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Design and development of automated suspension to prevent chassis damage

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Abstract - *Recent technological advance has brought about automobiles. In particular automated pneumatic system with the use of prevention of chassis damage using automated pneumatic system, the automatic chassis adjustment and damage of car chassis is effectively prevented.*

1.INTRODUCTION

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Unlike the first engine and chassis builders, who had no precedents to follow, the first auto body engineers represented an old established craft. It mattered little to them whether vehicles were to be propelled by a gasoline engine, electric power, or steam. The body builders contended that if carriages were good enough for horses, they were good enough for engines. In 1984 Volvo announced the use of epoxy to tack-weld body parts together, thus reducing the number of conventional spot welds from 4000 to 500. But Volvo is not No. 1 in the use of glue for this purpose. Body engineers used casein to hold early wooden body members together on the Cadillac, Columbia, Loco mobile, and Peerless of 1898 to 1904 among others.

1.1CHASSIS:

A chassis consists of an internal framework that supports a manmade object in its construction and use. It is analogous to an animal's skeleton. An example of a chassis is the under part of a motor vehicle, consisting of the frame (on which the body is mounted). If the running gear such as wheels and transmission, and sometimes even the driver's seat, are included, then the assembly is described as a rolling chassis. In the case of vehicles, the term rolling chassis means the frame plus the "running gear" like engine, transmission, drive shaft, differential, and suspension. A body (sometimes referred to as "coachwork"), which is usually not necessary for integrity of the structure, is built on the chassis to complete the vehicle. For commercial vehicles, a rolling chassis consists of an assembly of all the essential parts of a truck (without the body) to be ready for operation on the road. The design of a pleasure car chassis will be different than one for commercial vehicles because of the heavier loads and constant work use. This describes the lower hull, although common usage might include the upper hull to mean the AFV without the turret. The hull serves as a basis for platforms on tanks, armored personnel carriers, combat engineering vehicles, etc. Traditionally, the most common material for manufacturing vehicle chassis has been steel, in various forms. Over time, other materials have come into use, the majority of which have been covered here.

1.2 AIRSUSPENSION

Air suspension is a type of vehicle suspension powered by an electric or engine-driven air pump or compressor. This compressor pumps the air into a flexible bellows, usually made from textile-reinforced rubber. The air pressure inflates the bellows, and raises the chassis from the axle. Air suspension is used in place of conventional steel springs in passenger cars, and in heavy vehicle applications such as buses and trucks. It is broadly used on semi-trailers, trains (primarily passenger trains). One application was on EMD's experimental Aero train. The purpose of air suspension is to provide a smooth, constant ride quality, but in some cases is used for sports suspension. Modern electronically controlled systems in automobiles and light trucks almost always feature self-leveling along with raising and lowering functions. Vehicles that use air suspension today include models from Maybach, Rolls-Royce, Lexus, Jeep, Ram, Cadillac (GM), Mercedes-Benz, Porsche, Land Rover/Range Rover, SsangYong, Audi, Subaru, Volkswagen, Lincoln, Ford, and Tesla, among others. Citroën now feature Hydractive suspension, a computer controlled version of their Hydro pneumatic system, which features sport and comfort modes, lowers the height of the car at high speeds and continues to maintain ride height when the engine is not running. These technologies allow car manufacturers to achieve a greater degree of ride quality and car handling by keeping the tires perpendicular to the road in corners, allowing better traction and control**.**

2. LITERATURE SURVEY

Other important activity regarding chassis developments are

1) In 1897, a car named the Hugot hit the street with a wicker body. The nameplate and body soon became basket cases.

2) Aluminum and steel started vying to replace wood body panels as early as 1900. At the time, sheet aluminum was more expensive than steel, and cast aluminum brackets more expensive still. Thus was born the first car caste system. Cars having sheet steel body panels were manufactured for the masses, while those with aluminum body panels were made for the rich.

3) The first ever Cadillac, the 1902 model, sported patent leather fenders.

4) Hinged side doors -- two of them -- became popular in 1905; four of them started to become popular in 1913, although they were available in 1910.

5) In 1922, the Auburn came out with the first X-member frame. The structure provided a major stride in torsional stiffness and cut down on vibration.

6) The first production wood-body station wagon was the 1923 Star. The first all steel-body production model was the 1935 Chevy.
7) Lotus introduced its "backbone" chassis on the 1962 Elan. A central steel box section carried the engine, drive shaft, and suspension. The fiberglass body was bonded (glued) to this steel frame.

8) Lotus was first to build a unit body structure using the lightest and strongest materials available -- a combination of Kevlar and carbon fiber-reinforced resins. This structure significantly reduced noise and vibration.

