BE PROJECT

ADAPTIVE HEADLIGHT SYSTEM FOR AUTOMOBILES

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Need of Project

- In 2014 out of 6,98,451 people from accident 4,882 people dead.

- Night accidents-

  Poor Road visibility on Curved path - 25%

  Poor Road visibility due to slope of driving terrain - 30%

  Other reasons – 45%

AIM OF THE PROJECT

This project is aimed at developing an adaptive headlight system for automobiles that automates the movement of headlights without manual switching.

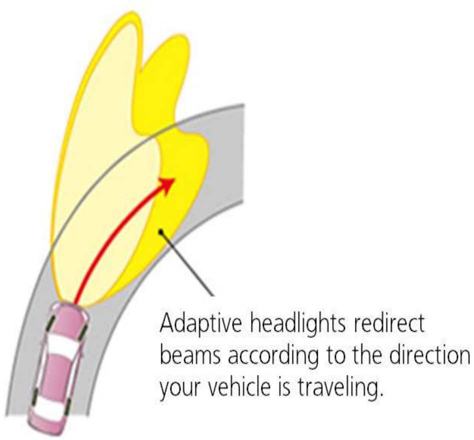
Project objectives

- To enhance existing functionality of headlights.
- Improve visibility on turns.
- Decrease number of night accidents.
- Increase safety for drivers and pedestrians

HORIZONTAL SWIVELING (Yawing OF HEADLIGHT)

1] Horizontal Swiveling Is Used To Turn The Headlight In Horizontal Plane.

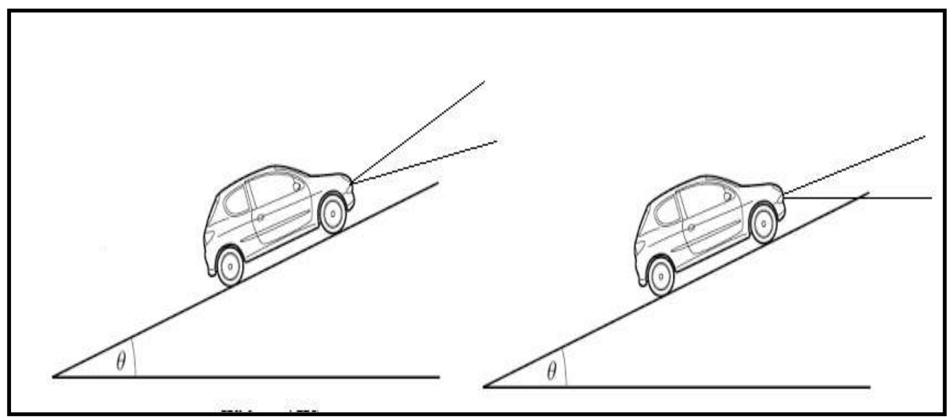
2] It Rotates In The Direction Proportionate To The Wheel While Taking Turn.



VERTICAL SWIVELING (Pitching OF HEADLIGHT)

1] Vertical Swiveling Is Used To Compensate The Pitching Of Car ,During Driving Through Steep Slope.

2] It Helps To Focus The Light At The Required Path.



Without AHS With AHS

LOCK TO LOCK POSITION

Center to Right/Left –

↓

1.5 turns

(540 degrees of steering wheel motion)

Lock to Lock

(Extreme Right to Extreme Left)

