KAUNAS UNIVERSITY OF TECHNOLOGY
MECHANICAL ENGINEERING AND DESIGN FACULTY

AJAY NAGAPPAN NACHIAPPAN

Development of Next Generation Automobile Safety Technology

Master's Degree Final Project

Supervisor
Lecturer. Dr.Darius Mazeika

KAUNAS, 2017

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Industrial Engineering and Management (code: 621H77003)

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Reviewer

Dr. Marius Gudauskis

Project made by

Ajay Nagappan Nachiappan

KAUNAS, 2017

KAUNAS UNIVERSITY OF TECHNOLOGY

Faculty of Mechanical Engineering and Design

Ajay Nagappan Nachiappan

Industrial Engineering and Management (621H77003)

DEVELOPMENT OF NEXT GENERATION AUTOMOBILE SAFETY TECHNOLOGY

DECLARATION OF ACADEMIC INTEGRITY

____ JUNE 2017

Kaunas

I confirm that the final project of mine, **Ajay Nagappan Nachiappan**, on the subject "Development of Next Generation Automobile Safety Technology" is written completely by myself; all the provided data and research results are correct and have been obtained honestly. None of the parts of this thesis have been plagiarized from any printed, Internet-based or otherwise recorded sources; all direct and indirect quotations from external resources are indicated in the list of references. No monetary funds (unless required by law) have been paid to anyone for any contribution to this thesis.

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Approved:

Head of
Production Engineering
Department

____
(Signature, date)

Kazimieras Juzėnas
(Name, Surname)

MASTER STUDIES FINAL PROJECT TASK ASSIGNMENT
Study programme INDUSTRIAL ENGINEERING AND MANAGEMENT

The final project of Master studies to gain the master qualification degree, is research or applied type project, for completion and defence of which 30 credits are assigned. The final project of the student must demonstrate the deepened and enlarged knowledge acquired in the main studies, also gained skills to formulate and solve an actual problem having limited and (or) contradictory information, independently conduct scientific or applied analysis and properly interpret data. By completing and defending the final project Master studies student must demonstrate the creativity, ability to apply fundamental knowledge, understanding of social and commercial environment, Legal Acts and financial possibilities, show the information search skills, ability to carry out the qualified analysis, use numerical methods, applied software, common information technologies and correct language, ability to formulate proper conclusions.

1. Title of the Project

Development of Next Generation Automobile Safety Technology

Approved by the Dean Order No. V25-11-8, 21 April 2017

2. Aim of the project

Aim of the project is to develop the Next generation automobile safety Technology to prevent the accidents and death caused by carelessness.

3. Structure of the project

- To design the Side view mirror.
- To select the connecting motor system and design the camshaft with the side view mirror.
- To stimulate the Servo motors using the micro controller in Proteas tool.
- To find the cost estimation of the whole system.

4. Requirements and conditions

- Designing a innovative Side view mirror control system
- Transfer sterering rotation to microcontroller for side view mirror angle adjustments without human interfierance.

5. This task assignment is an integral part of the final project

6. Project submission deadline: 2017 June ___

Student	Ajay Nagappan Nachiappan (*Name, Surname of the Student*)	________________ (*Signature, date*)
Supervisor	Lecturer. Dr. Darius Mazeika (*Position, Name, Surname*)	________________ (*Signature, date*)

Ajay Nagappan Nachiappan, Development of Next Generation Automobile Safety Technology. Master's Final Project / supervisor Lecturer. Dr. Darius Mazeika; Faculty of Mechanical Engineering and Design, Kaunas University of Technology.

Research field and area: Production Engineering, Technological Science

Keywords: *side view mirror, potentiometer, PIC16f84controller, servo motor, modelling, control, simulation.*

Kaunas, 2017. 55 P

SUMMARY

In automobile world, nowadays influence of automation are improved day by day. According to that, in Automobile industry, vehicles are controlled and equipped effectively by using Sensors and electronic technology, to reduce the accidents in roads with low cost and reach all people a safety driving mindset. Consequently, by improving the Blind spot to the driver to make a user-friendly driving technology. The main objective of this thesis work is to obtain angular mirror motion according to the steering movement and to indicate the danger in the mirror using Led blinkers. In sort of that it's important to deal with some theoretical part of the system with modelling by using appropriate assumptions to get an accurate response by designing the technology with the requirements of mirror. And more over, simulation of the system is done through modelling with simulation tool to the perfect working condition. In which simulation has included linearity of components to deal with accurate results. To do that, simulation is done with the help of Proteas tool to achieve a structural model of the mirror and by designing the mirror in Solid works. And simple PIC16F84 controller is used due to its simple, cost effective way of working and its simple to control while implementing.

Ajay Nagappan Nachiappan. Naujos kartos saugumo technologiju kurimas automobiliams. Pramonės inžinerijos ir vadybos magistro baigiamasis projektas / vadovas doc. dr.Darius Mazeika; Kauno technologijos universitetas, Mechanikos Inzinerijios ir dizaino Fakultetas.

Mokslo kryptis ir sritis: Gamybos inžinerija, technologijos mokslai

Reikšminiai žodžiai*: šoninis vaizdas veidrodis, potenciometras, PIC16f84controller, servo variklis, modeliavimas, valdymas, modeliavimas.*

Kaunas, 2017. 55 p.

SANTRAUKA

Šiandieninis automobilių pasaulis yra pagrįstas automatinėmis sistemomis, kurios diena iš dienos papildo viena kitą. Šios sistemos yra diegiamos į automobilius, tam kad pagerinti automobilio valdymą, sumažinti eismo įvykių tikimybę ir kartu apsaugoti žmones. Atsižvelgiant į tai, buvo pasirinkta „aklosios zonos“ sritis, kurią sumažinus, vairuotojas geriau matytų kas vyksta aplink. Baigiamajame darbe pagrindinis tikslas yra patobulinti automobilio veidrodėlius, kurie sektų kitų automobilių judesius ir aktyvuotu LED indikatorių, kad perspėti vairuotoją apie esančią kliūtį. Norint tinkamai suprojektuoti tokią sistemą, reikia atlikti įvairius modeliavimus ir skaičiavimus, kurie tenkintu visus keliamus reikalavimus automobilių veidrodėlių gamyboje. Skaičiavimai buvo atlikti naudojantis „Proteas“ programine įranga, o modeliavimas pasinaudojant SolidWorks programine įranga. Sukurto veidrodėlio valdymui buvo panaudotas PIC16F84 valdiklis.

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INTRODUCTION

Travelling is the activity, which is loved by all. Not only human kind but even animals love to travel. To travel we use different mode of transport. Travelling grasps knowledge of different geography, people etc. it also gives wide knowledge. For so many decades we have been inventing the machines that could help us travel and we were continuously keen on developing those,but did we think about the accidents that happen while we are travelling and the death rate of people which is high in accidents all over the globe. The manufacturers have been working in this kind of projects for more than decades to reduce the accidents and also the death but still its happening so I would like to express some of my ideas like the main reason for accident is Blind spot,Lane departure ,crashing in dividers, so if the vehicle shows you the external object which is near by in your mirror while your driving itself will make the driver concious and the accidents might be prevented or we can stop the cause of death by alerting every passenger,.In this project I am going to design a Split side view Mirror to show the blind spot for the driver by developing a simple contol system which controlls the mirror angles through the steering rotation without human interfierance .

AIM

Aim of the project is to develop the next generation automobile safety system to prevent the accidents and death caused by carelessness.

TASKS

- To design the Side view mirror.
- To select the connecting motor system and design the camshaft with the side view mirror.
- To stimulate the Servo motors using the micro controller in Proteas tool.
- To find the cost estimation of the whole system.

1. LITERATURE REVIEW

The automobile side-view mirror was a device for indirect vision that facilitates observance the traffic space adjacent to the vehicle that can't be determined by direct vision. having the ability to check what's behind the automobile is important once reversing or ever-changing lanes. The mirrors are typically settled on, simply in front of the driver’s and front passenger’s doors. because of legislation, today’s cars have 2 mirrors. There are several rules and laws once it involves mirrors, primarily because of safety factors. Today’s mirrors are manufactured using over a reflective glass. The mirror housing usually holds the indications, illumination options and a blind spot alarm.

Driving in wet conditions usually leads to dirty windows and mirror glasses. Having dirty windows reduces the visibility for the driver, then it affects the security. There are 2 main kinds of soiling; dirty water drops from surrounding vehicles or rain, and soil from dirt kick up and dirty water from one’s own wheels. The a-pillar controls most of the soil on the facet windows, however, the mirrors have some influence [1].

The current law is 2003/97/EC. The following are most important demands [2],

- There should be 2 mirrors, one in the driver’s side and another on the passenger’s side.
- Mirrors should be somehow adjustable.
- The end of the reflecting surface should be closed in a protective way.
- The dimensions of the mirror glass ought to be specified it's attainable to inscribe; a parallelogram 40 millimeter high with a base length reckoning on the typical of the radius of curvature measured over the mirror glass and a phase that is parallel to the peak of the rectangle. the peak of the rectangle is 70 millimeter long.
- The mirror glass should be either flat or spherically convex.
- Where the lower fringe of Associate in Nursing exterior mirror could be a smaller quantity than 2m beyond the bottom once the vehicle is loaded to its technically permissible most laden mass, this mirror shouldn't project quite 250 mm on the far side the dimension of the vehicle is measured excluding the mirrors [2].

The vision for the driver must me like this as shown in the Figure 1 Field of vision, then only he can see the marked areas.