3 .DESING AND CALCULATIONS

3.1 Conceptual design for pneumatic cylinder
For double acting pneumatic cylinder:-
3.1.1 Specifications:–

1. Cylinder diameter (d1) = 20 mm
2 .Stroke length (L) = 152.40 mm
3. Piston rod diameter (d20) = 5 mm
4. Force excreted (F)= 210 N = 21.5 Kg

3.2 Conceptual design for shock absorber
For spring or shock absorber used:-

3.2.0 Specifications:-

1. Maerial – spring steel (G= 79000N\mm2, Shear strength= 95 N\mm2)
2. Number of spring used = 4
3. Mean dia of coil (D) = 34mm
4. Wire dia (d) = 4 mm
5. Spring index (C) = 8.5(C=D\d)
6. Length of spring = 48 mm
7. Number of active coil (i) = 6
8. Force excreted on each spring = 55 N
9. End type – square and ground end

3.2.2 Calculation:-

1) Maximum shear stress:- τmax = 87.20 N\mm2

2) Total deflection:-

iI= i+n= 6+2=8 y = 5.13 mm

3) Pitch and length:-
l0= (i+n)d+y+a = (8*4)+5.13+1.2826
a= 25% of maximum deflection
l0= 38.4126 mm
a= 1.2826
Length (l0) is less than actual length.
So the design is safe. Pitch, p=3.735 mm

4) Natural frequency:-
Natural frequency, f =Mass , m = volume * density

m 2\4 * 7.75 * 10-6 m =0.0624 Kg = 62.4 gm

f1 = 1\ (10000.72\0.0624)

f1 = 62.41 Hz for k0= 10.72 N\mm
f2 = 63.71 Hz for k0= 10.72 N\mm
f5 = 222 Hz for k0= 19.829 N\mm
k0=F0= F\y= 55\5.13 =10.72 N\mm
mass density = 7.75 * 10-6 Kg\mm3

f3 = 99.2 Hz for k0= 12.42 N\mm
f4 = 112 Hz for k0= 13.02 N\mm
f6 = 222.7 Hz for k0= 20 N\mm

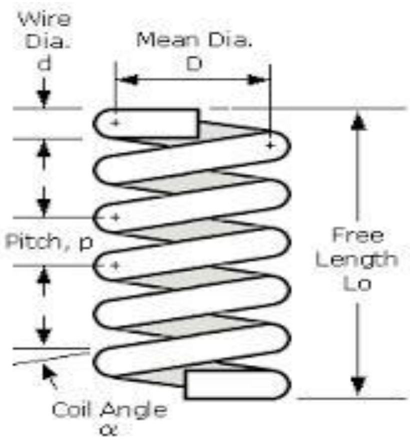


Fig 3.2- Helical spring

3.3 Cad design - It's being done by using software solid edge and shown in figures

below-

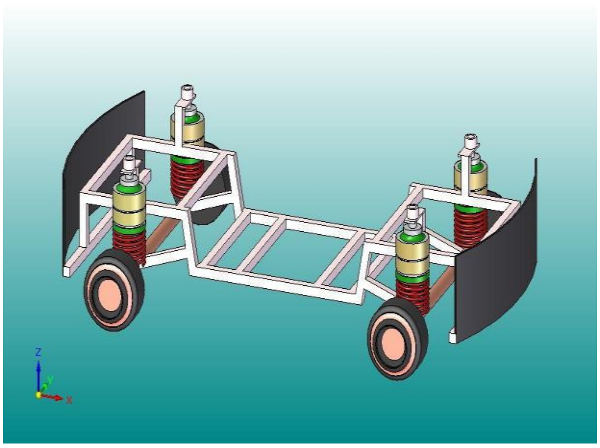


Fig 3.3- 3D cad model

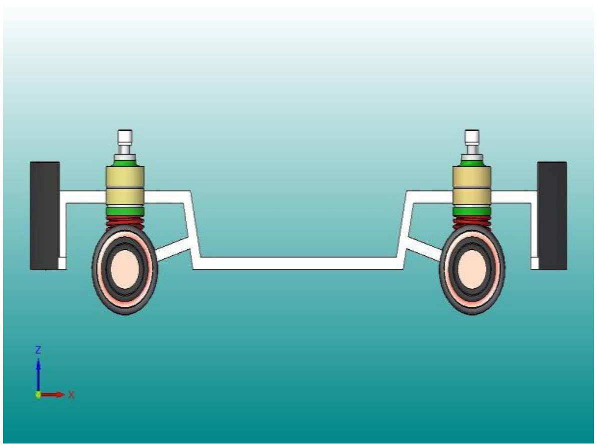
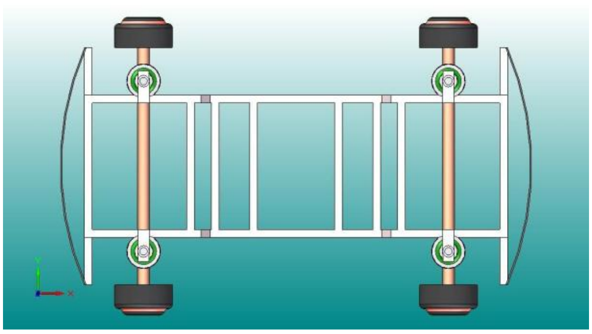


Fig 3.4- Front view

Fig 3.5- Top view



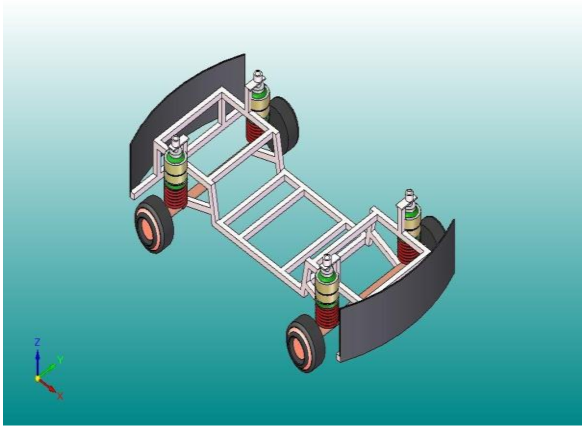


Fig 3.6- Side view

Solid Edge is a 3D CAD history based parametric feature and synchronous technology solid modeling software. It runs on Microsoft Windows and provides solid modeling, assembly modeling and drafting functionality for mechanical engineers, designers and drafters. Through third party applications it has links to many other Product Lifecycle Management (PLM) technologies.