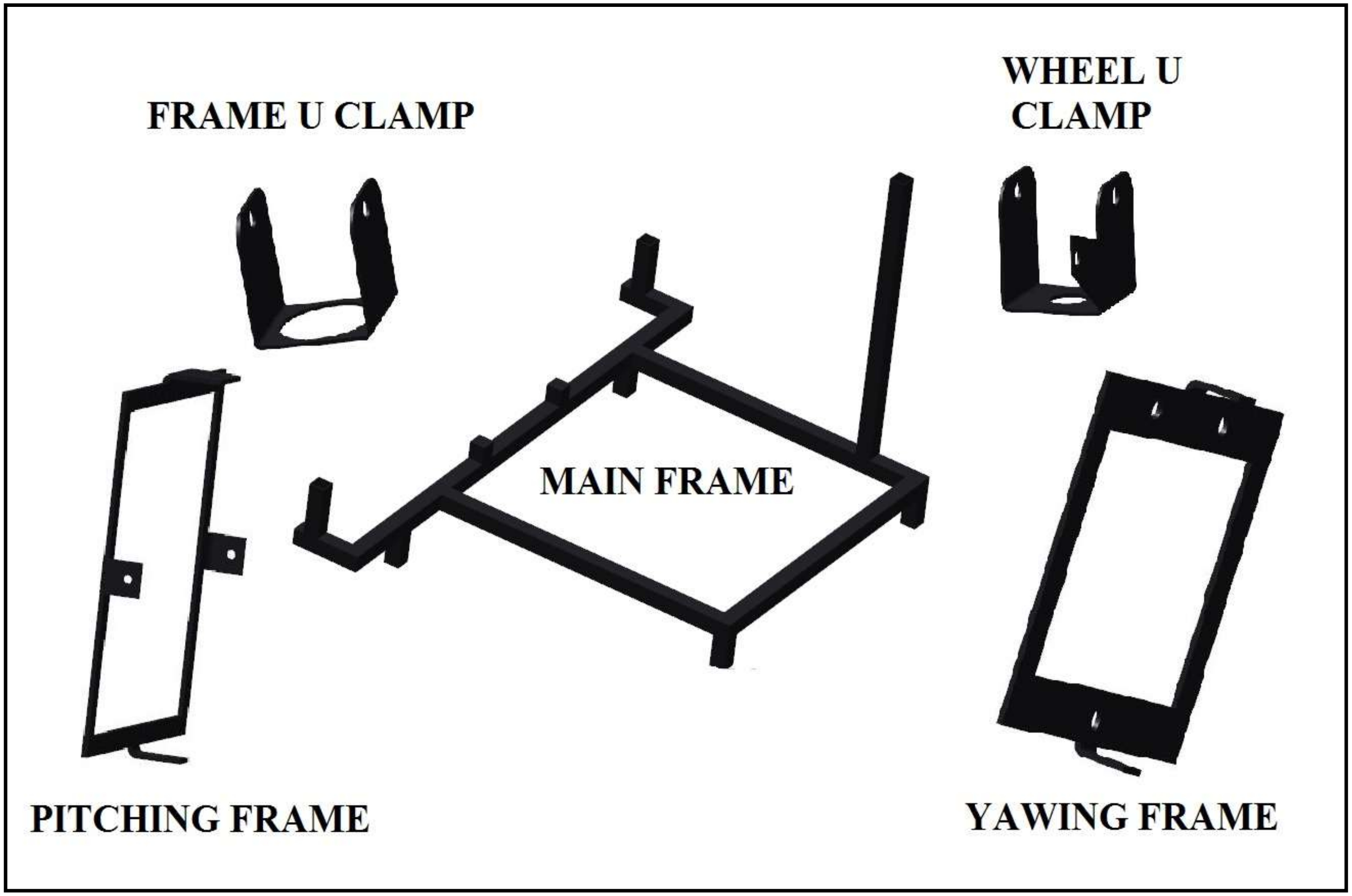
↓

3turns

(1080 degrees of steering wheel motion)

- **Center to Right/ Left caster wheel Angle-** 45 degrees
- **Lock to lock caster wheel Angle-** 90 degrees

Parts of Adaptive Headlight System



CALCULATIONS

- The steering wheel has to rotate **THREE** complete revolutions to move the caster wheel from **lock-to-lock position** .

- Thus **3 x 360** = **1080 degrees** to move from **lock-to-lock position**
- Thus **1.5 x 360** = **540 degrees** to move from **Center to Right/ Left position**

- Center to Right/ Left caster wheel Angle- 45 degrees
- Therefore

$$\textit{steering ratio} = \frac{\textit{Angle moved by steering wheel (degrees)}}{\textit{Angle moved by Caster wheel (degrees)}}$$

- S.R = **540/45** = **12:1**

❖ Specifications of rack and pinion assembly –

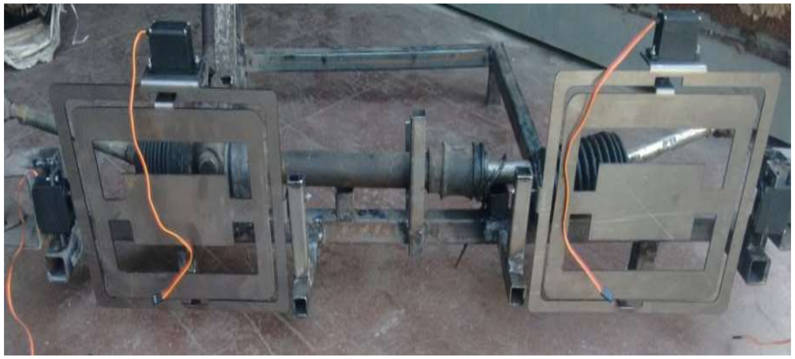
- Number of teeth on rack = **27**
- Number of teeth on pinion = **18**
- Module = **1.5 mm**
- Pressure angle = **20 degrees**
- Rack length = **127 mm**

CALCULATIONS

Parameter	Calculated Value
Area of Pitching Frame	(20.5 x 24.5) – (17.8 x 21.8) = **114.21 cm²**
Area of Yawing Frame	{[(21 x 17.5) – (17 x 13.5)] + (2 x 2.5 x 2.1) + (12 x 6.5)} = **226.5 cm²**
Total Area	114.21 + 226.5 = **340.71 cm²**
Total Volume	340.71 x 0.2 = **68.142 cm³**
Mass of Pitching and Yawing Frame	7.85 x 68.142 = **511.065 gram**
Total mass	511.065 + 55 = **approx 566 gram**
Moment	(566 x sin20^0) x (10.25) = **1984.22 gram-cm**
Actual moment	1984.22 x 1.5 = **2976.344 gram-cm**

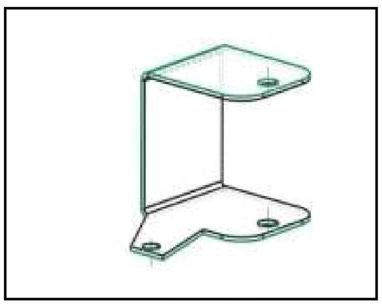
➢ Selecting motor such that Restoring Torque > Moment
➢As 9.40 kg-cm > 2.97 kg-cm
Therefore ,we selected **Motor MG995** as it is best suited for our project.