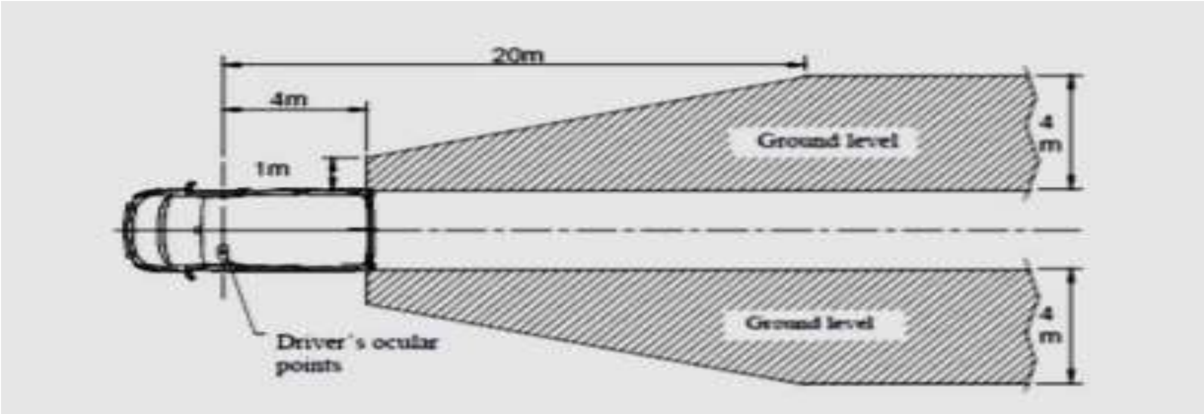

Figure 1 Field of vision [2]

The three-dimensional locations of points on the driver and vehicle were measured using a FARO Arm coordinate measurement device, The FARO Arm is constructed of three articulating arms with angle sensors at the joints. The arm reports the situation of the probe tip once a button is depressed. Coordinate systems for faro Arm measurements were established on the ground on either side of the stall close to the situation of the vehicle front doors. The horizontal axes of those coordinate systems were aligned exploitation manual measurements, and also the offsets between the origins were measured [3]. In every case, X is positive rearward relative to the vehicle, Y is positive to the proper, and Z is positive upward. before measuring with the card game Arm, the platform supporting the arm was placed below the sting of the vehicle and jacked up slightly to wedge the platform between the ground and therefore the vehicle. the information assortment reference frame was then aligned with the adjacent floor-mounted coordinates by digitizing 3 points shaping the origin and therefore the X and Y axes as shown in the Figure 1 Field of vision Figure 2 Measurement of FARO arc [3].

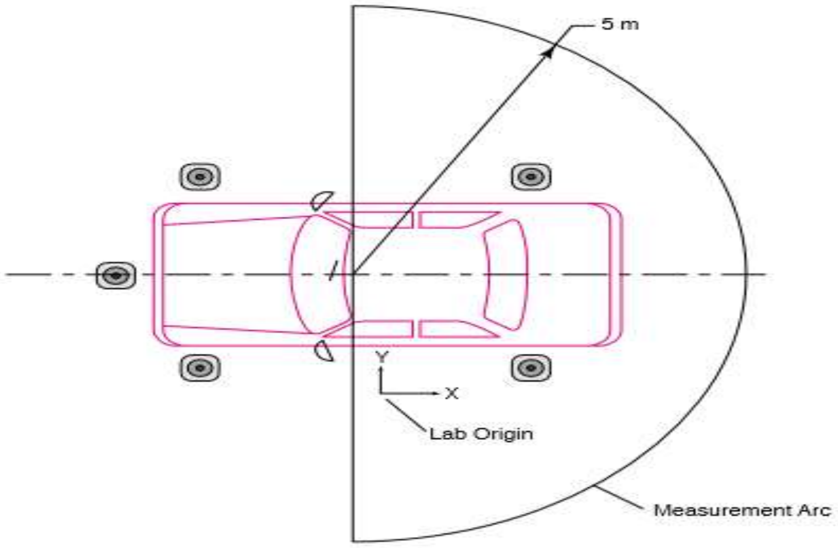

Figure 2 Measurement of FARO arc [3]

Using the measured relationship between the two coordinate systems, the data from the right side were combined with those from the left. Following Figure 3 Human view point the FARO Arm measurements through the vision of human eye [3].

Figure 3 Human view point [3]

The locations of the mirrors (centroid of the mirror perimeter points) with respect to the driver's cyclopean eye point when looking straight ahead are also listed, as are the mirror heights with respect to the ground plane. The average driver eye height above the ground when looking straight ahead was 1088 mm (standard deviation 49 mm). The right mirror radii were measured on thirty-six vehicles. The average right mirror radius was 1098 mm (minimum 972, maximum 1504). As expected, all were within the 889 to 1651 mm [3]. Table 1. Depicts the parameters of the mirror,

Table 1. Parameters of the mirror [3]

Dimension	mean	S.D	median
Left Mirror			
Width	168	10.7	170
Height	95	6.6	96
Fore-aft Position re Eye	-553	71.9	-551
Lateral Position re Eye	-523	29.6	-520
Vertical Position re Eye	-149	35.1	-145
Height Above Ground	939	33.8	935
Center Mirror			
Width	237	16.1	236
Height	57	5.0	56
Fore-aft Position re Eye	-374	65.1	-372
Lateral Position re Eye	334	34.6	330
Vertical Position re Eye	99	33.7	103
Height Above Ground	1187	30.7	1188
Right Mirror *			
Lateral Position re Eye	1209	63.2	1193

The Table 2. refers the description of each angle from the mirror used to show and what the driver can notice,

Table 2. Description of each angle from the mirror [3]

Variable	Definition
Inside (Left / Driver- Side) Edge	Angle with reference to rearward the longitudinal axis of the vehicle to the sting of the field view; is calculated using the vector from the projected cyclopean eye point to the FOV boundary on the measurement arc. For right mirror, angle is calculated using the vector from the FOV boundary point to the corresponding edge of the mirror.
Outside Edge	Complement to the Inside Edge.
Top Edge	Angle with respect to horizontal of the top edge of the field of view; calculated using the vector from the projected cyclopean eye point to the FOV boundary on the measurement arc. For right mirror, angle is calculated using the vector from the FOV boundary point to the top of the mirror. Measurement is made at the centre of the lateral FOV.
Bottom Edge	Complement to Top Edge.
Horizontal Field	Angular width of horizontal FOV, based on pole-sighting FOV measurements referenced to projected cyclopean eye; difference between left and right edge angles.
Vertical Field	Angular width of horizontal FOV, based on pole-sighting FOV measurements referenced to projected cyclopean eye; difference between top and bottom edge angles.
Horizontal. Field (Calculation)	Angular width of horizontal am binocular FOV, based on reflections of rays from both eye locations through points on the mirror perimeter. This is the actual FOV given by the mirror; because of interference from vehicle structure, the FOV behind the vehicle, described by the pole-sighting measurements, is generally smaller. The difference between Horizontal. Field (Calc.) and Horizontal Field is a measure of the amount of how much of the vehicle the driver can see in the mirrors.
Vert. Field	Analogous to Horizontal. Field
Horizontal Angle	Angle in the horizontal plane of a vector perpendicular to the face of the mirror (left and center mirrors) or perpendicular to a plane fit to the perimeter points (right mirror);a measure of the orientation of the mirror.
Vertical Angle	Analogous to Horizontal Angle

Horizontal Aim	Centre of the calculated cyclopean horizontal FOV, obtained by reflecting rays from the cyclopean eye point through the perimeter points on the mirror. This angle can be interpreted as the visual aim of the mirror, i.e., the vector angle that lies in the center of the mirror FOV.
Vertical Aim	Analogous to Horizontal Aim

The Figure 4 View angle from the driver point shows the description of the positive and negative angles from the driver's view and the field where the driver can see while he/she is in driver seat.

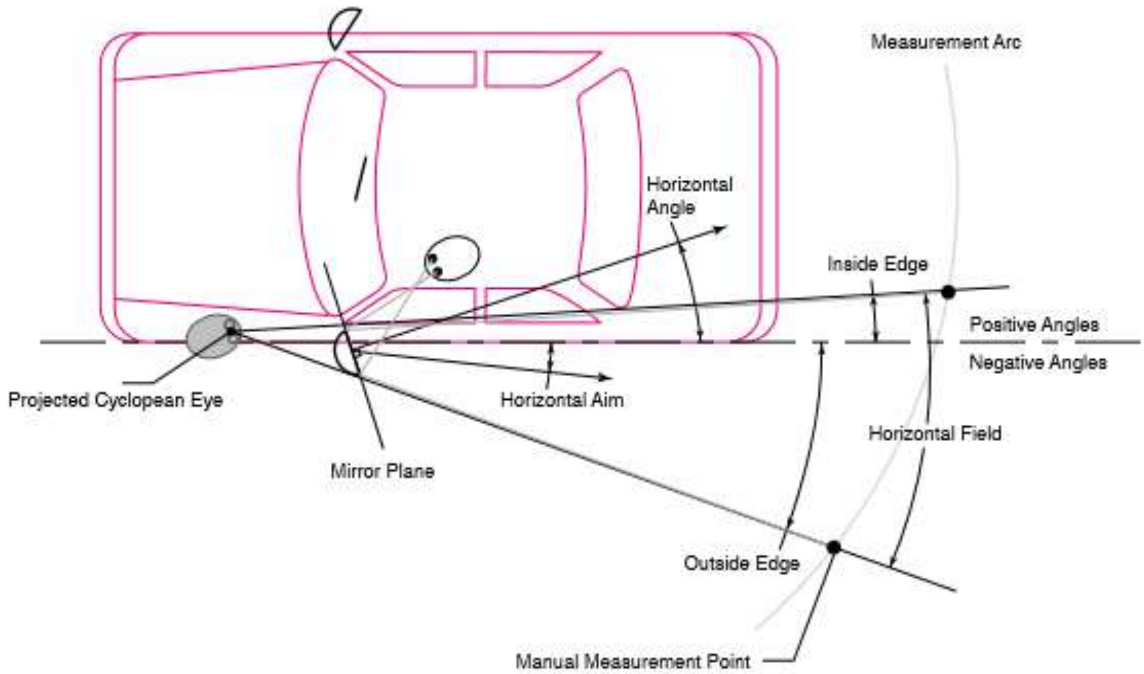

Figure 4 View angle from the driver point [3]

1.1 POTENTIOMETER

A potentiometer is an electrochemical electrical device that converts energy into current. The input to the device is within the kind of mechanical displacement, either linear or motion. once the voltage is applied across the mounted terminal of the potentiometer, the output voltage, that is measured across the variable terminal and ground, is proportional to the input displacement, either linearly or in line with some nonlinear relation [4].

