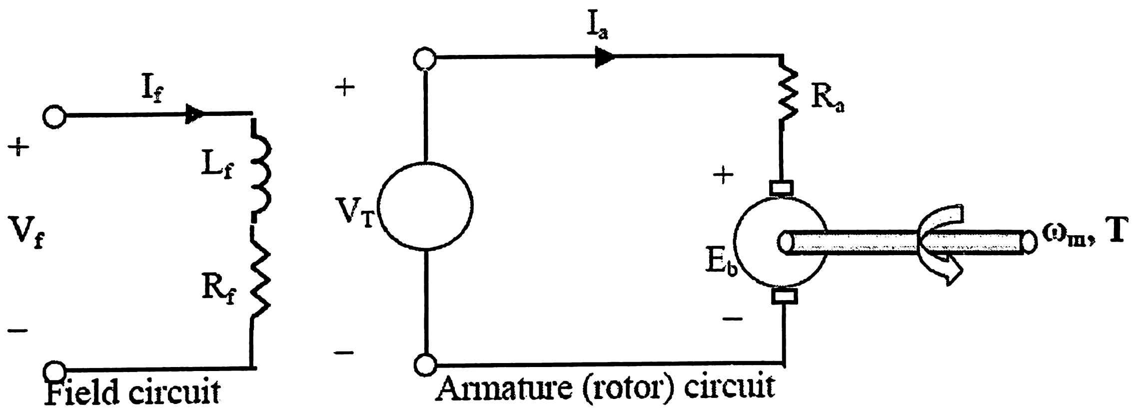


Figure 7: DC Motor representation

Battery

An electric vehicle battery (EVB) or traction battery can be either a primary (e.g. metal-air) battery or a secondary battery rechargeable battery used for propulsion of battery electric vehicles (BEVs). Traction batteries are used in forklifts, electric Golf carts, riding , electric motorcycles, full-size electric cars, trucks, and vans, and other electric vehicles.

Electric vehicle batteries differ from starting lighting and ignition (SLI) batteries because they are designed to give power over sustained periods of time. Deep cycle batteries are used instead of SLI batteries for these applications. Traction batteries must be designed with a high ampere-hour capacity. Batteries for electric vehicles are characterized by their relatively high power-to-weight ratio, energy to weight ratio and energy density; smaller, lighter

batteries reduce the weight of the vehicle and improve its performance. Compared to liquid fuels, most current battery technologies have much lower specific energy; and this often impacts the maximum all-electric range of the vehicles. However, metal-air batteries have high specific energy because the cathode is provided by the surrounding oxygen in the air.

Rechargeable batteries are usually the most expensive component of BEVs, being about half the retail cost of the car. The cost of battery manufacture is substantial, but increasing returns to scale lower costs. The BEV marketplace has reaped the benefits of these advances, but costs remain too high and, along with limited range, provide a key barrier to the use of rechargeable batteries in electric vehicles.

Rechargeable traction batteries are routinely used all day and fast–charged all night. Batteries in BEVs must be periodically recharged. BEVs most commonly charge from the power grid (at home or using a street or shop recharging point), which is in turn generated from a variety of domestic resources, such as coal, hydroelectricity, nuclear and others. Home power such as roof top photovoltaic solar cell panels, micro hydro or wind may also be used and are promoted because of concerns regarding global warming.

Charger

A **battery charger** is a device used to put energy into a secondary cell or rechargeable battery by forcing an electric current through it.

The charging protocol depends on the size and type of the battery being charged. Some battery types have high tolerance for overcharging and can be recharged by connection to a constant voltage source or a constant current source; simple chargers of this type require manual disconnection at the end of the charge cycle, or may have a timer to cut off charging current at a fixed time. Other battery types cannot withstand long high-rate over-charging; the charger may have temperature or voltage sensing circuits and a microprocessor controller to adjust the charging current, and cut off at the end of charge.

A trickle charger provides a relatively small amount of current, only enough to counteract self-discharge of a battery that is idle for a long time. Slow battery chargers may take several hours to complete a charge; high-rate chargers may restore most capacity within minutes or less than an hour, but generally require monitoring of the battery to protect it from overcharge.

Electric vehicles need high-rate chargers for public access; installation of such chargers and the distribution support for them is an issue in the proposed adoption of electric cars.

Relay

Relays are electro magnetically operated switches. An actuating current on a coil operates one or more galvanic ally separated contacts or load circuits. The electro mechanical relay is a remote controlled switch capable of switching multiple circuits, either individually, simultaneously, or in sequence.

The primary functions of a relay are:

- The galvanic separation of the primary or actuating circuit and the load circuits
- Single input/multiple output capability
- Separation of different load circuits for multi-pole relays
- Separation of AC and DC circuits
- Interface between electronic and power circuits
- Multiple switching functions, e.g. delay, signal conditioning
- Amplifier function.