Manufacturing Stages



Main Frame

- **Dimensions**- 900 x 600 x 525 mm^3
- **Material**- M.S (25 x 25 mm^2)
- **Manufacturing processes**-
  - Saw-cutting
  - Electric-arc Welding(230 V)



Wheel U-Clamp

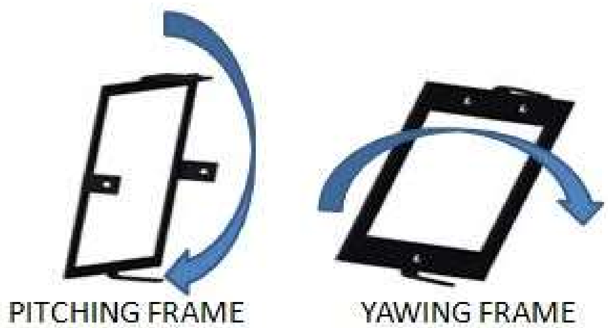
- **Dimensions**- 68 X 60 X 64 mm^3
- **Material**- M.S
- **Manufacturing processes**-
  - Laser-cutting
  - Bending
  - Drilling

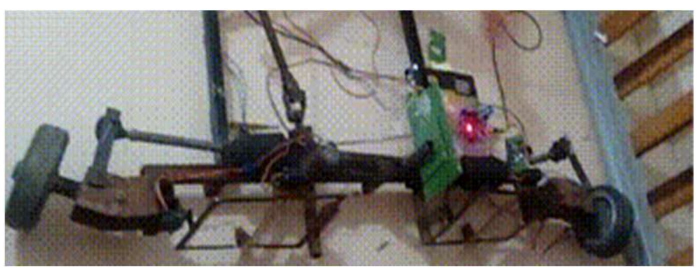
Frame U-Clamp

- **Dimensions**- 68 X 60 X 64 mm^3
- **Material**- M.S
- **Manufacturing processes**-
  - Laser-cutting
  - Bending
  - Drilling

Pitching frame

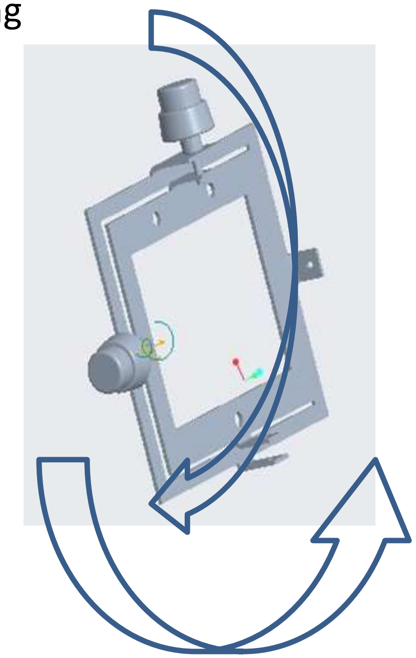
- **Dimensions**- 205 x 245 x 32
- **Material**- M.S
- **Manufacturing processes**-
  - ➢ Laser-cutting
  - ➢ Bending





Yawing frame

- **Dimensions**- 210 x 175 x 27
- **Material**- M.S
- **Manufacturing processes**-
  - ➢ Laser-cutting
  - ➢ Bending



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STEERING WHEEL &
STEERING COLUMN ASSEMBLY.

Ball Bearings(30mm OD and 17 mm ID)

- Two ball bearings with seal are press-fitted to steering column for smooth motion of steering wheel.