Rotary potentiometer is out there commercially in single revolution or multi revolution kind, with restricted or unlimited rotational motion. The potentiometers usually are created with wire wound or conductive plastic resistance material, as shown in the Figure 5 Potentiometer [6].

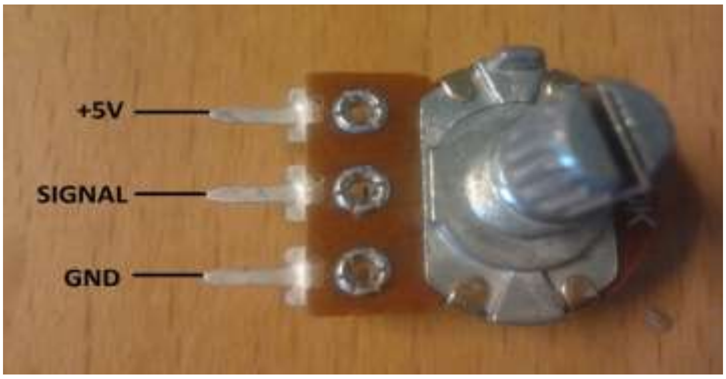

Figure 5 Potentiometer [5]

The simple Circuit representation of the potentiometer is shown in the Figure 6 Circuit diagram of the potentiometer which is below,

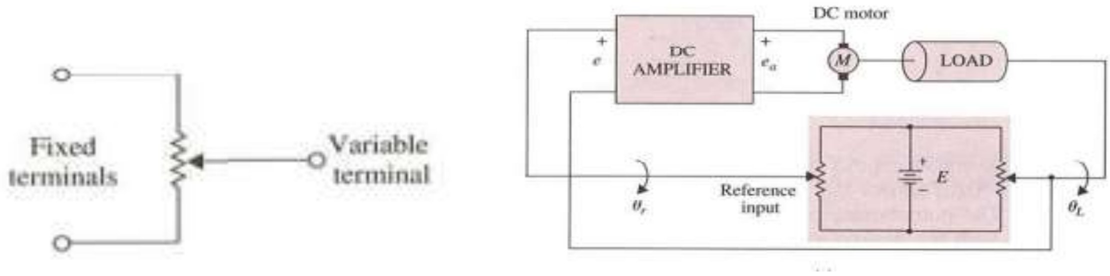

Figure 6 Circuit diagram of the potentiometer [7]

1.2 SERVO MOTOR

Servo arm will flip 180 degrees. using the PIC18F64, we will program a servo to travel to a fixed position and it will act there. A servo motor has everything engineered in: a motor, a electric circuit, and most vital, a motor driver. It simply wants one cable, one ground, and one management pin. Characterises of the servo motor is shown in the Figure 7 below,

Motor Type:	Coreless
Bearing Type:	Dual Ball Bearing
Speed (6.0V/7.4V):	0.15 / 0.12
Torque oz./in. (6.0V/7.4V):	333 / 403
Torque kg./cm. (6.0V/7.4V):	24.0 / 29.0
Size in Inches:	1.57 x 0.78 x 1.45
Size in Millimeters:	39.88 x 19.81 x 36.83
Weight oz.:	2.30
Weight g.:	65.20

Figure 7 Description of the servo meter [8]

The servo motor which is described above is shown in its partial and inner working condition, in the Figure 8 Servo meter.

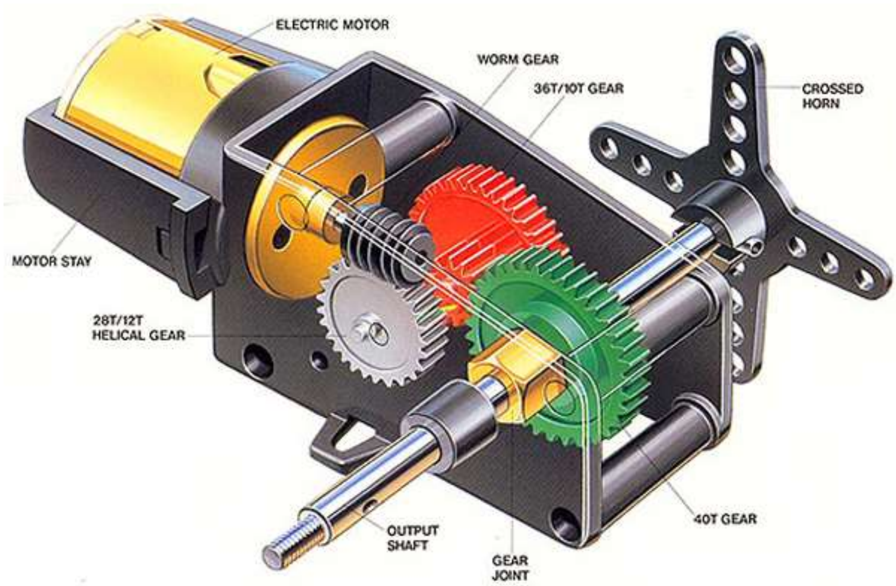

Figure 8 Servo meter [8]

1.3 PIC CONTROLLER

The PIC micro-controller based mostly design incorporates potentiometer, that is an interface between the steering and therefore the mechanism incorporated into the aspect mirror. The 16F84 PIC Microcontroller is the electronic interface between the potentiometer and therefore the motor. It contains one K words of FLASH program memory, 68 bytes of knowledge RAM and sixty-four bytes of knowledge EEPROM [9]. whereas this feels like a particularly restricted quantity of code and knowledge house, the PIC's implausibly compact code makes the foremost of it. 1024 instruction word memory means that 1024 directions, no less. Even immediate-mode directions, wherever an quantity is an element of the instruction itself, takes only 1 memory location, as do decision and GOTO directions [9]. The mathematical tracing curve for the drivers Steering movement that was enforced in our PIC controlled system. The mathematical curve representing handwheel takes into thought a district whereby any movement of the steering won't initiate mirrors movement (dead zone). this can be essential, because the mirrors needn't to maneuver for straightforward steering movements that result. the bounds for the dead zone is set and enforced into the code dominant algorithms due to calculations on the vehicle internal house [9].

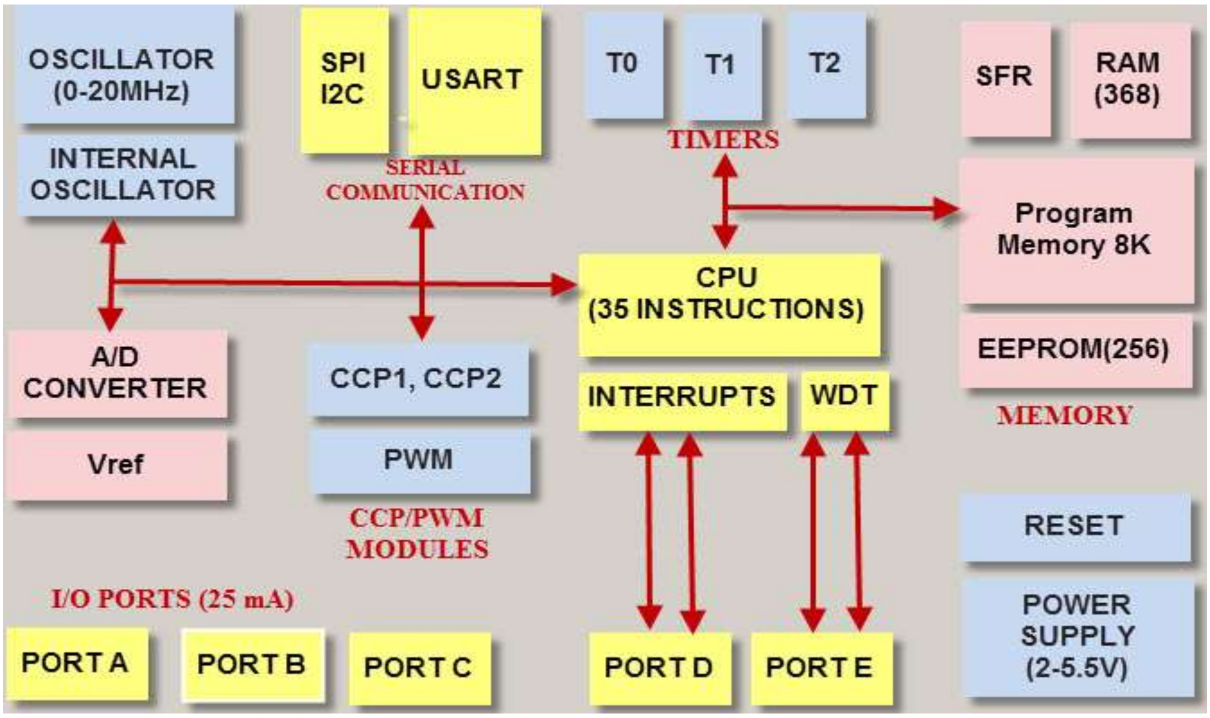

Figure 9 Architecture of the PIC microcontroller [9]

1.4 BLIND SPOT WARNING

The blind spot monitor may be a vehicle-based device that detects different vehicles set to the driver's facet and rear. Warnings will be visual, audible. but a lot of a driver pays attention, there could also be times once it's tough to remember of different vehicles traveling in what's usually brought up as a driver's "blind spot". this method assists drivers in driving safely by detecting and warning them of the presence of different vehicles within the blind spot space. the event of safety options and their rate of inclusion in new cars is formation ahead at an outstanding rate. the protection options in a very automotive will be split into 3 broad categories; passive safety options, active safety options and driver help technology [10] [11]. basically, passive safety options square measure people who facilitate to shield the occupants within the event of a crash, like airbags, seat belts and crumple zones. Active safety options can monitor the driving surroundings and jump in to assist forestall a crash or scale back the severity of it. These systems will exert a selected quantity of management over the vehicle, as well as electronic stability management, anti-lock braking, autonomous emergency braking, forward collision warning and lane departure warning [10] [11]. Driver help technology is that the broadest class, as well as all the options that facilitate the motive force scan and establish potential problems on the road. Options like auto-headlights, rear-view camera, rear cross-traffic alert, blind-spot observance, driver fatigue observance make up this area [13]. Blind spots represent associate extreme danger for motorists, particularly at main road speeds; annually, thousands of accidents happen once driver's amendment lanes and touch alternative vehicles that were in their blind spots. In keeping with the national main road traffic safety administration, blind spot-related accidents are answerable for over 800,000 accidents and over three hundred fatalities annually. These accidents are particularly troublesome to avoid because of even active defensive driving isn't continuously enough to forestall them; you can't react to a vehicle that you just cannot notice. Driving is that the bodily function task that needs a high visual work load; 95% of the knowledge is known by vision, what is more, drivers visual work is increasing because the setting (Example: traffic, pedestrians, roadside obstacles, and street vendors) becomes a lot of complicated.to deal with this complexity, driver should shift their visual attention frequently among a driving setting whereas activity alternative tasks like decision making and body management. These competitive tasks don't permit driver to continuously target info sources that are vital for safe driving. Once driver's attentions are occupied they will even commit a psychological feature failure referred to as "looked however did not see", within which they miss clearly visible objects [13] [14]