Applications of Relay

Typical applications for relays include laboratory instruments, telecommunication systems, computer interfaces, domestic appliances, air conditioning and heating, automotive electrics, traffic control, lighting control, building control, electric power control, business machines, control of motors and solenoids, tooling machines, production and test equipment.

Electromechanical Relays

In electromechanical relays the switching element is a mechanical contact, actuated by an electromagnet. This is the most widely used type of relay design. The principal internal functions of the electromechanical relay are:

- Conversion of electrical current (input, coil current) to a magnetic field
- Conversion of the magnetic field into a mechanical force
- This force operates the contacts (secondary side)
- Contacts switch and conduct electrical current (output, load current).
- Electromechanical Relay Design

The most important components are:

- Contact system or secondary side
- Fixed contacts

- Moving contacts (contacts being moved by the magnetic system to switch the load circuit)
- Contact springs (holding the contacts but sufficiently flexible to allow the contacts to move)

Magnetic system

- Coil (to generate the necessary magnetic field to actuate the armature and the contacts)
- Core (highly magnetic permeable - concentrates the magnetic field)
- Yoke (to establish the magnetic circuit)
- Armature (the moving part of the magnetic system which closes and opens the magnetic circuit and acts via an actuator to the moving relay contacts)
- Return spring (For quick return of the moving contact to normal condition on removal of the coil power)

Mechanical components

- Case & Base (to protect the relay against external influences and for protection against electric shock) .

- Insulation (within the relay to separate the primary circuit from the secondary side and to provide the required Actuator (used in some relay designs to translate the motion of the magnetic system to the contact system
- (Moving contacts). Must have insulation properties to isolate the primary circuit (coil, magnetic circuit) from the secondary side (contact system).
- Pins or terminals (to connect between the contact system and the load)
- Mounting devices (sockets / built in brackets / PCB)

PROBLEMS FACED

The CAD model that had been initially proposed three major drawbacks:

1. The suspension used in the model could not be used on all terrains. It would fail on a rough mountainous terrain.
2. We had proposed the use of chain drive. This was not possible if the vehicle base was to be lifted to prevent toppling of the vehicle.

3. The chassis was built by welding the steel pipes. A ladder chassis could be used in its place. It would give similar amount of strength while reducing the cost and weight of the proposed design.

Modifications proposed

1. An independent suspension for all the vehicles. The suspension design of normal ATVs was evaluated and proposed.
2. Chain drive was replaced by the idea of independent drive. Each wheel would be powered by a separate motor.
3. The differential steering system (discussed above) was proposed.
4. Ladder chassis was proposed as it would lead to lesser weight and cost of the vehicle while giving equal amount of strength.

These ideas were then further worked upon to give the next modified CAD model. This model did not face any of the previous problems.

CALCULATIONS

Chassis:

Length= 600mm

Width= 300mm

Wheel base= 540mm

Track width= 480mm

Material Used- Mild steel

Thickness of steel pipe=19mm

Total weight of Chassis= 2kg

Clearance= 180mm (after loading)

Motor specification:

- 24 v, 700mAh (each)
- 125 rpm (each)

- Total no. Of motors= 4

Power required (P) =VI

P= $24*4*700*10^{-3}$

= 67.2 watt

Battery specification:

- 24v, 2.5Ah (each)
- Total no. Of batteries= 2
- Total weight of batteries=4kg (2kg each)

Total Power (P) available= VI

P= 2*24*2.5

= 120 watt

Tyre specification:

Considering a slow moving vehicle of speed around 3km/h

So,

V=3km/h

N=125 rpm

Therefore, v= $2\pi rn$

So, r = 65mm approx.

Therefore D=130mm

Check for the design:

Shear stress developed in Chassis= $\frac{P}{A}$

$$= \frac{9*9.81}{600*300*10^{-6}}$$

=490.5 N/m^2 (which is under allowable stress for the given material)

Power required to pull the weight of the vehicle at 60°slope

$F + f = mgsin\theta$

$F = mgsin\theta - \mu mgcos\theta$

$= (9*9.81)(sin60^{\circ} - 0.3cos60^{\circ})$

$=63.2$ N

P= 63.2Watt

Suspension design:

Arm length= 255mm

Angle variation = $0^{\circ} - 63.2^{\circ}$

5 – Validation and Discussion of Results

Drive Test

Maximum Power required during inclination = 120watt

Inclination test

Maximum Angle of Incline =63.2degree

Load test

Max Payload carried =25kg

6 – Conclusions and Recommendations for future work

An AGV with an independent suspension system is the best suited vehicle for hilly terrains. The efficiency of the vehicle is not very high but it has a productivity increasing feature due to its flexibility of path, central control and ability to add sensors to detect the payload conditions. But it has some disadvantages; it should be recharged periodically, and has high initial cost. The Advantages of the AGV far shadow over the disadvantages and hence it is concluded that this is the best suitable mean for collecting chirr pines.

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