Originally developed and released by Intergraph in 1996 using the ACIS geometric modeling kernel it later changed to using the Para solid kernel. In 1998 it was purchased and further developed by UGS Corp (the purchase date corresponds to the kernel swap). In 2007, UGS was acquired by the Automation & Drives Division of Siemens AG. UGS company was renamed Siemens PLM Software on October 1, 2007. Since Sep 2006 Siemens also offers a free 2D version called Solid Edge 2D Drafting. Solid Edge is a direct competitor to Solid Works and Autodesk Inventor.

An assembly is built from individual part documents connected by mating constraints, as well as assembly features and directed parts like frames which only exist in the Assembly context. Solid Edge supports large assemblies with over 1,000,000 parts.

The benefits of 3D design are well known, but many design processes follow a workflow of first establishing a basic product structure, utilizing new and existing 2D layouts to create a concept and moving to 3D only when appropriate. Solid Edge 2D/3D hybrid design capabilities encapsulate this valuable workflow, giving you the flexibility to choose the approach that best suits each individual step in your development process and allowing you to adapt to varying design data and supporting information that you have available at the time. Product and process complexity is a growing concern for manufacturing organizations, and thousands around the world have come to rely on Solid Edge to battle this increasing complexity head-on. Complexity is significantly eased when the right tools are available at the right time. Good engineering design needs a mixture of both 2D and 3D to function to its full potential, and with Solid Edge you have the means to reach and exceed that potential.

4.4 Methodologies-

4.4.1 Sensor placing-

The ultrasonic sensor is placed at the bottom of car bonnet (12 cm from ground) and other ultrasonic sensor is placed at the top (49 cm from ground), for both rare and front side. These sensors are connected to the microcontroller which is activated when hump is sensed.

4.4.2 Condition for working-

Condition 1-

Both the sensor send a signal to the microprocessor and it will send a command to the compressor to lift the chassis, by analyzing the obstacles as hump. The compressor supplies a sufficient amount of compressed air to the pneumatic cylinder, which lifts the chassis.

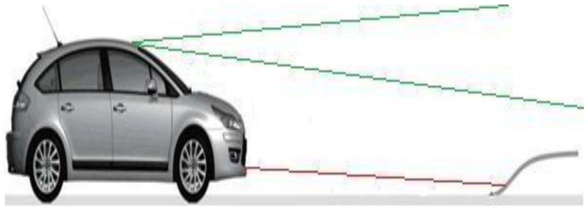


Fig 4.2- condition for lifting

Condition 2-

If it indicates an obstacle for both the sensor then it is concluded that there is another car in front of it. Both the sensor send signal to the microprocessor and the microprocessor concludes that there is a car in front of it. And it does not send any command to the compressor as a result the chassis stays still

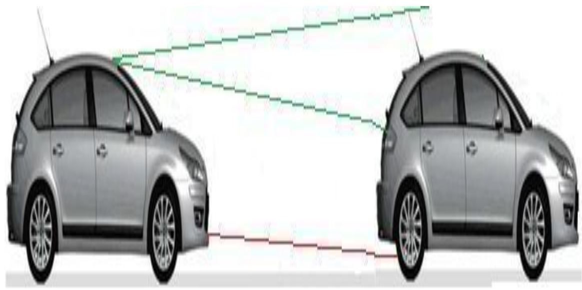


Fig 4.3- Condition for no lifting

4.4.3 Sensing process-

There are several ways to measure distance without contact. One way is to use ultrasonic waves at 40 kHz for distance measurement. Ultrasonic transducers measure the amount of time taken for a pulse of sound to travel to a particular surface and return as the reflected echo. This circuit calculates the distance based on the speed of sound at 25°C ambient temperature and shows it on a 7-segment display. Using it, you can measure distance up to 2.5 meters. For this particular application, the required components are AT89C2051 microcontroller, two 40kHz ultrasonic transducers (one each for transmitter and receiver), current buffer ULN2003, operational amplifier LM324, inverter CD4049, four 7-segment displays, five transistors and some discreet components.

Ultrasonic generators use piezoelectric materials such as zinc or lead zirconium tart rates or quartz crystal. The material thickness decides the resonant frequency when mounted and excited by electrodes attached on either side of it. The medical scanners used for abdomen or heart ultrasound are designed at 2.5 MHz. In this circuit, a 40 kHz transducer is used for measurement in the air medium. The velocity of sound in the air is around 330 m/s at 0°C and varies with temperature.

In this project, you excite the ultrasonic transmitter unit with a 40kHz pulse burst and expect an echo from the object whose distance you want to measure. The transmitted burst, which lasts for a period of approximately 0.5 Mrs. It travels to the object in the air and the echo signal is picked up by another ultrasonic transducer unit (receiver), also a 40 kHz pre-tuned unit. The received signal, which is very weak, is amplified several times in the receiver circuit.