1.5 LANE KEEPING ASSIST

Lane Keeping Assist may be a driver assist system that works in conjunction with LDW to alert the driver if the vehicle begins to drift out of a detected lane. LKAS goes a step additional by actively applying steering torsion to assist keep the vehicle inside the lane [15]. When LKAS is activated, a camera mounted at the highest centre of the windscreen detects lane markings to watch the vehicle's position on the road at speeds between 72-145 KM/H. If the vehicle drifts from the supposed lane while not the utilization of a blinker, a visible warning seems within the middle, in the middle of associate degree audible chime. The system conjointly provides steering assist by using counteracting steering torsion to assist guide the vehicle to the centre of the lane [16]. LKAS is particularly useful throughout long-distance main road driving once driver fatigue is a lot of probably to occur. LKAS helps keep the driver attentive to the road ahead and also the vehicle inside the lane, LKAS not solely helps keep the driver safe that encompassing motorists in addition [15] [16] [17] Lane keeping assist uses a Camera to look at the lane markings. once it's turned on, the system is active at the speed of thirty mph. once the functioning system finds out that the vehicle is drifting from the lane, it makes a speedy beeping sound, blinking lane lines on the show and alerts the driver, once this lane keeping assist is employed at the sped higher than 45mph or 50mph, the functioning system often applies a small quantity of force to the wheel to take care of the vehicle within the lane [18] as shown in Table 3.

Table 3. Number of people using lane keeping assist [18]

Operators using Lane-Keeping Assistance considering (number of people = 100)
Daily using = 13
Regular interval using = 46
Rare case of using = 29
Not even used = 12

As shown in the above table based on general survey with 100 people, only 13 of them use this sensor and 46 uses sometimes, there are 12 of them who never use it but there are 29 who use rarely this technology [18].

1.6 LANE DEPARTURE WARNING

In road-transport nomenclature, a lane departure warning system could be a mechanism designed to warn the driver once the vehicle begins to maneuver out of its lane (unless a visual signal is on therein direction) on freeways and blood vessel roads [19]. These systems area unit designed to attenuate accidents by addressing the most causes of collisions: driver error, distractions, and sleepiness [19], There are 2 main styles of systems [20] [21] [22]:

- Systems that warn the driver (lane departure warning, LDW) if the vehicle is deed its lane (visual, audible, and/or vibration warnings) [20]
- Systems that warn the driver and, if no action is taken, automatically take steps to confirm the vehicle stays in its lane (lane keeping system, LKS) [20]

Lane Keeping Assist could be a feature that additionally to Lane Departure Warning System automatically take steps to confirm the vehicle stays in its lane. whereas the mix of those options creates a semi-autonomous vehicle, most need the driver to stay on top of things of the vehicle whereas it's in use [21]. this is often attributable to the constraints related to the lane-keeping feature. Lane departure warning employs an easy camera that prices some greenbacks. It may prevent thousands in crash repairs. The camera and process code watch however shut you're to paved surface markings. It alerts you once you're close to drift across, however providing your visual signal isn't on. Lane departure warning has emerged as a key tool for driver safety [21]. Lane departure warning/lane keep assist is thus smart, the most effective systems that would keep you cantered for miles and miles. It's very a self-driving automotive at that time. All of them cut out once a number of seconds if they notice no hands on the steering wheel [22]. The most common LDW system could be a camera mounted high within the windscreen (photo above), usually as a part of the rear-view mirror mounting block. It captures a moving read of the road ahead. The digitized image is parsed for straight or broken lines — the lane markings. because the driver, you're presupposed to centre the automotive between the 2 lines. because the automotive deviates and approaches or reaches the lane marking, the driving force gets a warning: a visible alert and either a hearable tone If the blinker is on, the automotive assumes the driver is designedly crossover the lane, and there's no alert [22]. Lane departure warning system is set up by the detector suite of one camera trying forward to content lane borders and observe potential lane departure in an extremely sensing vary of 100 meters, 2 internet cameras placed into the side mirrors detective work the oncoming vehicles among the adjacent lanes in an extremely sensing vary of 24 meters [20] [21] [22].

1.7 REAR CROSS TRAFFIC ALERT

Rear cross traffic alert is intended to warn you, of cars that is getting into your backing path. You will not be able to see these cars as quickly as your rear cross traffic alert system will on a road or in an exceedingly automobile parking space [23].

Figure 10 Detection of the rear vehicle [23]

Sensors around the rear of the automobile detects vehicle approaching from both left and right sides. A blinker on the mirrors alert the operator to prevent as shown in the Figure 10 Detection of the rear vehicle [23] [24].

1.8 OVERVIEW

A wing mirror, additionally called the fender mirror, door mirror, outside rear-view mirror or scene mirror, could be a mirror found on the outside of automobiles for the needs of serving to the driver see areas behind and to the edges of the vehicle, outside of the driver's sight (in the 'blind spot'). The types of side view mirror: Dual-contour wing mirror, Fender mirror, Wing mirror within built turn signal, Side mirror with warning, Side mirror with cameras, Wide angle mirrors.

The pros for the side view mirror are;

- The drivers are more focused and alert when driving
- Drivers gain more confidence while driving
- They become better drivers and are safer on road while driving
- The mirrors tell you whether it is safe to change lanes
- Whether it is safe to move and how to turn accurately and timely without your head.

The cons of the side view mirror are;

- The driver adjusts the side view mirror to see the car which comes behind but they don’t see the vehicle which appears in the rear-view mirror in the side view mirror then they are in blind spot
- The wide-angle mirror is cheap and available but it gives a bad feel of driving while seeing the mirror it is the most common opinion
- The cameras in the mirror are costly and if we get cheap one it won’t work properly within a year
- The fender mirror breaks easily if someone just slaps it
- The mirror with indicator is also costly and these indicators also breaks easily if we get cheap one

To prove my aim I have just proposed a concept of making the mirror into two half according to the needed size and then make the half to pivot according to the steering rotation without human interference with the help of placing the potentiometer in the steering knuckle and regulate the voltage according to the rotation of the steering and passes the current to the servomotor with the help of pic controller which indicates the angle as coded and the driver doesn't need to worry about changing the angle of the mirror manually to see the blind spot while taking a turn or changing the lane in critical situations and also this concept doesn't cost a lot and it is affordable by every one who is owning even an economical car.

2. KINEMATIC REPRESENTATION OF THE MIRROR

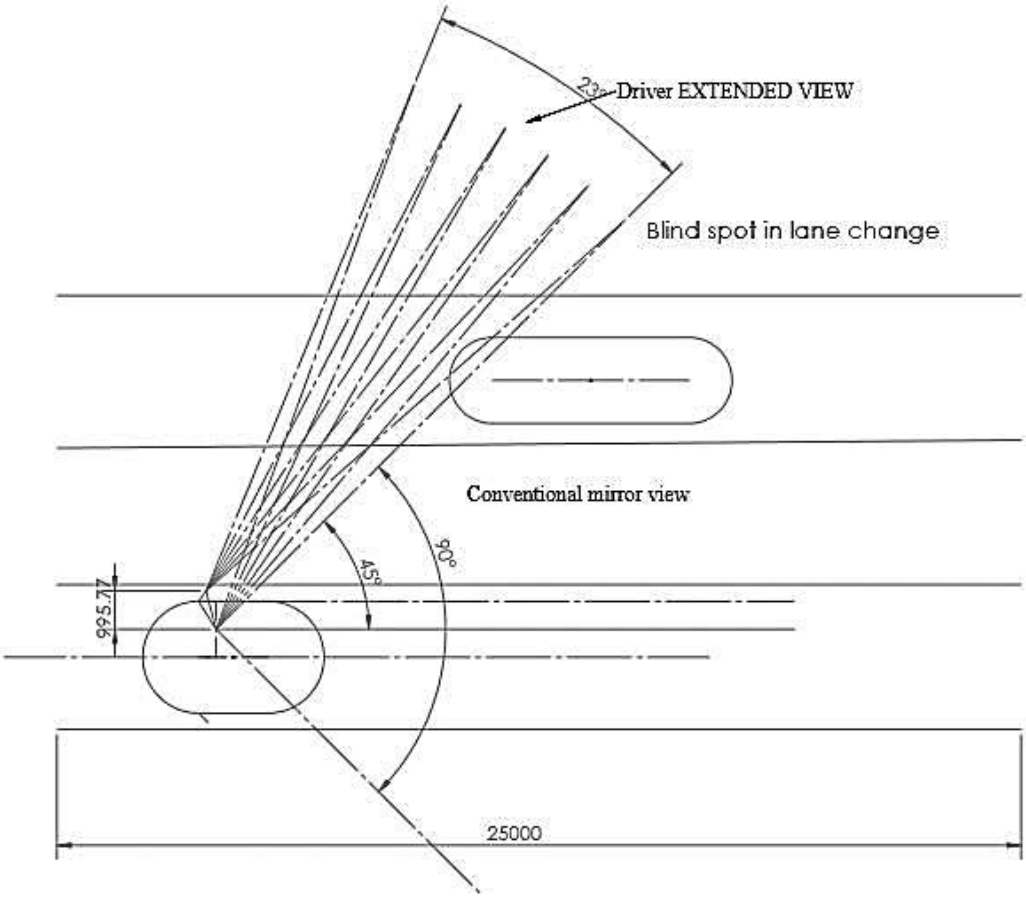

Figure 11 Blind spot reduction angles

The field of vision for the driver while he is driving is basically 45° in left side and 55° in right side on the side view mirror accurately as placed by the manufacturers but the blind spot for the driver is actually above the given angle so to avoid that the design has been done in this thesis with some new research and ideas as shown in the below figure 12.

