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Fabrication of Vehicle Transporting Mechanism for Hill Top Roads

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Abstract: ***The Mechanism constructed here is very useful for road connectivity between two roads ends over the hill tops. While laying roads in the province of hills and valleys, it is very difficult to built roads over the valleys or hill tops due to the deep depths, here at such places construction of bridges with pillars is highly impossible. To overcome this problem and to make connectivity between two roads, here a tough mechanism is constructed which is aimed to transport the vehicles from one end of the road to the other starting point of the road. Here two ways transport mechanism is designed such that two way traveling vehicles can be transported individually using simplest and cheapest mechanism. The mechanical structure constructed with metal angles is designed to hold all electric and mechanical components, for transporting the vehicles from both sides and both ends of the roads, the vehicle carrying mechanism attached to the head track constructed with metal rails moves between two reference points. Hanging type of rail running chassis is constructed with four special types of metal wheels attached to this chassis through axel and is driven through DC motor.***
Keys: Dc Motor, Amplifier, Controller Bridge

I. INTRODUCTION

A road is a route or way on land between two places that has been leveled and paved to allow travel over it through motor vehicles. Most of the roads consists two-ways to allow the flow of traffic smoothly. Construction of roads over a plain land is quite simple, but whereas building roads Trough Mountains and through deep valleys is the most critical task, it is too risky and costliest issue, in addition lot of man power and machine power is required, also consumes lot of time.

Road connectivity between two mountains covers largest area due to the hairpin turnings, though the distance between two peaks of mountains is less, lengthy roads must be constructed because of the more turnings. These are known as ghat roads, these roads are too lengthy when compared with normal roads. To avoid constructing lengthy roads over the regions of mountains and to overcome all above described problems, the technology must be upgraded by adapting sophisticated vehicle transporting mechanisms, there by this project work is chosen which carries the vehicles from one end of the road (where the road ends over a hill top) to the other starting point of the road.

In our country there are many regions where mountains are more, for Ex; Tirumala, Nilgiri in Tamilnadu, kodaikanal, Khandala in Eastern Ghats, etc, the list is endless. Ghat Roads are access routes into the mountainous region of western and Eastern Ghats, these roads are remarkable feats of engineering and most date back to British times. Ghat roads were built to connect to the famous Hill Stations of the Indian Subcontinent.

There are many ghat roads in India which can be classed as mountaineer Ghat Roads. The state of Karnataka in our country has most of ghat roads in Western Ghat region.

The project work described here is very useful for road connectivity in hill areas which avoids hairpin turning roads over the mountains. As any type of motor vehicle cannot climb ramp type of roads, these hair pin turnings are essential to reduce the angle of roads; in this regard lengthy roads are essential to cover short distance. While laying a road over the mountain to reach its top, lot of hairpin turnings are essential, these are known as ghat roads. Ghats refer to the areas in holy river-side cities like Varanasi and Haridwar where stairs exist to reach the Ganges. It is also used for mountainous regions like the Western and Eastern Ghats. The following is the picture shows the hair pin turning.

II. FUNCTIONAL DESCRIPTION

Hanging type of vehicle carrying mechanism is designed which is aimed to carry the platform that is attached to the moving mechanism. The moving mechanism constructed with 4 metal grooved wheels runs over a metal rail arranged over the head of a main mechanical structure. Each wheel is having a furrow of 3mm thick and 2.5mm depth, and the rail constructed with aluminum angle of ½” breadth at both sides is used, this angle thickness is 1.2mm such that the wheel groove will be meshed with angle

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accurately. While running the chassis over the metal track, as grooved wheels are aligned with projection of track, moving mechanism will not be deviated under any circumstances.

A. Function of control keys

At both ends of moving mechanism two similar but independent processing units are constructed using atmel 89c2051 microcontrollers, each control unit is having two control keys. These keys are interfaced with controller chip as a input information source, whenever the start key is activated, the moving platform that holds a vehicle will be moved in forward direction and

The control keys are nothing but push to on keys, with four push buttons (two on either side) interfaced with microcontroller at input side, all required functions are performed. When any key is activated, the input signal is grounded through the key & it is treated as command signal. Each motor is controlled independently and to rotate the motor in one direction the corresponding push button must be pressed. The function of each key differs with other key function, as a motor can rotate in both directions, by pressing one key, the motor rotates in forward direction, similarly by activating the other the key, rotates the motor in reverse direction, like wise motion can be created in the mechanism by activating the corresponding keys.