Seal with bearings

Procured Parts

Caster Wheel

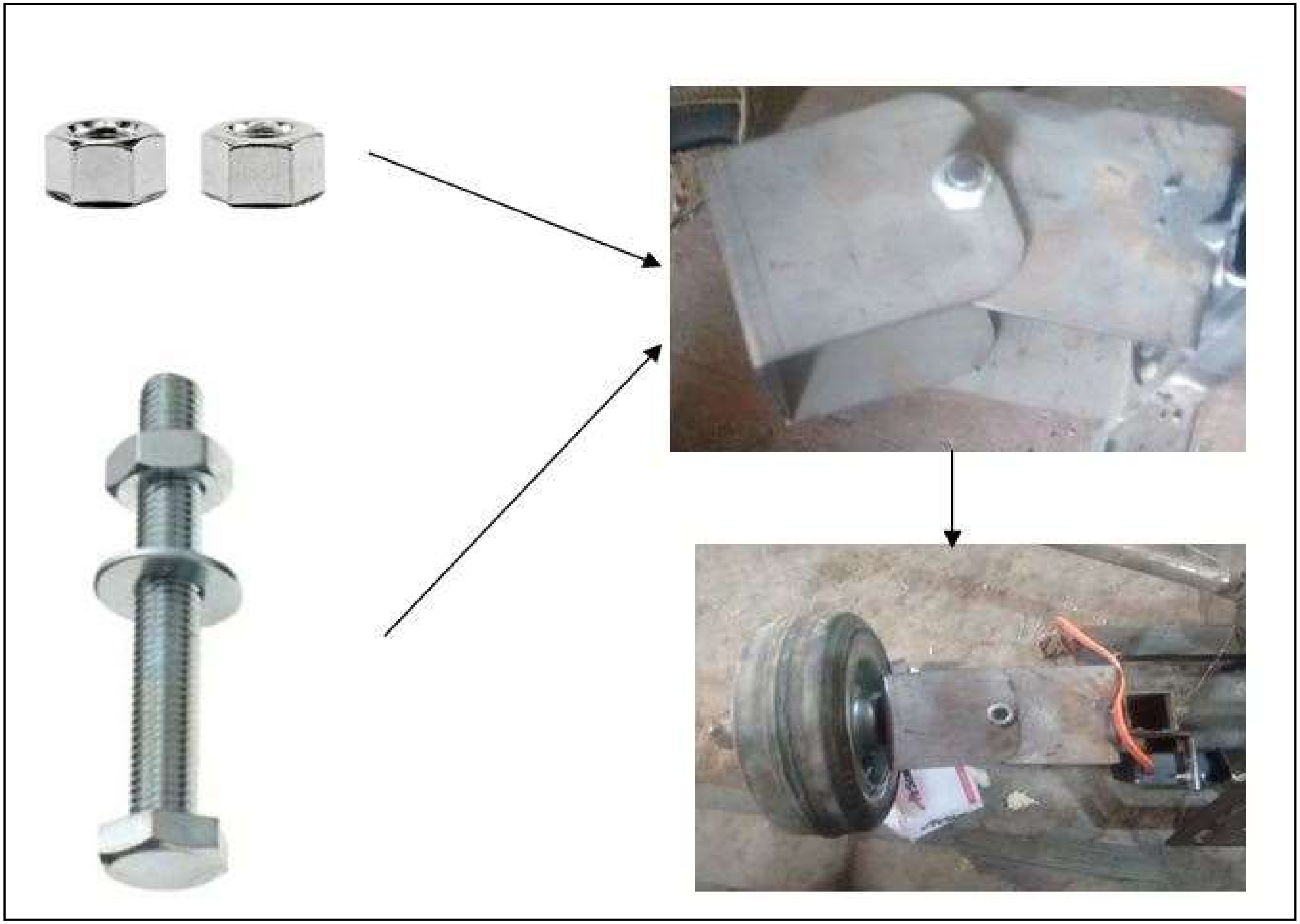
Dimensions

- ➢15 cm Diameter
- ➢10 cm axle length
- ➢ 3 cm axle diameter

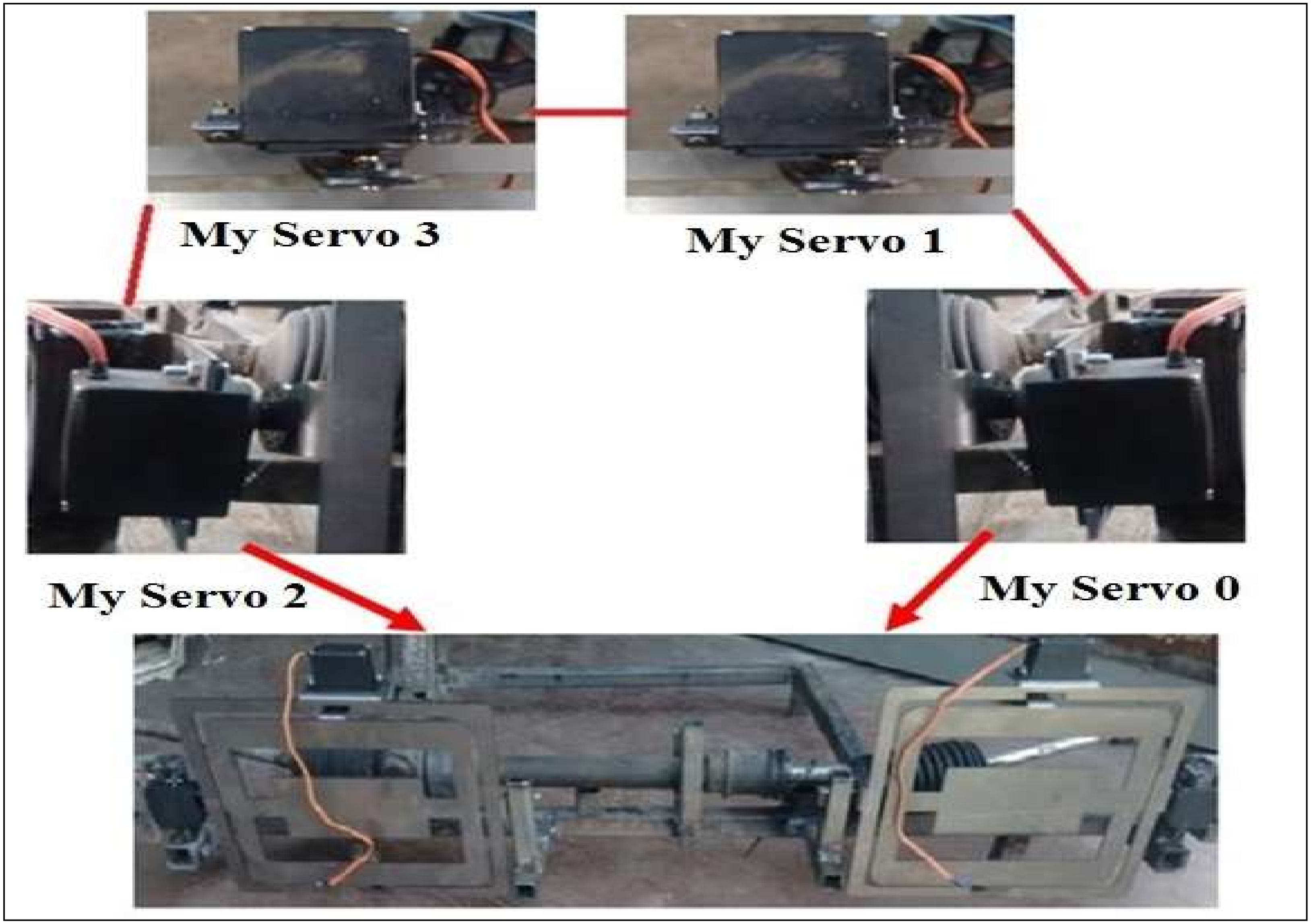
Rack and Pinion Mechanism

Specifications	**Dimensions**
Number of teeth on rack	27
Number of teeth on pinion	18
Module	1.5 mm
Pressure angle	20^{0}
Rack length	127 mm

Wheel U Clamp and Frame U Clamp with Caster Wheel



Fastening Servo Frame



BILL OF MATERIAL(BOM)

Part Name	**Quantity**	**Rate Per Piece**	**Amount**
Main Frame	4 m	65	260
Plate (45 x 45 cm^2)	1	400	400
Servo Motor (5 kg-cm torque)	6	450	2700
Steering Column and Steering Wheel	1	1000	1000
Steering Rack	1	1000	1000