Weak echoes also occur due to the signals being directly received through the side lobes. These are ignored as the real echo received alone would give the correct distance. That is why we should have a level control. Of course, the signal gets weaker if the target is farther than 2.5 meters and will need 7-segment displays the distance in centimeters and millimeters (three digits for centimeters and one for millimeters). The software is written in Assembly language and assembled using 8051 cross-assembler. It is well commented and easy to understand. The pulse train for 0.5 s is started by making pin 8 high and low alternately for 12.5 microseconds so that the pulse frequency is 40 kHz. After 25 such pulses

while the timer runs counting time in microseconds. When the echo arrives, port-3 pin P3.6 goes high, the timer reads and the 16-bit number is divided by twice the velocity and converted into decimal format as a 4-digit number. If the echo does not arrive even after 48 milliseconds, the waiting loop is broken and the pulse train sequence is started once again. If the echo comes within this time, it is displayed for half a second before proceeding to another measurement. Thus, the display appears continuous and flicker-free.

Assemble the PCB and put the programmed microcontroller into the socket. After switching on the power supply and microcontroller automatically getting reset upon power- 'on,' the level of reference voltage set on pin.

Block diagram and circuit diagram can give as follows-

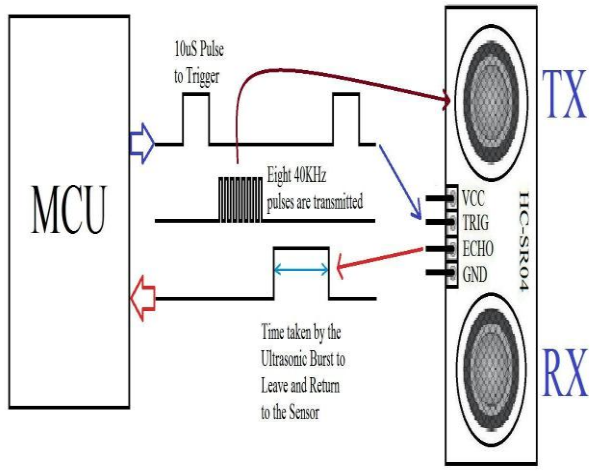


Fig 4.4- Block diagram of circuit used

4.5 Microcontroller and embedded system (coding)-

In our aforesaid project the synchronization between mechanical system (suspension with shocker) and pneumatics system (cylinder powered by compressor) for lifting, is being done by microcontroller (8051) which has to code in embedded system (link between hardware and software).

4.5.1 Arduino microcontroller:-

The Intel 8051 is an 8-bit microcontroller which means that most available operations are limited to 8 bits. There are 3 basic "sizes" of the 8051: Short, Standard, and Extended. The Short and Standard chips are often available in DIP (dual in-line package) form, but the Extended 8051 models often have a different form factor, and are not "drop-in compatible". All these things are called 8051 because they can all be programmed using 8051 assembly language, and they all share certain features (although the different models all have their own special features).

4.5.2 Features of arduino microcontroller:–

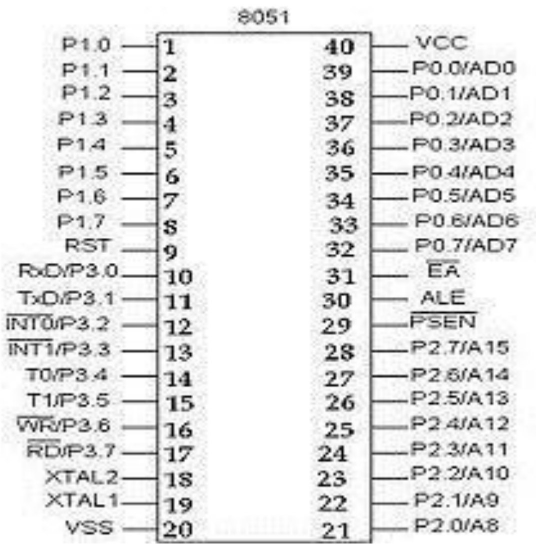
1.4 KB on chip program memory.
2.128 bytes on chip data memory (RAM)
3.4 register banks.
4.128 user defined software flags.

5.8-bit data bus
6.16-bit address bus

7.16 bit timers (usually 2, but may have more, or less).
8.3 internal and 2 external interrupts.
9. Bit as well as byte addressable RAM area of 16 bytes.
10. Four 8-bit ports, (short models have two 8-bit ports).

8051 models may also have a number of special, model-specific features, such as UART, ADC, Op-Amps, etc... It is a very powerful micro controller.8051 chips are used in a wide variety of control systems, telecom applications, robotics as well as in the automotive.

4.5.3 Basic pins:-



1. Pin 9: IN is the reset pin which is used to reset the microcontroller's internal registers and ports upon starting up. (Pin should be held high for 2 machine cycles.)

2. Pins 18 & 19: The 8051 has a built-in oscillator amplifier hence we need to only connect a crystal at these pins to provide clock pulses to the circuit.

3. PIN 40 and 20: Pins 40 and 20 are VCC and ground respectively. The 8051 chip needs +5V 500mA to function properly, although there are lower powered versions like the Atmel 2051 which is a scaled down

4. version of the 8051 which runs on +3V.

5. Pins 29, 30 & 31: As described in the features of the 8051, this chip contains a built-in flash memory. In order to program this we need to supply a voltage of +12V at pin 31. If external memory is connected then PIN 31, also called EA/VPP, should be connected to ground to indicate the presence of external memory. PIN 30 is called ALE (address latch enable), which is used when multiple memory chips are connected to the controller and only one of them needs to be selected. We will deal with this in depth in the later chapters. PIN 29 is called PSEN. This is "program store enable". In order to use the external memory it is required to provide the low voltage

(0) on both PSEN and EA pins.