Fig: 2.1 Switch

B. Function of the Limit switch

The mechanical movement of each moving platform is restricted through two limit switches & these switches are interfaced with microcontroller as input signals. This limit switch is having long lever & when little pressure is applied to the lever, switch will be activated automatically. Limit switches are used to control the mechanical transmission section, for this purpose total 4 limit switches are used to restrict the movements of both moving mechanisms independently. These switches are arranged in such a fashion such that whenever any platform reaches to any reference point to position the platform to the existing road, corresponding switch will be activated automatically.

C. Signal lights for Road traffic

Red and yellow lights are arranged for Road traffic at both sides of the road ends simulated with wooden platforms, these lights are controlled automatically according to the interrupt signals obtained from the control keys. During normal condition, means there is no vehicle present over the structure, but for approaching vehicle it is essential to provide signal to indicate that the bridge is ahead and therefore the vehicle speed must be reduced. For this purpose here yellow indicator is provided and it flashes continuously, whenever any vehicle is ready to leave the road end through the vehicle transport mechanism, and when the start button is activated, the yellow indicator will be switched off and red indicator will be energized automatically. Once this red indicator glows, it remains in energized condition until the platform reaches to its home position. .

D. Motor drives the mechanism through driver chip

The DC Motor used here is rated for 12V DC, this is a built in reduction gear mechanism motor by which speed will be reduced and torque will be increased. As the torque of this motor is sufficient to drive the mechanism its shaft is directly coupled with the axel mechanism. Here 30 RPM motor is used and there by the mechanism will be moved horizontally in both directions.

An axle is a central shaft for a rotating wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle. In the former case, bearings or bushings are provided at the mounting points where the axle is supported. In the latter case, a bearing or bushing sits inside a central hole in the wheel to allow the wheel or gear to rotate around the axle. Sometimes, especially on bicycles, the latter type axle is referred to as a spindle.

Fig: 2.2 Axle Wheels

Since the motor used here is small in size and to increase its torque, this motor is built in with reduction gear mechanism such that speed will be reduced and torque will be increased. A gear box that contains multiple gear wheels or cog wheels is a rotating mechanism that increases or decreases the speed of main motor shaft. Each wheel part is having cut teeth, or cogs, which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source. Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape. Two or more meshing gears, working in a sequence, are called a gear train or a transmission. A gear can mesh with a linear toothed part, called a rack, thereby producing translation instead of rotation.

The gears in a transmission are analogous to the wheels in a crossed belt pulley system. An advantage of gears is that the teeth of a gear prevent slippage. When two gears mesh, if one

gear is bigger than the other, a mechanical advantage is produced, with the rotational speeds, and the torques, of the two gears differing in proportion to their diameters.

III. MECHANICAL AND ELECTRICAL DRAWINGS

A. DC Motor Driver Circuit

The motor drive circuit is designed with 'H' Bridge IC, for this purpose L293D is used. This is a dual H-Bridge motor driver, so with one IC, two DC motors can be interfaced which can be controlled in both clockwise and counter clockwise directions and its direction of motion can also be fixed. But here we are using only one motor and there by half of its section is used to run the motor in both directions.

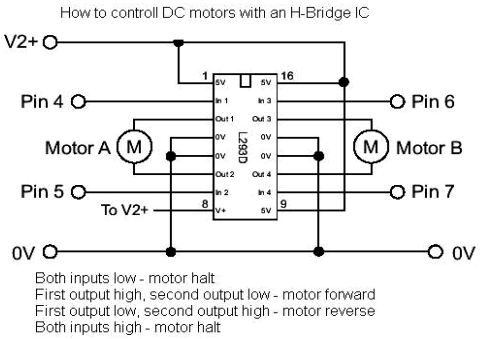

Fig: 3.1 Motor Driver Circuit

B. DC Motor Control with H-Bridge

The Device is a monolithic integrated high voltage, high current four channel driver designed to accept standard DTL or TTL logic levels and drive inductive loads (such as relays solenoids, DC and stepping motors) and switching power transistors. To simplify use as two bridges each pair of channels is equipped with an enable input. A separate supply input is provided for the logic, allowing

operation at a lower voltage and internal clamp diodes are included. This device is suitable for use in switching applications at frequencies up to 5 kHz. The L293D is assembled in a 16 lead plastic package which has 4 center pins connected together and used for heat sinking The L293DD is assembled in a 20 lead surface mount which has 8 center pins connected together and used for heat sinking.