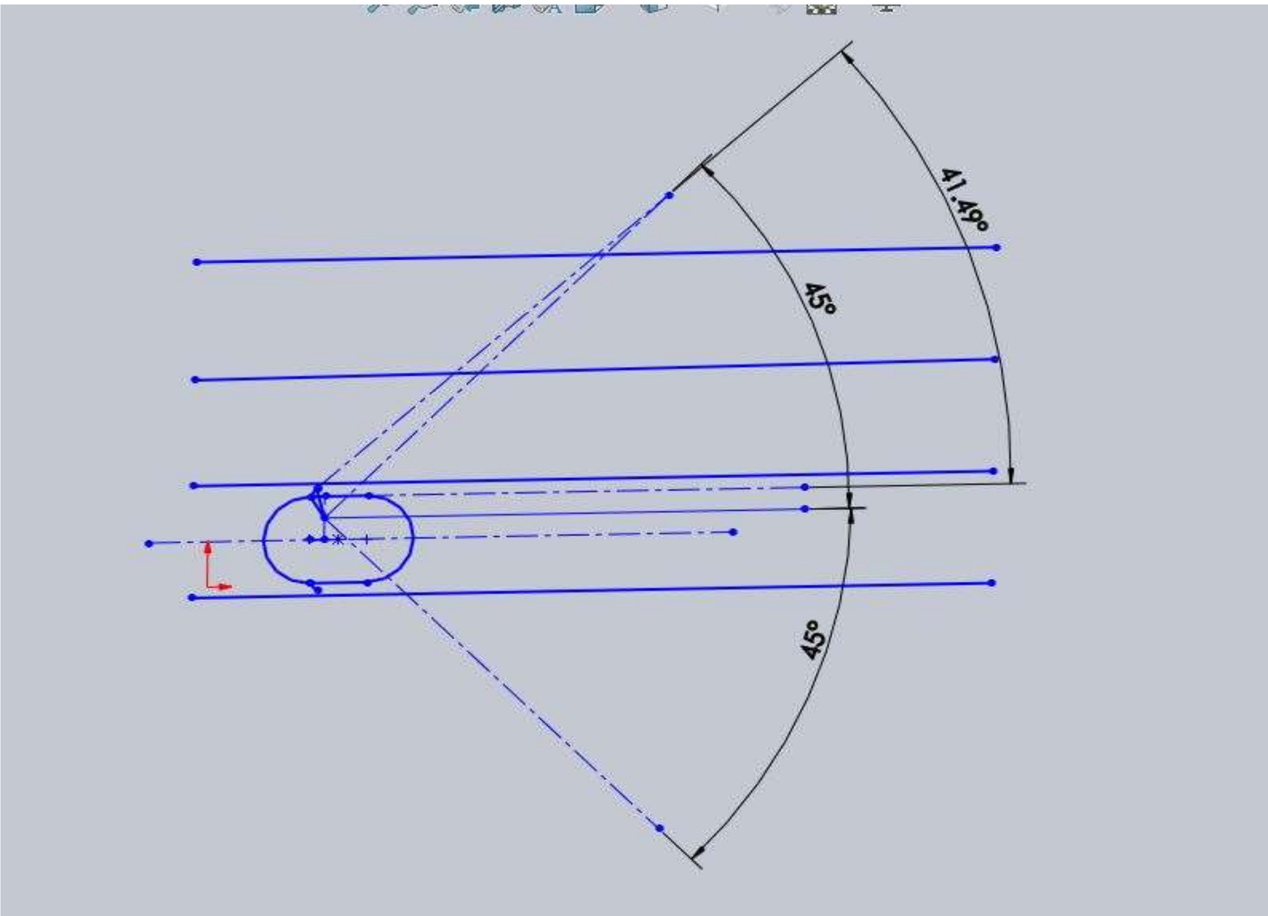

Figure 12 Field of Vision Sketch

The rotation of the steering is calculated as 540° basically (the steering wheel rotates one and a half rotation for one full turn so one full rotation is 360° and the other half is 180° so totally 540°). Here we have designed the new mirror portion to pivot 25° because it's enough to show the blind spot to the driver without any distraction as we have shown in the Figure 12, to calculate the angle of each pivot is done as,

$$540° \div 25° = 21.6° \quad (1.1)$$

Where, for each 1° of mirror pivot the steering has to rotate 21.6°. Hence for 1° of steering rotation the mirror pivots to 0.04°.