Ball-bearings	2	60	120
Laser-cuts	8	350	2800
Bending	20	30	600
Electronics	1	-	1214
Wheel (Caster)	2	350	700

SENSORS USED
1. Ultrasonic Sensor. 2. Accelerometer.

Ultrasonic sensor

The **Ultrasonic sensor** is been used to sense-

• Distance moved by the caster wheel .

➢It is used as an input to Arduino .

➢It sends waves of particular frequency and when wave collides on nearest object it reflect back

➢Distance is calculated from the given formula

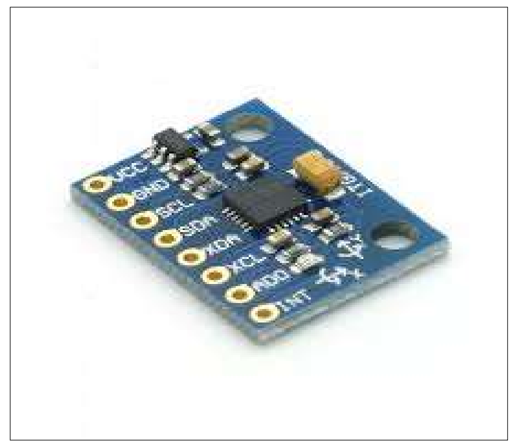
L = V x **T**

1. It works on **+5 volts**
2. **<u>Output</u>** is **<u>DC</u>**
3. **<u>Range</u>** is **<u>2 to 450cm</u>**
4. **<u>Static current < 2mA</u>**
5. **<u>Sensor</u>** used is **<u>HC-SR04</u>**