C. Direct current motor control

Control for the two motors in the system is carried out by using the L293D integrated circuit H Bridge, a microcontroller enable and disable the motor excitation elements using the
internal H bridges in the circuit. The easy operation of the L293D circuit and considering the only one movement in a single direction, it is possible to us the following operation movement's codification as

D. DC Motor

DC motors are widely used, inexpensive, small and powerful for their size. They are most easy to control. One DC motor requires only two singals for its operation. DC motors take direct current voltages as input and convert it into rotation movement. DC motors usually have two wires and can be powered directly from battery or DC power supply. DC motor can also be powered through drivers circuit that can regulate the speed and direction of the motor

E. Microcontroller chip 89C2051

Depending up on the program prepared for the processing unit in assembly language, the microcontroller chip controls the moving mechanism through DC motor. The heart of the project work is microcontroller, since this chip is having lot of I/O lines entire electronic and electrical hardware is interfaced with single chip.

F. Mechanical construction details

A Full-fledged prototype module is constructed for live demonstration. DC motors are used to drive the moving mechanisms, mechanical movements are restricted using limit switches and control circuit is designed with 89c51 controller. The basic mechanical structure to hold the both moving mechanisms horizontally are constructed with aluminum angles. For this purpose ¼", ½" and ¾" angles are used, depending up on the dimensions mentioned in the mechanical drawings, they are cut in to different lengths and attached to each other to build a bridge mechanism that hold1s the vehicle carrying mechanisms.
The mechanical system is considered as motion converter, this can be created by implementing electro-mechanical techniques. The concept is to transform the motion from one form to some other required form by using suitable mechanical and electrical devices. In this project work the technique of transform the rotational motion in to linear motion is implemented. For this purpose a DC motors are used to create the motion the carrier movement. These motors are constructed with reduction gear mechanism which is built in with the motor internally. As the machine is designed as prototype module, low rating motors are used to drive the mechanism. The advantage of selecting reduction gear mechanism motors are that a small motor can drive heavy loads. As these motors are purchased from local market, ratings regarding torque are not mentioned. Only speed and operating voltage is specified and as per this data, the motor is designed to operate at 12V DC and the motor speed is 30 RPM. These motors driving capacity is tested practically, in our test we came to know that each motor can drive an independent load of maximum 2Kg only. There by according to the driving capacity of these motors, one small mechanical structure is designed for the demo purpose.

IV. DESCRIPTION ABOUT PROCESSING (CONTROLLER) UNIT

A. Microcontroller 89c2051

The AT89C2051 is a low-voltage, high-performance CMOS 8-bit microcomputer with 2K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C2051 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

B. Restrictions on Certain Instructions

The AT89C2051 and is an economical and cost-effective member of Atmel's growing family of microcontrollers. It contains 2K bytes of flash program memory. It is fully comp a t i b l e with the MCS-51 architecture, and can be programmed using the MCS-51

instruction set. However, there are a few considerations one must keep in mind when utilizing certain instructions to program this device. All the instructions related to jumping or branching should be restricted such that the destination address falls within the physical program memory space of the device, which is 2K for the AT89C2051. This should be the responsibility of t h e software

C. Features

1) Compatible with MCS-51™ Products
2) 2K Bytes of Reprogrammable Flash Memory Endurance: 1,000 Write/Erase Cycles
3) 2.7V to 6V Operating Range
4) Fully Static Operation: 0 Hz to 24 MHz
5) Two-level Program Memory Lock
6) 128 x 8-bit Internal RAM
7) Programmable I/O Lines
8) Two 16-bit Timer/Counters
9) Six Interrupt Sources
10) Programmable Serial UART Channel
11) Direct LED Drive Outputs
12) On-chip Analog Comparator
13) Low-power Idle and Power-down Modes

V. PIN DESCRIPTION

A. VCC -Supply voltage.
B. GND- Ground.
C. Port Pin *Alternate Functions*

P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	INT0 (external interrupt 0)
P3.3	INT1 (external interrupt 1)
P3.4	T0 (timer 0 external input)
P3.5	T1 (timer 1 external input)

Port 3 also receives some control signals for Flash programming and verification.