The below Table 4 shows the steering angle for each pivot,

Table 4 Blind Spot Angles

Angle of mirror	Angle of steering
5°	108°
10°	216°
15°	324°
20°	432°
25°	540°

The visual sketch for each angle is shown respectfully below,

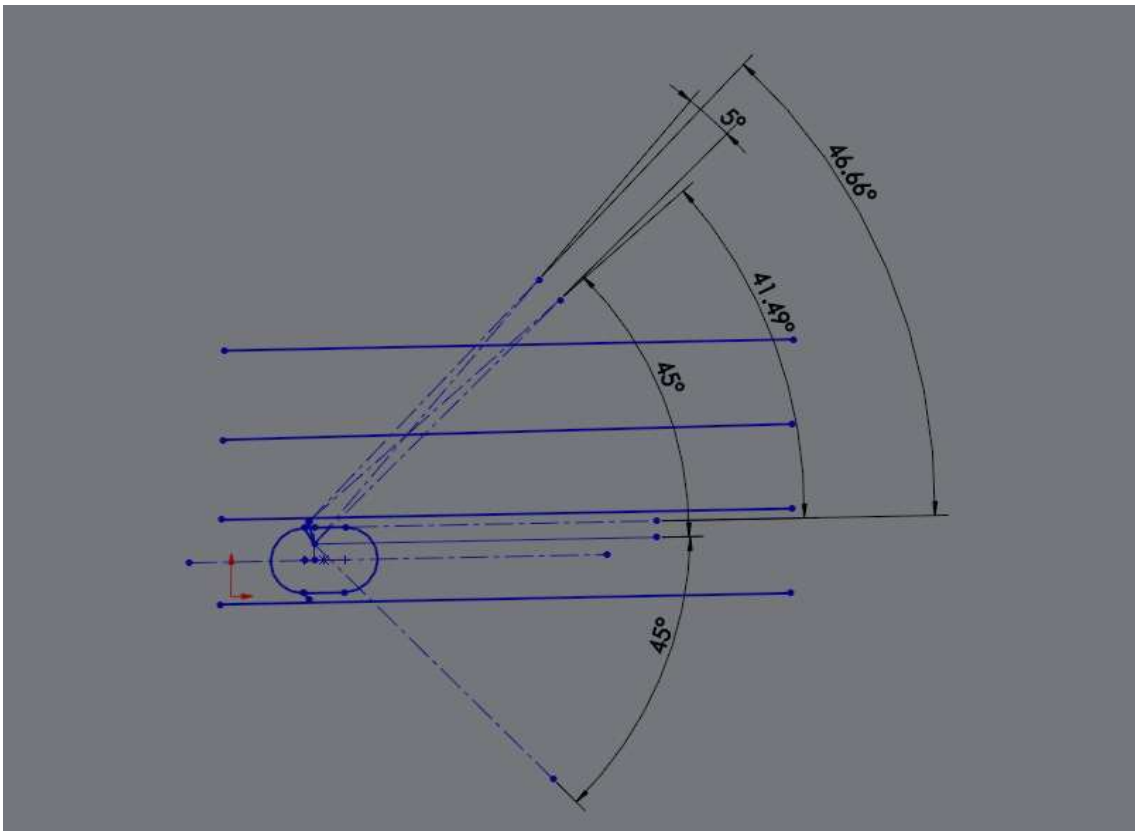

Figure 13 Blind Spot Angle for 5 Degree

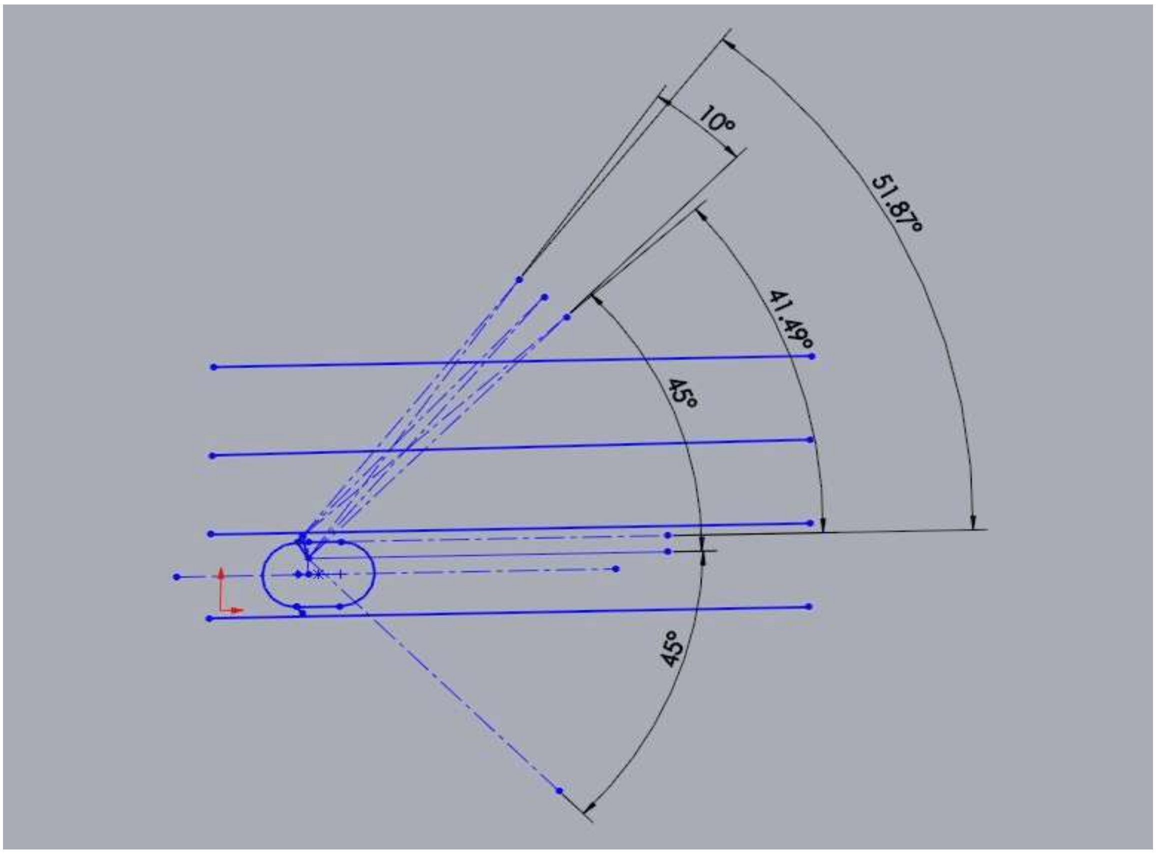

Figure 14 Blind Spot Angle for 10 degrees

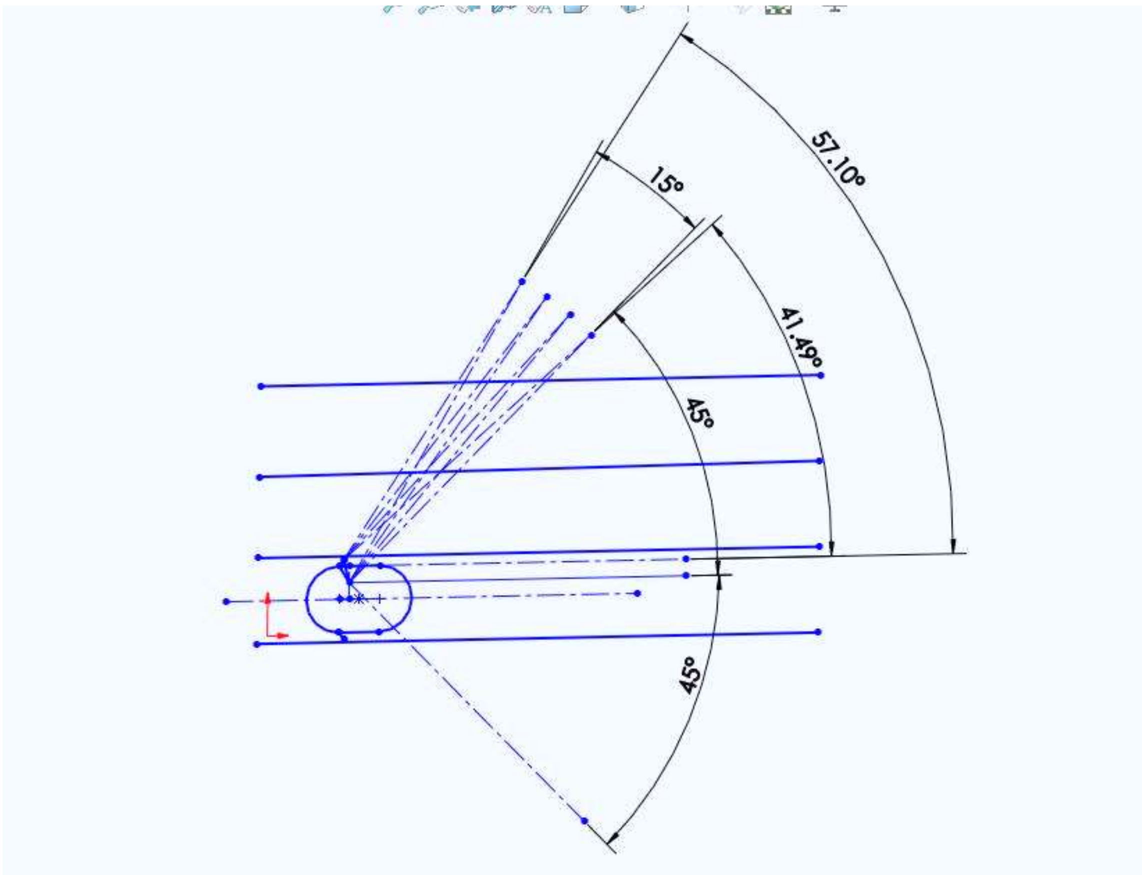

Figure 15 Blind Spot Angle for 15 degrees

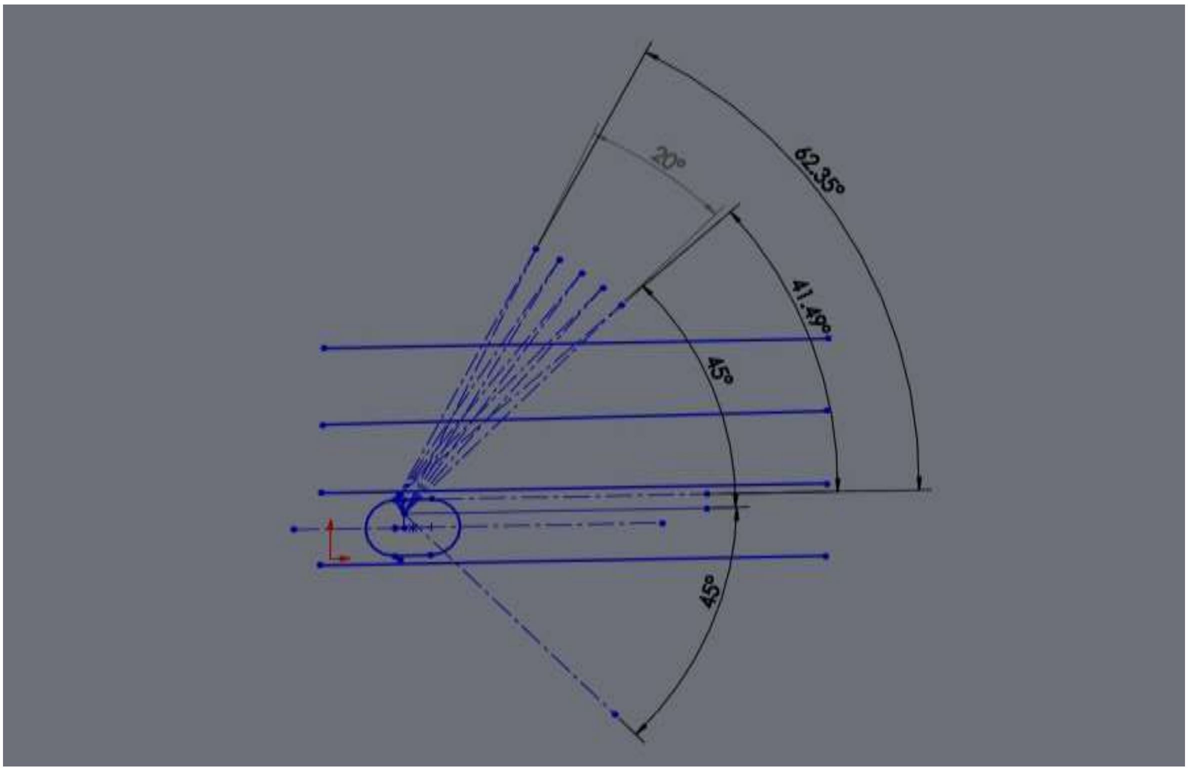

Figure 16 Blind Spot Angle for 20 degrees

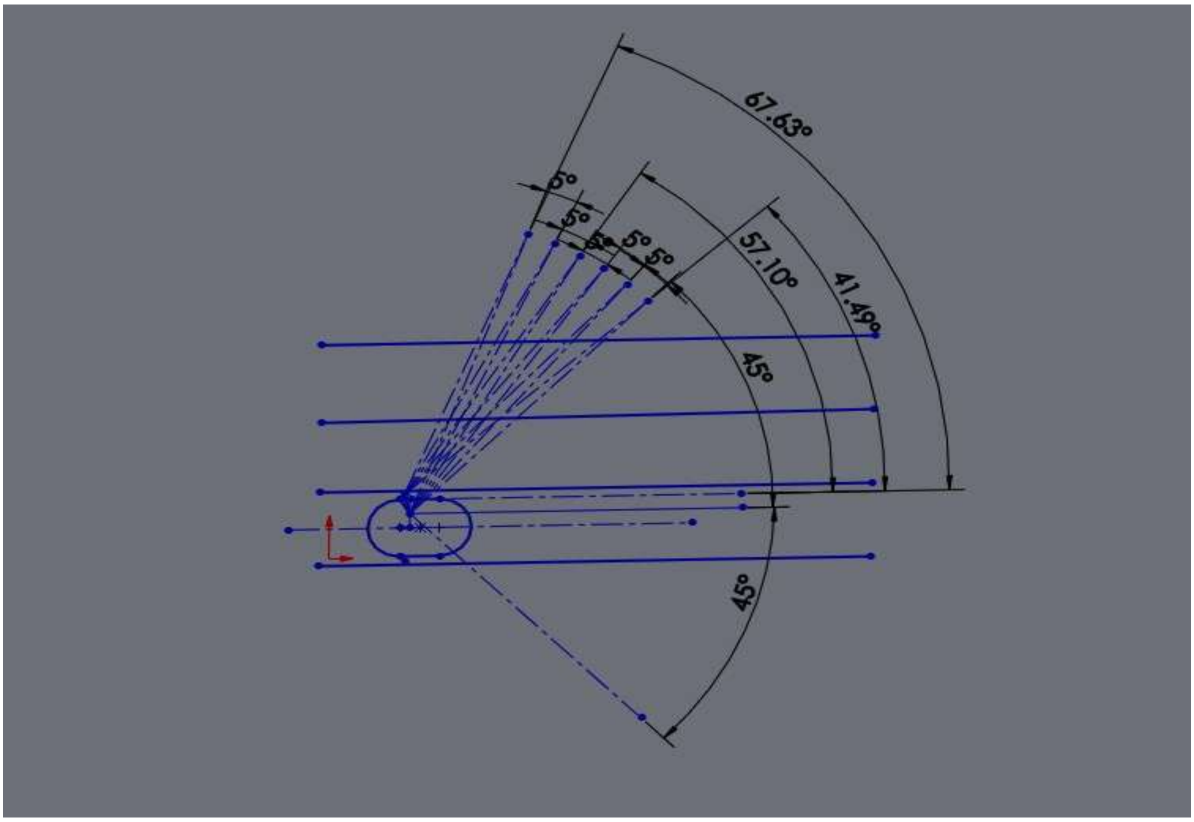

Figure 17 Blind Spot Angle for 25 degrees

3. MECHANICAL DESIGN

From this master thesis work, by designing a simple mirror structure with the simple control system, which controls the half portion of the mirror to show the blind spot to the driver with desired angular direction. With the PCI16F84 controller and potentiometer, the mirror is controlled in the desired direction with more accurate level without any human interaction. Due to this way of approaching system and design, it creates a user-friendly environment to the driver and driving will be more safe.so, they can reduce accidents in less cost instead of updating it to costly technologies. Main Components used in this work;