4.5.4 Ports: -

There are 4 8-bit ports: P0, P1, P2 and P3.

1. Port P1 (Pins 1 to 8): The port P1 is a general purpose input/output port which can be used for a variety of interfacing tasks. The other ports P0, P2 and P3 have dual roles or additional functions associated with them based upon the context of their usage. The port 1 output buffers can sink/source four TTL inputs. When 1s are written to portn1 pins are pulled high by the internal pull-ups and can be used as inputs.

2. Port P3 (Pins 10 to 17): PORT P3 acts as a normal IO port, but Port P3 has additional functions such as, serial transmit and receive pins, 2 external interrupt pins, 2 external counter inputs, read and write pins for memory access.

3. Port P2 (pins 21 to 28): PORT P2 can also be used as a general purpose 8 bit port when no external memory is present, but if external memory access is required then PORT P2 will act as an address bus in conjunction with PORT P0 to access external memory. PORT P2 acts as A8-A15, as can be seen from fig 4.6.

4. Port p0 (pins 32 to 39) PORT P0 can be used as a general purpose 8 bit port when no external memory is present, but if external memory access is required then PORT P0 acts as a multiplexed address and data bus that can be used to access external memory in conjunction with PORT P2. P0 acts as AD0-AD7, as can be seen from fig 4.5.

5. Port p10: Asynchronous communication input or Serial synchronous communication output.

4.5.5 Data and program memory:-

The arduino Microcontroller can be programmed in PL/M, 8051 Assembly, C and a number of other high-level languages. Many compilers even have support for compiling C++ for an 8051.

Program memory in the arduino is read-only, while the data memory is considered to be read/write accessible. When stored on EEPROM or Flash, the program memory can be rewritten when the microcontroller is in the special programmer circuit.

4.5.6 Embedded system:-

An embedded system is a computer system with a dedicated function within a larger mechanical or electrical system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today.

Properties typical of embedded computers when compared with general-purpose ones are e.g. low power consumption, small size, rugged operating ranges and low per-unit cost. This comes at the price of limited processing resources, which make them significantly more difficult to program and to interface with. However, by building intelligence mechanisms on the top of the hardware, taking advantage of possible existing sensors and the existence of a network of embedded units, one can both optimally manage available resources at the unit and network levels as well as provide augmented functionalities, well beyond those available. For example, intelligent techniques can be designed to manage power consumption of embedded systems.

Modern embedded systems are often based on microcontrollers (i.e. CPUs with integrated memory or peripheral interfaces) but ordinary microprocessors (using external chips for memory and peripheral interface circuits) are also still common, especially in more complex systems. In either case, the processor(s) used may be types ranging from general purpose to those specialized in certain class of computations or even custom designed for the application at hand. A common standard class of dedicated processors is the digital signal processor (DSP).

4.5.7 History:-

One of the very first recognizably modern embedded systems was the Apollo Guidance Computer, developed by Charles Stark Draper at the MIT Instrumentation Laboratory. At the project's inception, the Apollo guidance computer was considered the riskiest item in the Apollo project as it employed the then newly developed monolithic integrated circuits to reduce the size and weight. An early mass-produced embedded system was the Autonetics D-17 guidance computer for the Minuteman missile, released in 1961.

When the Minuteman II went into production in 1966, the D-17 was replaced with a new computer that was the first high-volume use of integrated circuits. This program alone reduced prices on quad nand gate ICs from $1000/each to $3/each[citation needed], permitting their use in commercial products.

Since these early applications in the 1960s, embedded systems have come down in price and there has been a dramatic rise in processing power and functionality. An early microprocessor for example, the Intel 4004, was designed for calculators and other small systems but still required external memory and support chips. In 1978 National Engineering Manufacturers Association released a "standard" for programmable microcontrollers, including almost any computer-based controllers, such as single board computers, numerical, and event-based controllers.

As the cost of microprocessors and microcontrollers fell it became feasible to replace expensive knob-based analog components such as potentiometers and variable capacitors with up/down buttons or knobs read out by a microprocessor even in consumer products. By the early 1980s, memory, input and output system components had been integrated into the same chip as the processor forming a microcontroller. Microcontrollers find applications where a general-purpose computer would be too costly.

A comparatively low-cost microcontroller may be programmed to fulfill the same role as a large number of separate components. Although in this context an embedded system is usually more complex than a traditional solution, most of the complexity is contained within the microcontroller itself. Very few additional components may be needed and most of the design effort is in the software. Software prototype and test can be quicker compared with the design and construction of a new circuit not using an embedded processor.

4.5.8 Characteristics:-

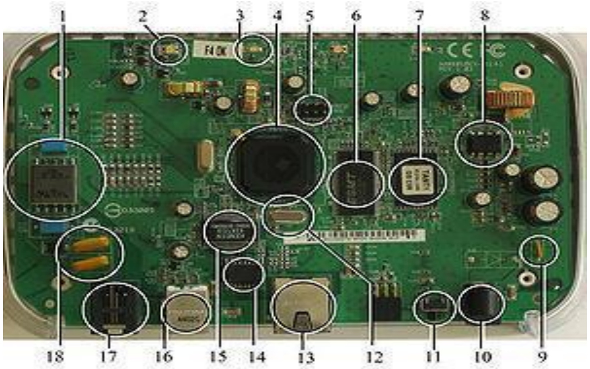


Fig 4.6- A modern example of an embedded system

Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reasons such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs.