D. RST

Reset input. All I/O pins are reset to 1s as soon as RST goes high. Holding the RST pin high for two machine cycles while the oscillator is running resets the device. Each machine cycle takes 12 oscillator or clock cycles.
Each machine cycle takes 12 oscillator or clock cycles. XTAL1 Input to the inverting oscillator amplifier and input to the internal clock operating circuit. XTAL2 Output from the inverting oscillator amplifier.

E. SBUF (Serial Buffer, 99h)

SBUF is used to hold data in serial communication. It is physically two registers. One is writing only and is used to hold data to be transmitted out of 8051 via TXD. The other is read only and holds received data from external sources via RXD. Both mutually exclusive registers use address 99h.

F. I/O Ports

One major feature of a microcontroller is the versatility built into the input/output (I/O) circuits that connect the 8051 to the outside world. The main constraint that limits numerous functions is the number of pins available in the 8051 circuit. The DIP had 40 pins and the success of the design depends on the flexibility incorporated into use of these pins. For this reason, 24 of the pins may each used for one of the two entirely different functions which depend, first, on what is physically connected to it and, then, on what software programs are used to “program” the pins.

G. PORT 1

Port 1 is exclusively used for input/output operations. PORT 1 pins have no dual function. When a pin is to be configured as input, 1 is to be written into the corresponding Port 1 latch.

H. PORT 3

Port 3 may be used to input /output port. The input and output functions can be programmed under the control of the P3 latches or under the control of various special function registers. Unlike Port 0 and Port 2, which can have external addressing functions and change all eight-port b se, each pin of port 3 maybe individually programmed to be used as I/O or as one of the alternate functions. The Port 3 alternate uses are:

Table: 4.1 Port 3 Alternate Uses

Pin (SFR)	Alternate Use
P3.0-RXD (SBUF)	Serial data input
P3.1-TXD (SBUF)	Serial data output
P3.2-INTO 0 (TCON.1)	External interrupt 0
P3.3 - INTO 1 (TCON.3)	External interrupt 1
P3.4 - T0 (TMOD)	External Timer 0 input
P3.5 – T1 (TMOD)	External timer 1 input
$\overline{P3.6}$ - WR	External memory write pulse
$\overline{P3.7}$ - RD	External memory read pulse

I. Interrupts

Interrupts are hardware signals that are used to determine conditions that exist in external and internal circuits. Any interrupt can cause the 8051 to perform a hardware call to an interrupt –handling subroutine that is located at a predetermined absolute address in the program memory.

VI. ABOUT 'H' - BRIDGE DESCRIPTION

Whenever a robotics hobbyist talk about making a robot, the first thing comes to his mind is making the robot move on the ground. And there are always two options in front of the designer whether to use a DC motor or a stepper motor. When it comes to speed, weight, size, and cost... DC motors are always preferred over stepper motors. There are many things, which we can do with DC motor when interfaced with a micro controller. For example we can control the speed of motor, we can control the direction of rotation, we can also do encoding of the rotation made by DC motor i.e. keeping track of how many turns are made by the motors etc. So we can see DC motors are better than stepper motors.

In this part of tutorial we will learn to interface a DC motor with a micro controller. Usually H-bridge is preferred way of interfacing a DC motor. These days many IC manufacturers have H-bridge motor drivers available in the market like L293D is most used H-Bridge driver IC. H-bridge can also be made with the help of transistors and MOSFET's etc. rather of being cheap, they only increase the size of the design board, which is sometimes not required so using a small 16 pin IC is preferred for this purpose. L293D is having two 'H' Bridges inside, so that we can drive two DC motors simultaneously. Before discussing about this device, first we must learn basic theory of 'H' Bridges. The following is the description.