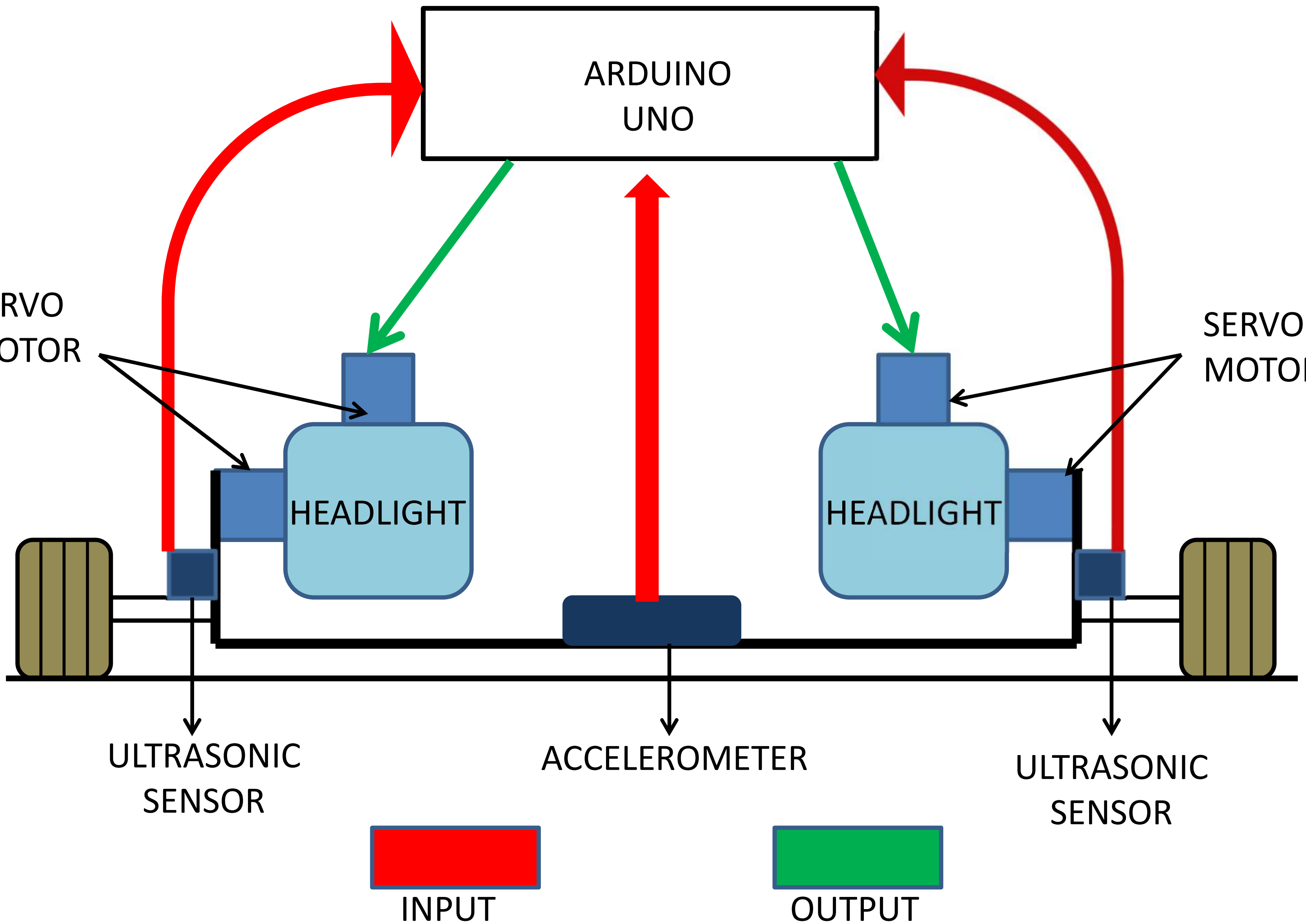
Accelerometer sensor

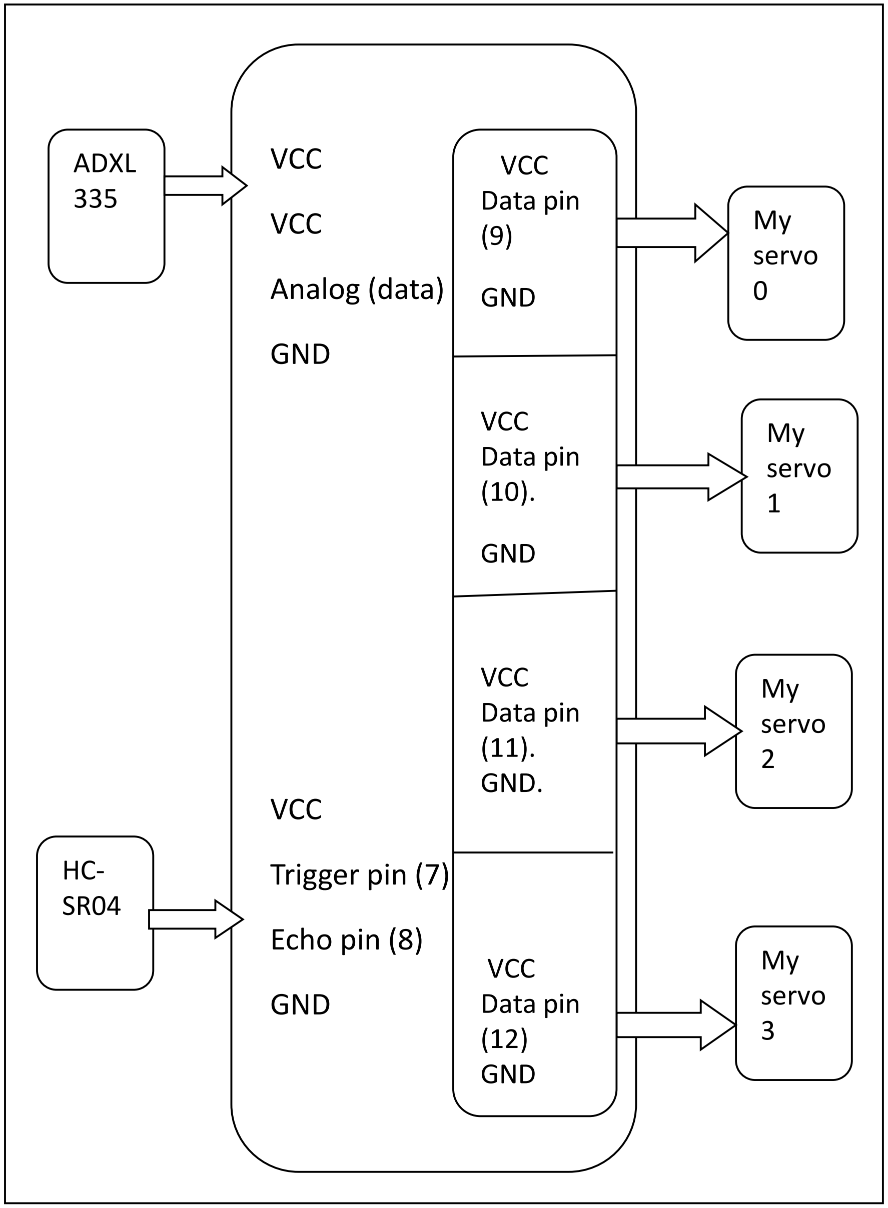
This sensor is used –

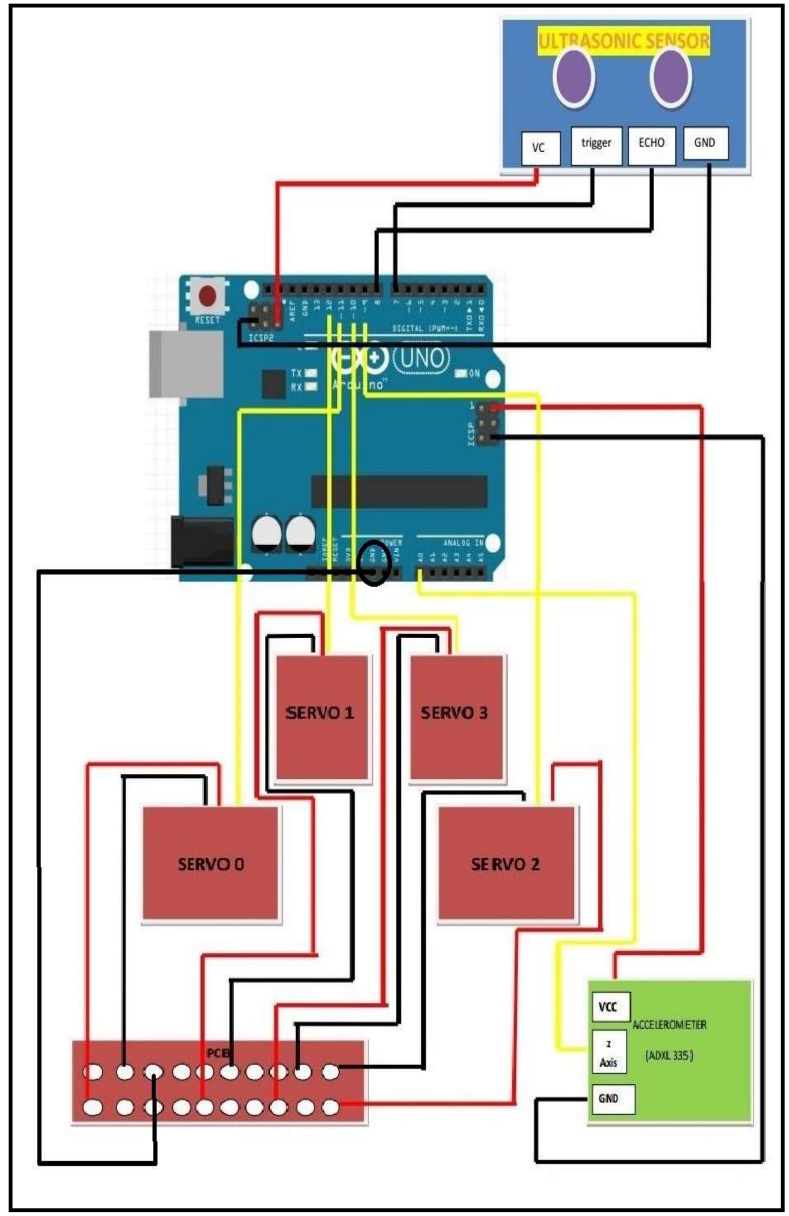
- To identify the pitching (motion of the frame structure in vertical plane)
- It is used to determine vibration ,shock in 2 or 3 dimensions.
- The sensor is a **polysilicon surface micro machined structure** built on top of a **silicon wafer.**
- It is a **capacitive type accelerometer.**
- It gives **output in analog form** thus needs **ADC**, before being processed by **Arduino.**
- Input - **5volts**
- We have used **ADXL335**



BASIC ELECTRONIC STRUCTURE




ADXL 335
HC-SR04
VCC
VCC
Analog (data)
GND
VCC
Trigger pin (7)
Echo pin (8)
GND
VCC
Data pin (9)
GND
VCC
Data pin (10).
GND
VCC
Data pin (11).
GND.
VCC
Data pin (12)
GND
My servo 0
My servo 1
My servo 2
My servo 3


ULTRASONIC SENSOR
VC
trigger
ECHO
GND
UNO
SERVO 1
SERVO 3
SERVO 0
SERVO 2
PCB
VCC
z Axis
GND
ACCELEROMETER
(ADXL 335)

Adaptive_code_Integration §

```
#include <Servo.h>

Servo myservo;
Servo myservo1;
Servo myservo2;
Servo myservo3;

const int y = A0;
int  triggerPin = 7;
 int  echoPin = 8;

int light_val, press_val, alch_val, adxl_y_val, duration, distance;

void setup()
{
 Serial.begin (9600);

   myservo.attach (9);
myservo1.attach (10);
myservo2.attach (11);
myservo3.attach(12);


  pinMode (triggerPin, OUTPUT);
  pinMode(echoPin, INPUT);
}
```