Embedded systems are not always standalone devices. Many embedded systems consist of small, computerized parts within a larger device that serves a more general purpose. For example, the Gibson Robot Guitar features an embedded system for tuning the strings, but the overall purpose of the Robot Guitar is, of course, to play music. Similarly, an embedded system in an automobile provides a specific function as a subsystem of the car itself.

The program instructions written for embedded systems are referred to as firmware, and are stored in read-only memory or Flash memory chips. They run with limited computer hardware resources: little memory, small or non-existent keyboard or screen. Embedded systems range from no user interface at all, in systems dedicated only to one task, to complex graphical user interfaces that resemble modern computer desktop operating systems. Simple embedded devices use buttons, LEDs, graphic or character LCDs (HD44780 LCD for example) with a simple menu system.

4.5.9 Reliability:-

Embedded systems often reside in machines that are expected to run continuously for years without errors and in some cases recover by themselves if an error occurs. Therefore the software is usually developed and tested more carefully than that for personal computers, and unreliable mechanical moving parts such as disk drives, switches or buttons are avoided.

Specific reliability issues may include:

1. The system cannot safely be shut down for repair, or it is too inaccessible to repair. Examples include space systems, undersea cables, navigational beacons, bore-hole systems, and automobiles.

2. The system must be kept running for safety reasons. "Limp modes" are less tolerable. Often backups are selected by an operator. Examples include aircraft navigation, reactor control systems, safety-critical chemical factory controls, train signals.

3. The system will lose large amounts of money when shut down: Telephone switches, factory controls, bridge and elevator controls, funds transfer and market making, automated sales and service.

Fig 4.7- An embedded ethernet chip

4.6 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

In our existing project we used timing relay to on-off the compressor with time constrain.

Timing relay-

Timing relays are arranged for an intentional delay in operating their contacts. A very short (a fraction of a second) delay would use a copper disk between the armature and moving blade assembly. Current flowing in the disk maintains magnetic field for a short time, lengthening release time. The time period can be varied by increasing or decreasing the flow rate. For longer time periods, a mechanical clockwork timer is installed. Relays may be arranged for a fixed timing period, or may be field adjustable, or remotely set from a control panel. First we have the normally-open, timed-closed (NOTC) contact. This type of contact is normally open when the coil is unpowered (de-energized). The contact is closed by the application of power to the relay coil, but only after the coil has been continuously powered for the specified amount of time. In other words, the direction of the contact's motion (either to close or to open) is identical to a regular NO contact, but there is a delay in closing direction.

4.7 Solenoid valve-

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. Besides the plunger-type actuator which is used most frequently, pivoted-armature actuators and rocker actuators are also used.

Solenoid valves can be used for a wide array of industrial applications, including general on-off control, calibration and test stands, pilot plant control loops, process control systems, and various original equipment manufacturer applications.

In our project in order to on off compressed air we have to use solenoid valve which control the flow of air for lifting process.

Fig 4.8- Solenoid valve

4.8 Programming-

sensor programming is given by-

```
#include <Timer.h>
#include <LiquidCrystal.h>
#define trigPin1 2
#define echoPin1 3
#define trigPin2 4
#define echoPin2 5
#define Relay2 12
#define led   13
LiquidCrystal lcd(A0, A1, A2, A3, A4, A5);
long duration1, distance1,duration2,distance2;;
Timer t;
void setup() {
Serial.begin (9600);
pinMode(trigPin1, OUTPUT);
pinMode(echoPin1, INPUT);
pinMode(trigPin2, OUTPUT);
pinMode(echoPin2, INPUT);
pinMode(Relay2, OUTPUT);
pinMode(led, OUTPUT);
lcd.begin(16, 2);
lcd.setCursor(0,0);
lcd.print("ULTRASONIC RANGE");
lcd.setCursor(0,1);
```

```
lcd.print(" & HUMP DETECTOR");
delay(3000); lcd.clear();
//lcd.print(distance1, DEC);
lcd.println(distance1); t.every(50, u_s_s1);
t.every(60, u_s_s2);
}
void loop()
{
t.update();
}
// SENSOR 1 ROAD HUMPS DETECTOR// void u_s_s1(void)
{
digitalWrite(trigPin1, LOW); delayMicroseconds(2); digitalWrite(trigPin1, HIGH); delayMicroseconds(10); digitalWrite(trigPin1, LOW); duration1 = pulseIn(echoPin1, HIGH); distance1 = (duration1/2) / 29.1;
if (distance1 < 70 && distance2 < 70)
{
Serial.print("BOTH DETECTING\t LED ON\n"); lcd.clear();
lcd.setCursor(0,1);
lcd.println(" BOTH DETECTING "); digitalWrite(led,HIGH);
}
if (distance1 < 70)
{
lcd.clear();
lcd.setCursor(0,0);
lcd.println("ROAD HUMP DETECT"); lcd.setCursor(0,1); lcd.println("RELAY ACTIVE "); lcd.setCursor(14,1); lcd.println(distance1); digitalWrite(Relay2,HIGH); digitalWrite(led,LOW); Serial.print(distance1); Serial.print("\n");
Serial.print("ROAD HUMP DETECTED\t RELAY ACTIVATED\n"); delay(10000);
}
if (distance1 > 90)
{
Serial.print(distance1);
lcd.clear();
lcd.println(" NO DETECTION "); Serial.print(" NO DETECTION \n");
}
if (distance2 < 90 )
{

Serial.print("VEHICLE DETECTED\t LED OFF\n"); digitalWrite(led,HIGH);
Meanwhile lcd.clear();
lcd.setCursor(0,0); lcd.println("VEHICLE DETECTED");
}
else
{
digitalWrite(Relay2,LOW);
digitalWrite(led,LOW);
Serial.print(" NO DETECTION \n");
Serial.print(distance1);
Serial.print("\n");
lcd.clear();
lcd.println(" NO DETECTION "); digitalWrite(led,LOW);
}
}
// SENSOR 2 ROAD VEHICLES AND WALL DETECTOR// void u_s_s2(void)
{
digitalWrite(trigPin2, LOW); delayMicroseconds(2); digitalWrite(trigPin2, HIGH); delayMicroseconds(10); digitalWrite(trigPin2, LOW); duration2 = pulseIn(echoPin2, HIGH); distance2 = (duration2/2) / 29.1;
}
```