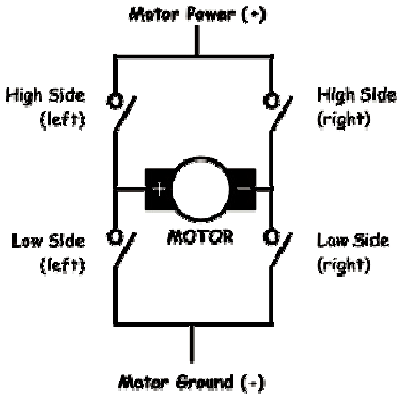

Fig: 6.1 H-bridge

The switches are turned on in pairs, either high left and lower right, or lower left and high right, but never both switches on the same "side" of the bridge. If both switches on one side of a bridge are turned on it creates a short circuit between the battery plus and battery minus terminals. If the bridge is sufficiently powerful it will absorb that load and your batteries will simply drain quickly. Usually however the switches in question melt.

To power the motor, turn on two switches that are diagonally opposed. The current flows and the motor begin to turn in a "positive" direction. Switch off these two switches and switch on other two switches diagonally in other direction then the motor starts rotating in opposite direction. Actually it is quite simple, the tricky part comes in when we decide what to use for switches.

Table: 6.1 operations of H Bridge

High Side Left	High Side Right	Low Side Left	Low Side Right	Quadrant Description
On	Off	Off	On	Forward Running
Off	On	On	Off	Backward Running
On	On	Off	Off	Braking
Off	Off	On	On	Braking

In the above table the last two rows describes condition about short circuit the motor that causes the motors generator effect to work against it. The turning motor generates a voltage, which tries to force the motor to turn the opposite direction. This causes the motor to rapidly stop spinning and is called "braking" on a lot of H-bridge designs. Of course there is also the state where all the transistors are turned off. In this case the motor coasts freely if it was spinning and does nothing if it was doing nothing.

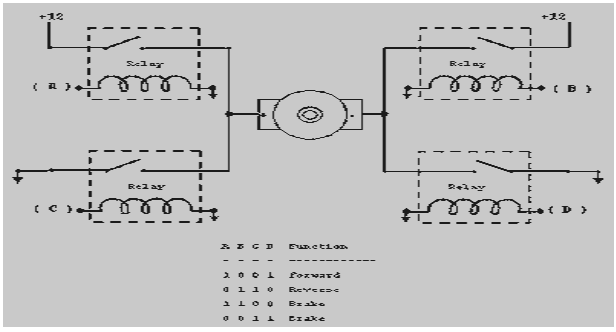

Fig:6.2 implementation of a H Bridge using four SPST relays

VII. DC MOTORS – AN OVERVIEW

At the most basic level, electric motors exist to convert electrical energy into mechanical energy. This is done by way of two interacting magnetic fields -- one stationary, and another attached to a part that can move. A number of types of electric motors exist, but most BEAM bots use DC motors in some form or another. DC motors have the potential for very high torque capabilities (although this is generally a function of the physical size of the motor), are easy to miniaturize, and can be "throttled" via adjusting their supply voltage. DC motors are also not only the simplest, but the oldest electric motors.

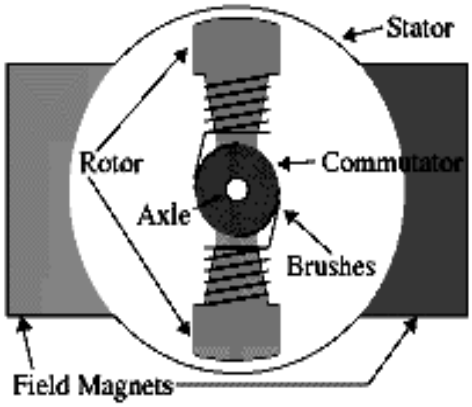

Fig: 7.1 A common motor layout

VIII. BRIEF DESCRIPTION ABOUT MECHATRONICS

Mechatronics and Measurement Systems provide an accessible overview of the evolving field of Mechatronics. David G. Alciatore and Michael B. Histand have taken careful steps to present measurement systems and electronics, which are fundamental to understanding Mechatronic systems. A complete analysis of Mechatronics is provided in their book “Introduction to Mechatronics and Measurement Systems”. This second edition features a new chapter that presents Microcontroller programming and interfacing. This chapter mainly focuses about microcontrollers, which is quite useful for the designers those who are dealing with Mechatronics. In addition to analysis techniques; design considerations are presented throughout the text. The text's numerous illustrations, examples, and problems provide an opportunity to see and apply Mechatronics to actual problems encountered in engineering practice. This text has been tested over several years to ensure accuracy.