Adaptive_code_Integration §

```
void loop ( )
{
   digital Write (triggerPin, HIGH);
   delay Microseconds(10);
   digital Write(triggerPin, LOW);
   duration = pulseIn(echoPin, HIGH);
   distance = (duration / 2) / 29.1;
   delay(1000);
   Serial.print(distance);
   Serial.print("cm");
   Serial.println(" ");
   Sensor_Read();
   servo_run();
}

void Sensor_Read()
{
 adxl_y_val = analogRead(y);
 Serial.print("ADXL: ");
 Serial.print(adxl_y_val);
 Serial.print("\t");
 delay(1000);
}
```

Adaptive_code_integration §

```
void servo_run()
{
 if ((adxl_y_val > 320) &&
    (adxl_y_val < 370))
 {
  Serial.println("In centre motor");

  myservo.write(90);
  myservo2.write(90);
  delay(15);
 }
 else if (adxl_y_val >= 370)
 {
  Serial.println("In up motor");

  myservo.write(70);
  myservo2.write(110);
  delay(15);
 }
 else if (adxl_y_val <= 320)
 {
  Serial.println("In dowm motor");

  myservo.write(110);
  myservo2.write(70);
  delay(15);
 }
```

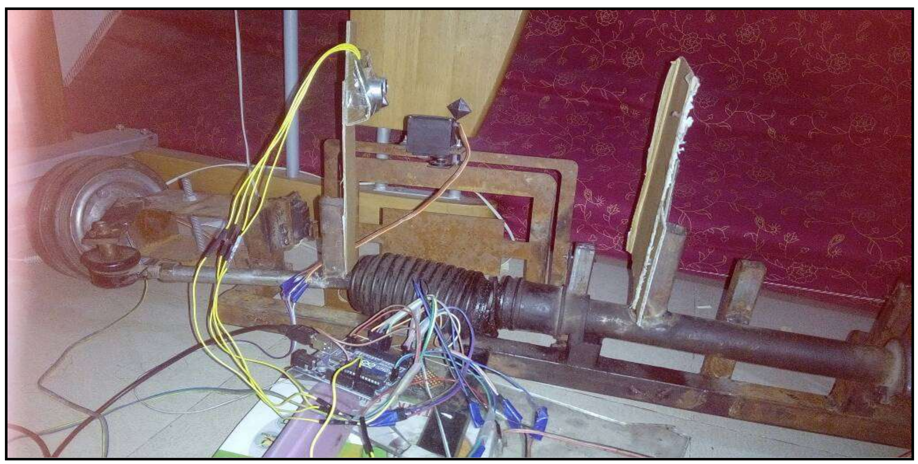
Adaptive_code_integration §

```
if ((distance < 23) && (distance > 19))
 {
  Serial.println("In center motor");

  myservo1.write(100);
  myservo3.write(100);
  delay(15);

 }
 else if (distance >= 23)
 {
  Serial.println("In right motor");

  myservo1.write(150);
  myservo3.write(135);
  delay(15);
 }
 else if (distance <= 19)
 {
  Serial.println("In left motor");

  myservo1.write(65);
  myservo3.write(50);
 delay(15);
 }
}
```

TROUBLE SHOOTING

- Increase the height of the ultrasonic sensor by moving the sensor along positive Y axis.

- In order to solve this problem we could move the ultrasonic sensor along negative Z axis Best optimum solution selected:



RESULT TABLE - YAWING FRAME

SR. NO.	Theoretical Value Of Outside Lock Angle In Degrees	Experiment Value Of Outside Lock Angle In Degrees	Accuracy
1	35	32	91.428%
2	35	34	
3	35	31	

SR. NO.	Theoretical Value Of Inside Lock Angle In Degrees	Experiment Value Of Inside Lock Angle In Degrees	Accuracy
1	45	44	97.77%
2	45	45	
3	45	43	

RESULT TABLE - PITCHING FRAME

SR. NO.	Actual Value In Degrees	Experiment Value In Degrees	Accuracy
1	20	18	88.33%
2	20	16	
3	20	19	

Gantt Chart

Activity Schedule	Project Status	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Literature Survey	✓											
Project Identification	✓											
Project literature study	✓											
Field work	✓											
Project Report (Stage 1)	✓											
Project Presentation (Stage 1)	✓											
Design Modeling	✓											
Design Calculations												
Material Procurement	✓											
Manufacturing Stage	✓											
Assembly	✓											
Trials and Troubleshooting	✓											
Testing	✓											
Conclusion	✓											
Report Preparation	✓											

CONCLUSION

➢Considering functionality, adaptability, accuracy of adaptive headlight system-

✓ Objective of headlight motion according to vehicle dynamics (Pitching and Yawing of headlight) is achieved by mechanical and electronic coupling of Arduino UNO,
ultrasonic sensor, accelerometer (ADXL 335).

✓ The level of accuracy is optimized using several experimental tests for user comfort and convenience.

✓ It is concluded that with Adaptive headlight system, the number of night accidents will reduce reasonably and that the reaction time or response time of the system in range of milliseconds (15 to 30).

REFERENCES

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[4] Shirsat Shashikant, Mechkul M.A. "Adaptive Front Light System “ IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834, p-ISSN: 2278-8735 (PP 05-09)

[5] Renton Ma "Automotive Adaptive Front-lighting System Reference Design" Texas Instrumentation-Reference design SPRUHP3 july-2013

Thank you!