- Side view mirror
- Potentiometer
- Servo motor
- Pic16F84 controller
- Range sensors

3.1 DESIGN

The new design of the propesed side view mirror is show in the Figure 18 it is designed with the help of solid works.

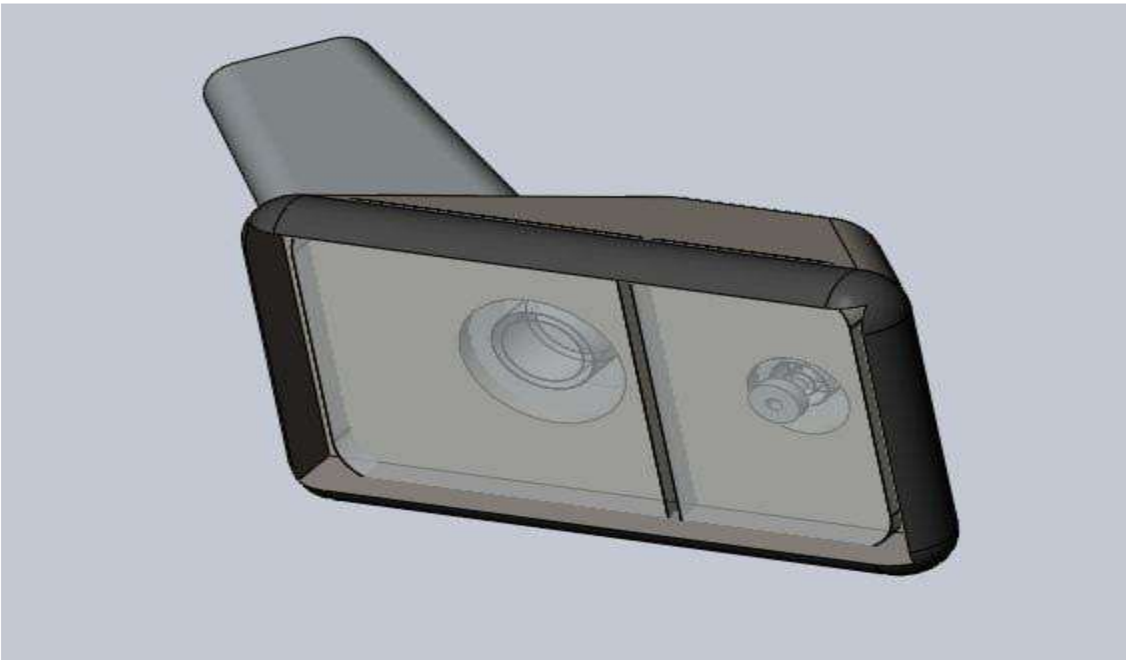

Figure 18 New split mirror

In the above shown Figure 18 the full structure of the newly designed mirror is shown and here the assembly is shown in solid work design,with the connection of camshaft,split mirror in the full case.

The design of the simple camshaft which we are using in the mirror is designed in the solid works as shown in the Figure 19 simple camshaft design

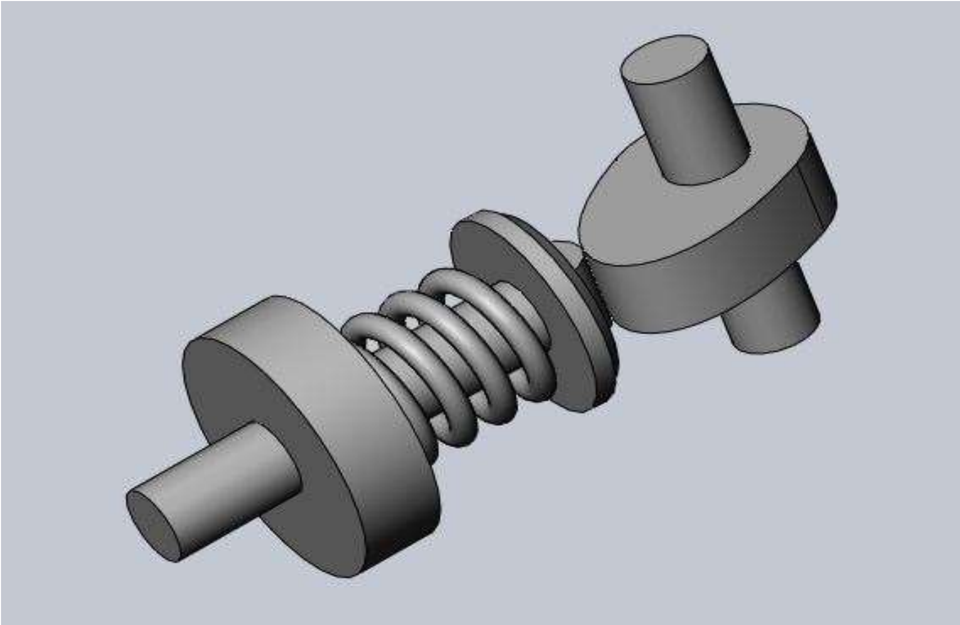

Figure 19 simple camshaft design

The outer case of the Designed mirror is shown in the Figure 20 Outer case of the mirror,

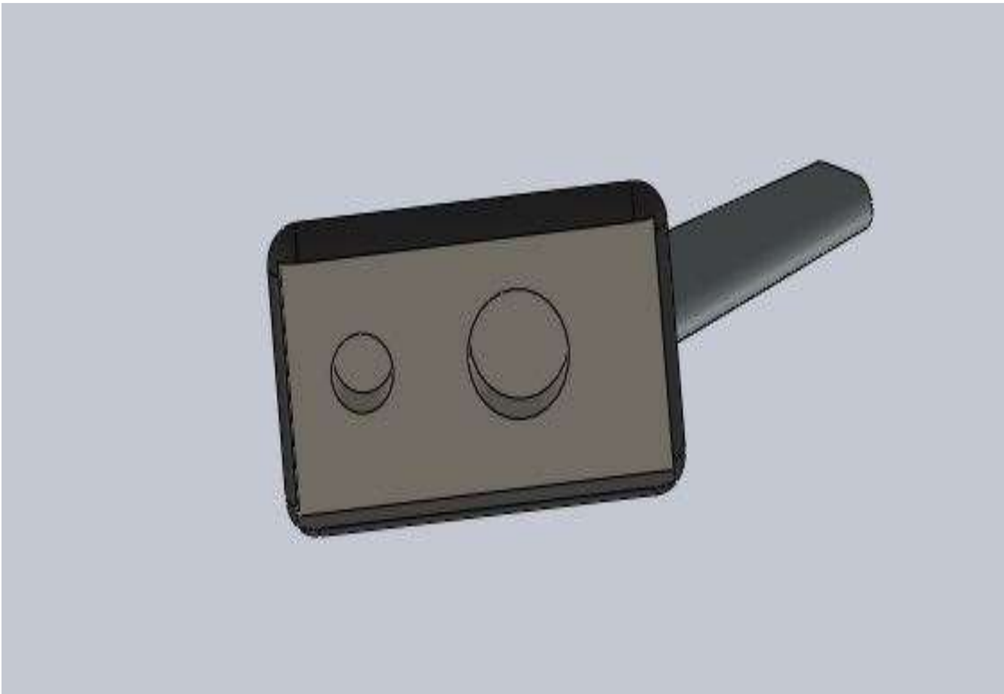

Figure 20 Outer case of the mirror

The 2D representation of the mirror case is shown in the Figure 21 2D of mirror case with the measurements,