IX. FABRICATION OF THE MACHINISM

There are few types of fabrication methods are done on the machine. They are:
Arc cutting.
Drilling.
Grinding.
Turning.

A. Further Operation

Cleaning.
Assembling

B. Machining Operations

In this project it is used to cut the raw material such as plates, rod. This is done by arc cutting machine.

C. Drilling

Drilling is used to produce holes in objects. In this project the square type pipe required the holes for making rake assembly. These holes are done by vertical type drilling machine.

D. Fine Grinding

It is nothing but a grinding process, which is done as smooth with fine grains. It is done by convention grinding machine.

E. Turning

It is used in this project to make the groove on the both sides of top cover plate. This is done by conventional lathe.

F. Further operations:=

1) Cleaning: It is the operation to clean the all machined parts without burrs, dust and chip formals. By meaning the parts they are brightened and good looking

2) Assembling: It is the operation, its deals with the assembling of various parts produced by above operations

X. UNDERSTANDING GEAR REDUCTION MECHANISM

The reason that we need to know about gear reduction is because the output speed of a motor is usually too fast for normal use. Most DC motors at normal operating voltages spin at well over 1,000 rpm (revolutions per minute) and some even as high at 50,000 rpm for brushless DC motors. If we had a motor than spun at say, 3,000 rpm, and we attached a 6 inch wheel to it then the wheel would theoretically be able to move the bot at almost 54 miles per hour! That is way too fast to control in an arena due to other considerations that wouldn't happen but we'll get into that later. So we need to reduce the rate at which the wheel spins so that we get a robot that we can at least control. Hint, the quick way of determining the speed of a wheel is to multiply the diameter (in inches) of the wheel by the rpm and divide the result by 336 (or for a really close figure use 336.13523981).

Fig:10.1 four inch diameter wheel

Let's take a look at what this circumference thing really means. To the left is a representation of a 4 inch diameter wheel. Click on the wheel to watch it as it moves through one complete revolution. You will see that the distance covered in one revolution is equal to the circumference of the wheel.

Now, let's take a look at a wheel that is twice the size. Click on the 8 inch wheel to watch it as it goes through one complete revolution. What you will notice is that notice is that not only does the wheel have twice the diameter but it travels twice the distance in one revolution. Therefore the circumference is twice that of the 4 inch wheel. So, if the 4 inch wheel were to cover the same distance as the 8 inch wheel then it has to complete 2 full revolutions.

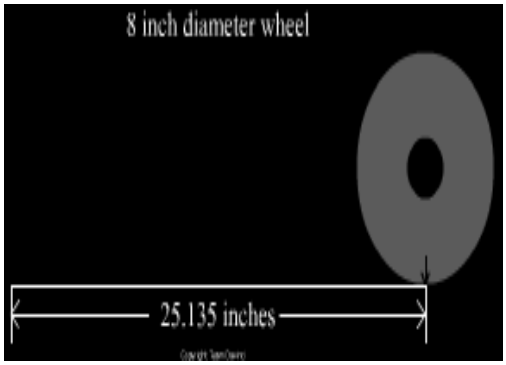

Fig: 10.2 Eight inch diameter wheel

So, is there a way to figure out the circumference of a wheel? You bet! Remember the magical number ***Pi***? Pi is roughly equivalent to 3.14. So, to determine the circumference of the wheel we multiply 2 times Pi times the radius of the wheel (radius = half the wheel diameter). So, for our four inch wheel we have 2 x 3.14 x 2 = 12.5663706144... inches. (remember to keep your units of measure the same throughout your calculations).