Chapter 5

EXPREIMENTAL APPROACH

5.1 Tube materials-

Cold drawn seamless tube is used (2cm square).This material has a yield strength of 350 to 700 N/mm2. One could use higher end materials such as chrome-moly steel, however the minimum dimensions prevent the application of tubes with a smaller wall thickness, so the benefit in weight savings using stronger steel cannot be obtained.

5.2 Fabrication or Construction-

The space-frame part of the chassis will be constructed by cutting straight lengths of tube at precise angles and welding them together. There is a large number of welds in the space-frame so it is important to ensure they are strong enough to withstand the loads placed on the chassis and that they do not warp the chassis during construction.

Metal in the weld region heats up to and above its melting temperature during welding, it then cools after welding and the material shrinks. Often this heating and shrinking will not occur evenly over a join and thus the weld can cause warping. To avoid or minimize this effect the welding process must be performed in a particular order. One method of reducing the warping due to weld shrinkage is to tack joints in place before making a complete weld. The order of welding also plays a part in how the structure reacts to weld shrinkage. Welds that will cause shrinkage and warping in opposite directions should be done consecutively so the residual stresses balance one another. When welding to square tubing pieces together this means that the joint should be tacked first, then one face welded, followed by the opposing face, then the remaining faces can be welded. With a complete design the construction stage of the project can begin.

The design of the space-frame includes four horizontal sections made from square tube that can be constructed on a flat surface where they can be clamped down. As each of these sections is in a single plane the cuts that make up the angled joints can be made accurately with a miter saw, meaning that the weld does not have to bridge a gap in the joint due to poor cutting tolerances. With the members clamped to a flat surface they can be welded together to form each rectangular section as well as the more complicated top section

For joining process we have used arc welding and gas welding. The actual chassis is as shown below-

Fig 5.1- Actual chassis construction

5.3 Pneumatic cylinder placing:-

Pneumatic cylinders are installed between chassis and wheel connecting rod. This is done by reducing the shocker length and mounting the pneumatic cylinder over it. Each of the four pneumatic cylinders is connected to a air compressor, which in turn is connected to a microprocessor. The suitable pneumatic cylinder is mounted over the shock absorber with a link L as shown in fig 5.6. The pneumatic cylinder powered by air compressor is connected with chassis

Fig 5.6- Actual joint in construction

This system of pneumatic cylinder fitted over an shock absorber is similar as ―Self Lifting Suspension System‖ as used in some old fashion cars worldwide.

Chapter 6

ANALYSIS AND PERFORMANCE EVALUATION

FEA is a method of analyzing the machine parts for structural analysis which is shows the mode analysis as in our spring. Here red color shows maximum stress followed by others.

6.1 Finite Element Analysis of Spring-

6.1.1 Shear stress analysis:-

Shear stress analysis is done by fine mesh method in ANSYS V15.0 to check theoretical value to actual value and it more or less the same. The analysis result is given below-

In figure the red colour indicates the maximum shear stress value and blue colour indicates minimum shear stress value.

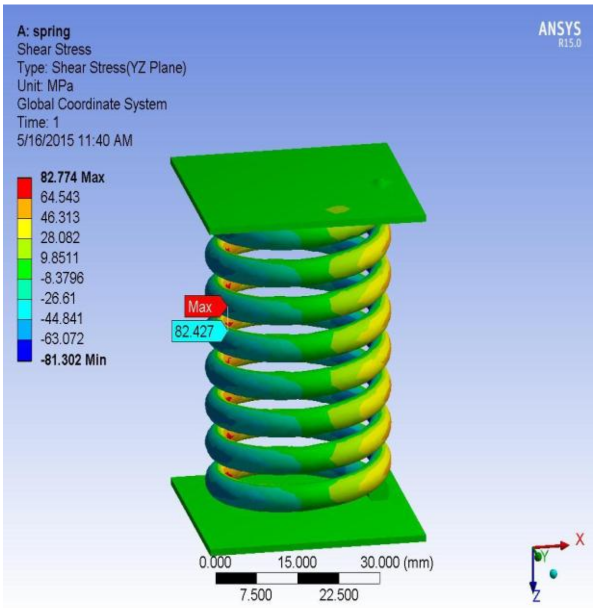


Fig 6.1- shear stress analysis in ANSYS V 15.0

6.1.2 Analysis for natural frequency:-

Natural frequency analysis is done by fine mesh method in ANSYS V15.0 to check theoretical value to actual value and it more or less the same.

In figure 6.2 the red colour indicates the maximum deformation and blue colour indicates minimum deformation.