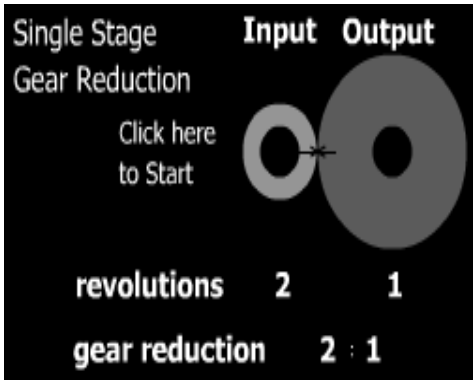

Fig: 10.3 Single Stage Gear Reduction

A. Description About Spur Gear Mechanism

Generally speaking, a gear is a round wheel with teeth. In order to be functional, a gear must be rotated so that the teeth stay in motion while connected to another object. The functional gear then interlocks with this other object and transfers the rotational motion to that object as well. More often than not, this other object is another gear, as seen in the picture, with the larger gear and the smaller gear interlocked. In the picture, the smaller gear is also connected to a pulley.

B. Spur Gears

Spur gears are the most common and also the oldest type of gear available. They are used in many different machines for a wide variety of functions. Although they are very simple in design, several different, discrete types of spur gears exist. Anyone who is interested in mechanical engineering or who is about to undertake a project that involves the use of gears of any type ought to familiarize themselves with spur gears and the ways in which they are used.

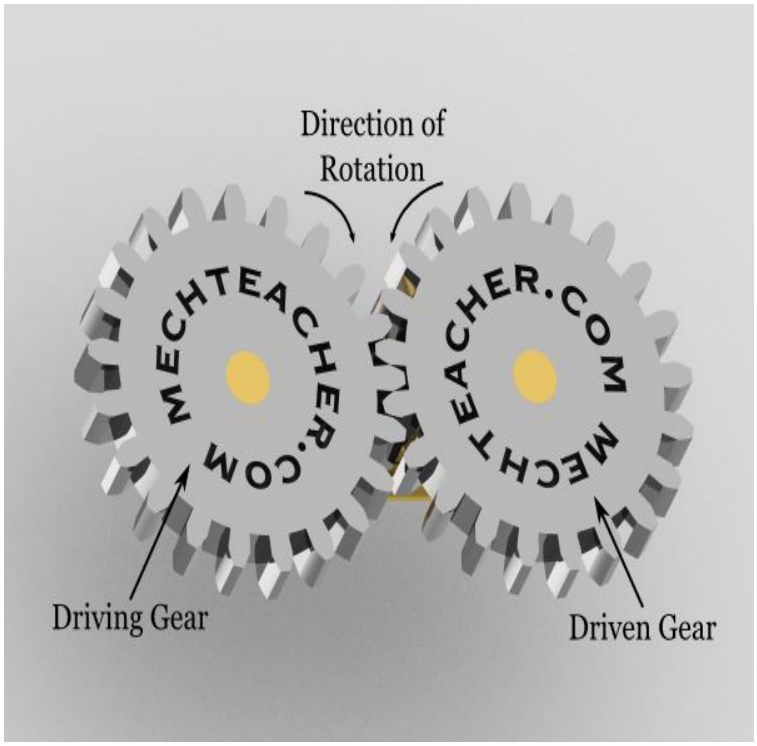

Fig: 11.1 Spur Gear

XI. RESULTS AND DISCUSSION

The project work **"**VEHICLE TRANSPORTING MECHANISM FOR HILL TOP ROADS**"** is designed and developed successfully, for the demonstration purpose prototype module is constructed & results are found to be satisfactory

Fig:13.1 Front view of working model

Table: results

PARAMETER	VALUE
Maximum weight carrying capacity	2kg
Velocity of platform	0.1m/s
Length of track	900mm
Height	520mm
Tensile strength	110mpa
Yield strength	105mpa
Hardness	28

XII. CONCLUSIONS

The project work is designed and developed successfully. For the demonstration purpose, a prototype module is constructed; and the results are found to be satisfactory. Since it is a prototype module, a simple mechanical structure is constructed. While designing and developing this proto type module, we have consulted few experts those who are having knowledge in Mechatronics, and these professionals working at different organizations belongs to Hyderabad helped us while fabricating this project work. Since it is a prototype module, much amount is not invested. The whole machine is constructed with locally available components, especially the mechanical components used in this project work are procured from mechanical fabricators and they are not exactly up to the requirement. Some of the modifications must be carried out in design to make it as real working system.

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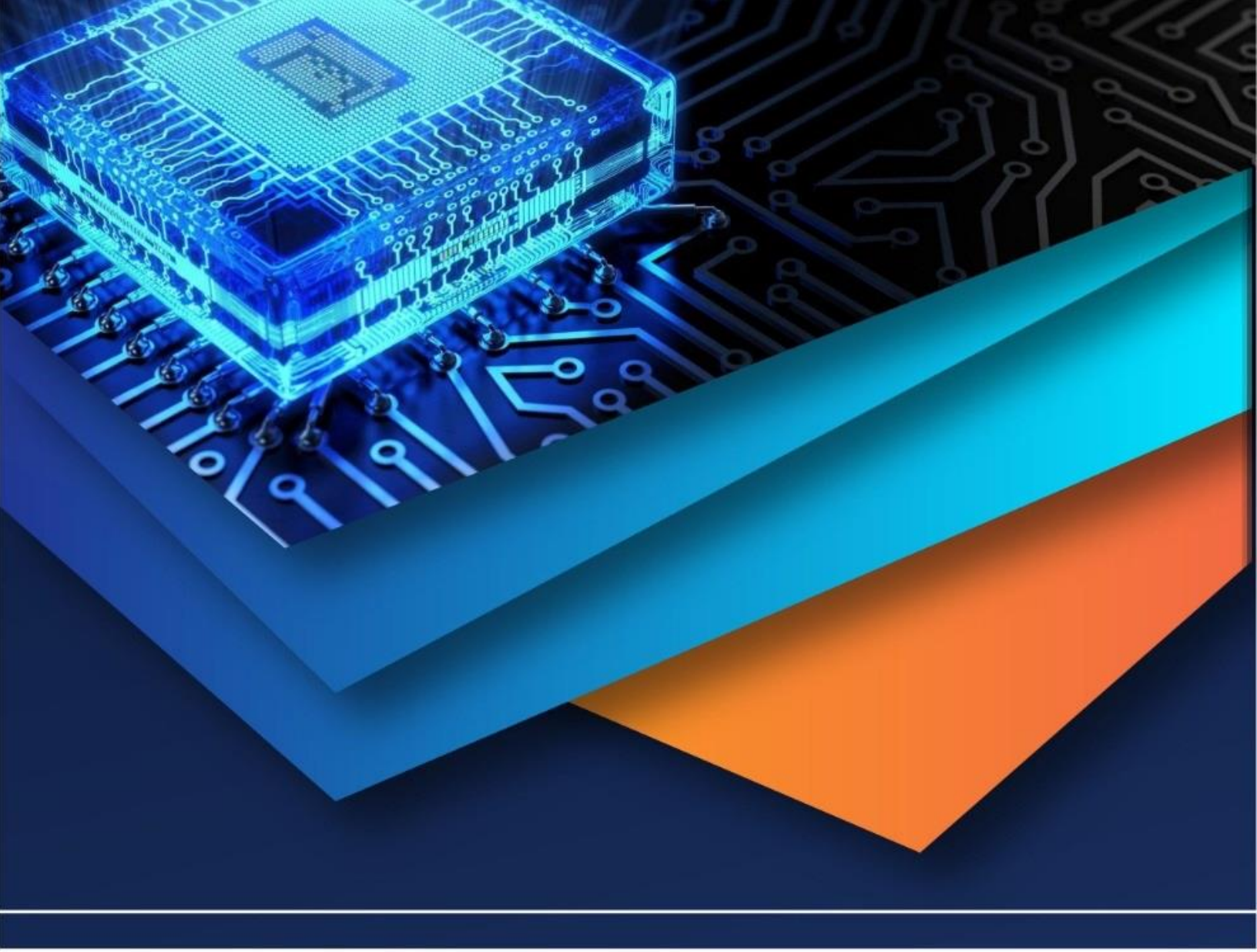

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