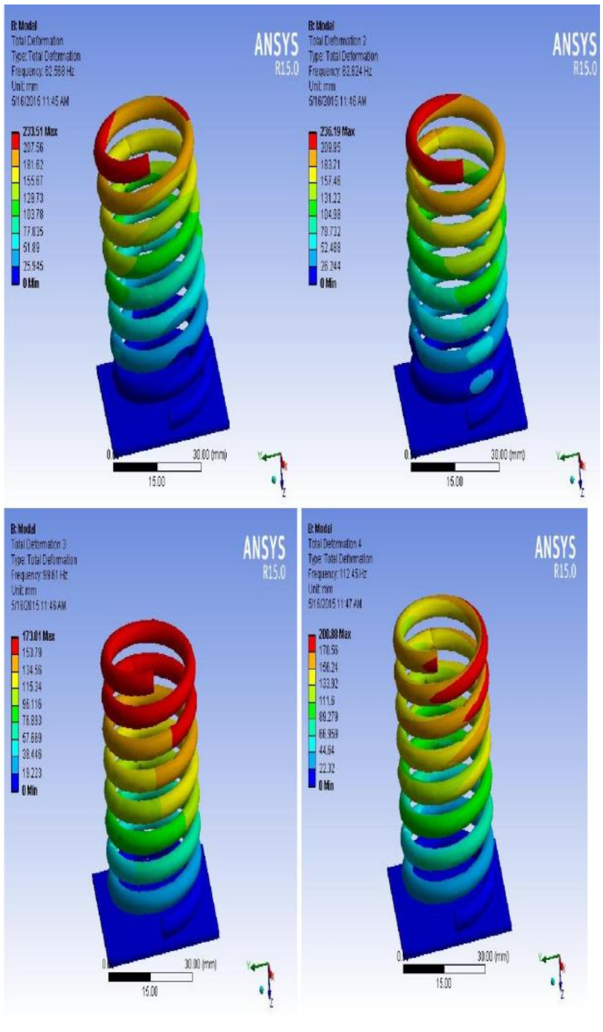


Fig 6.2- Deformation due to natural frequency in various modes

6.2 Performance evaluation-

Hump is detected by the ultrasonic sensor used at the range of 1 m then it passes signal to the microcontroller and it gives command to the solenoid valve to open and it results to flow of compressed air from compressor to actuate pneumatic cylinders which results lifting action of chassis within 2 seconds. It will remain lifted around 10 seconds. As rear wheel passes the hump the lowering action of chassis is takes place in 2 seconds by realizing the compressed air from cylinder. Specification of system is given below-

Specification:-

1. Initial ground clearance – 4 cm
2. Sensor range – 1 miter
3. Hump height – 8 cm
4. Time taken to lift the chassis – 2 seconds
5. Total time for crossing hump – 10 seconds
6. Relay timing – 12 seconds
7. Speed range – 10 to 25 seconds

Minimum time to pass hump – 6 to 8 seconds

6.3Applications:-

1. Applicable in all type of four-wheeler especially imported car.
2. Applicable in luxury bus by replacing pneumatic system by hydraulics.
3. Could make new dimensions to car design for Indian subcontinent.
4. Full automation leads to any automobile usage including radio control cars.

It can be design for next generation cars which having adjustable ground clearance.

Chapter 7

RESULT AND DISCUSSIONS

During the testing of the mechanism of aforesaid project, lifting of the chassis along with the body successfully achieved. Automation process guides the vehicle body to lift when hump appears within a range of 3 miters in optimum speed range of 15 to 20 KMPH. The main aim of project as said earlier is to prevent the chassis damage is successfully achieved. The pneumatic system can be replaced by hydraulics in original condition to overcome the much precise scenario with higher accuracy with low power consumption.

The FEA analysis has being done by spring design to withstand loads in real conditions. The natural frequencies are checked and it almost match with calculation done and compression between those can be shown in figure below-

Theoretical results	Actual results
Max Shear stress: τ_{max} = 87.20 N\mm^2	Max Shear stress: τ_{max} = 82.774 N\mm^2
Natural frequencies: f_1 = 62.41 Hz; f_2 = 63.71 Hz; f_3 = 99.2 Hz; f_4 = 112 Hz; f_5 = 222 Hz; f_6 = 222.7 Hz	Natural frequencies: f_1 = 62.56 Hz; f_2 = 62.642 Hz; f_3 = 99.61 Hz; f_4 = 112.45 Hz; f_5 = 222.71 Hz; f_6 = 227.04 Hz

Table 7.1- Comparison between actual and theoretical results

Chapter 8

CONCLUSION

We can conclude that, with the use of prevention of chassis damage using automated pneumatic system, the automatic chassis adjustment and damage of car chassis is effectively prevented. The main of our project is successfully achieved and testing with performance evolution is done and shown in above. In addition to that the use of sensor will help to act as an accident preventer or an alarm provider. With precision it can prevent serious accident by automatically break control and distance sensor can be used for fully automated car. Here some of our conclusions are pointed, as-

1. Chassis damage of car is isolated.
2. Makes a fruitful design alteration for imported car running in Indian roads.
3. Suspension of car has been improved by this design.
4. Lifting and lowering of car is completely automated to reduce human error.

5. Body of car made an attractive resolution to its looks.

6. Accident prevention using automatic break system can be achieved.

Original system usages, the hydraulic system used for higher precision and greater control for an higher weight lifting as actual car is of at least 250 Kg.

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