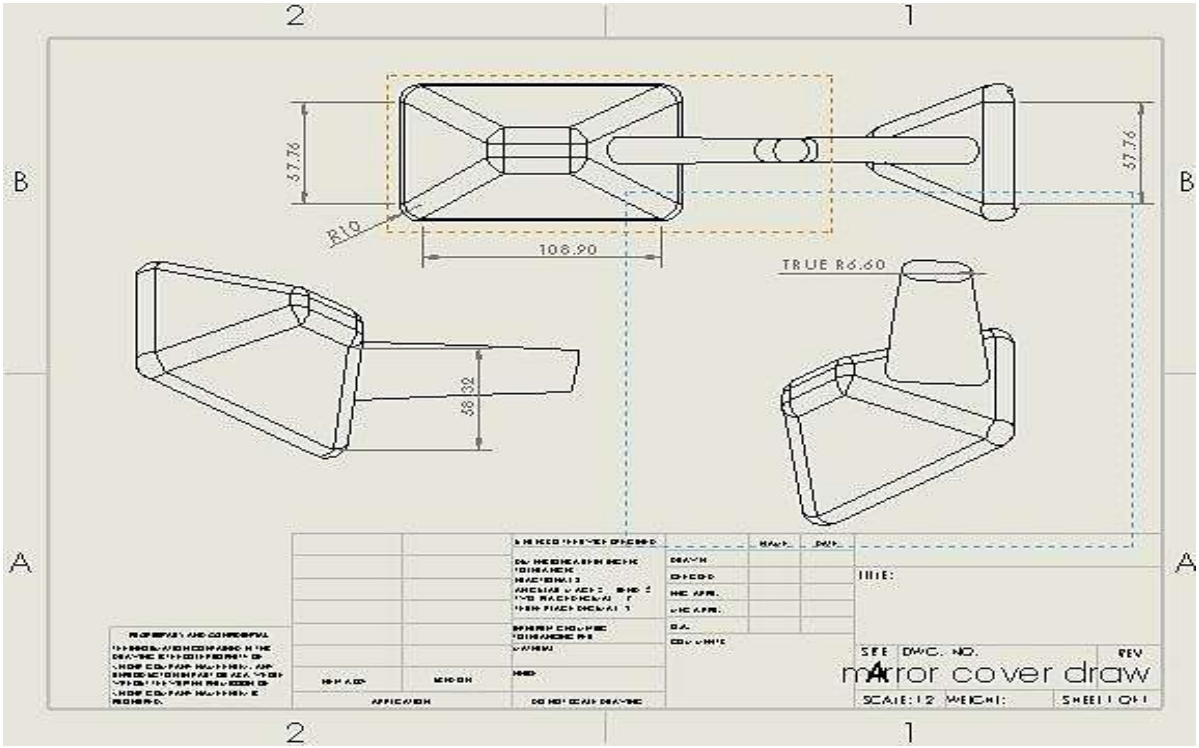

Figure 21 2D of mirror case

The new design of the split mirror is shown in the Figure 22 Split mirror,this is the mirror which is designed for the thesis work.

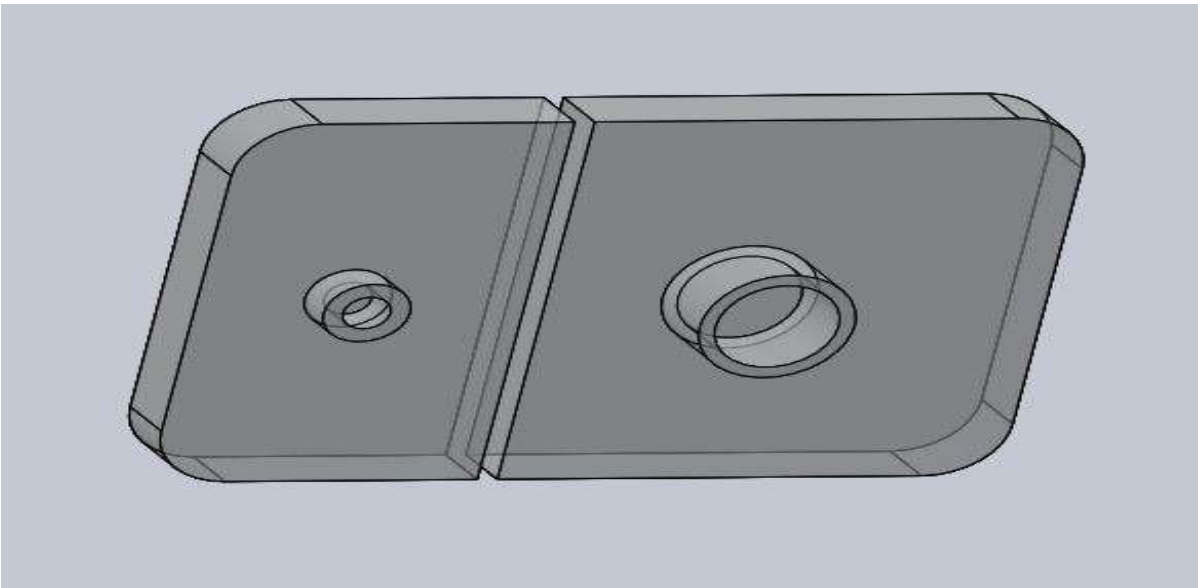

Figure 22 Split mirror

The assembly of the camshaft with the mirror is shown in the Figure 23 Assembly of mirror with

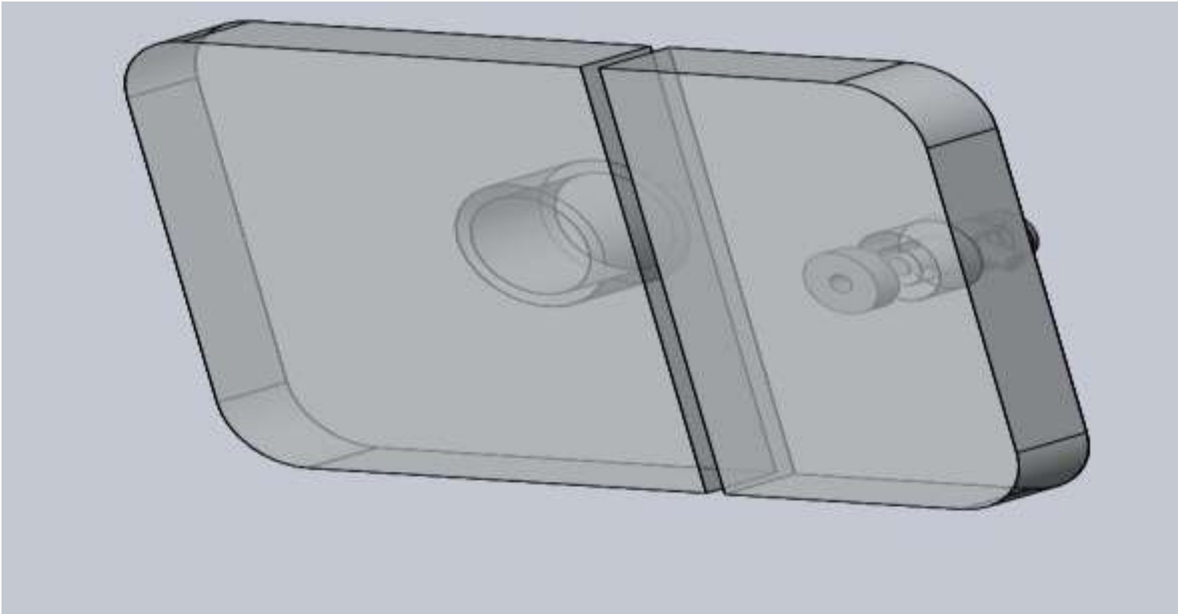

Figure 23 Assembly of mirror with camshaft

3.2 CALCULATION TO FIND THE E FACTOR

The right facet mirror and therefore the left facet mirror are frequently placed at the same vertical position on a vehicle, this equation equates the angles ɵLS and ɵRS. However, it will be appreciated that a simple modification to the equation are usually performed if a vehicle were to utilize facet mirrors at different vertical positions. As before, the mirror adjustment angles inside the vertical plane compared to a vertical axis among the vehicle, once documented to an index line running parallel to the longitudinal axis of the vehicle, equal one half the angle from the operator's eyes to the facet mirrors inside the vertical plane, yielding the following relationship [29]

$$\beta LS = \beta RS = 1\ 2\ tan - 1\ (h - S\ IR\ l\ IR + e) = 1\ 2\ tan - 1\ (h - tan\ (2\ \beta\ IR)\ tan\ (2\ \delta\ IR)\ d\ IR\ d\ IR\ tan\ (2\ \delta\ IR) + e) \qquad (2.1)$$

Input angles from the adjustment of a rear-view mirror can be used to generate side mirror adjustment angles[27][28][29].

3.3 RESULT OF E-FACTOR

Here, let's first consider the Steering angle β LS = 45°

$$45° = 12tan \quad - 1(h - Sir1ir + e)$$

45° = 12(1)-(3.02-37.057*0.168+e)

45° = 12-1(-34.037*0.168+e)

45° = 12(5.718+e)

So e = -1.968° angle

Here the e-factor represents the angle of the mirror after the steering rotation happen to 45° which makes the driver to see the blind spot at 45° with clear image.

For 90° = β RS

90°= 12tan -1(h -tan(2βIR) tan (2δIR) dIR d IR tan (2 δ IR) +e)

90° = 12(-1)-1(3.02-(-1)(2(-1.196))(-1)(2(1.140)*(0.880)(0.880*-1(2(-1.196)+e

90° = -12(-0.628*-2.006*2.104+e)

90° = -12(2.651+e)

So, e = -10.1° angle

3.4 CALCULATION FOR POTENTIOMETER

The equation of the potentiometer,

$$r = R\frac{(l_1 - l_2)}{l_2} \qquad (2.2)$$

Where r is the total resistance that is (R+r); R is the resistance; l is the balancing length.

The circuit representation of the simple potentiometer is shown below in the Figure 24 Circuit diagram of potentiometer.

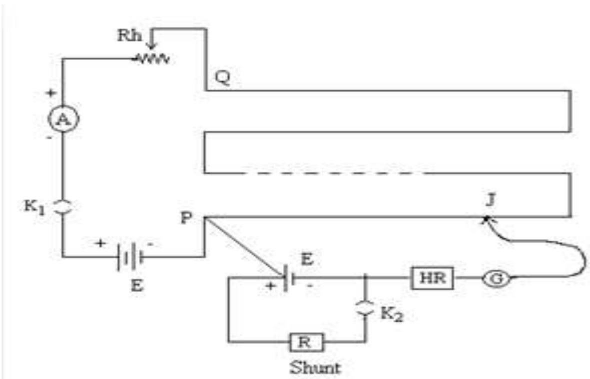

Figure 24 Circuit diagram of potentiometer [30]

Here the R resistance value is V=I*R; V=48 amp; I=12 volts; Therefore R=4 ohm,

When substituting in the potentiometer formula;

$$\gamma = 4\,\frac{(12-4)}{4}$$

Therefore r = 8 Ohm.

The calculation for potentiometer according to the mirror pivot is

$$540° = 10 \text{ volt} = 25°$$

Then, 540÷ 10 =54

So 54°=1 volt

Hence 1° $steering\ angle = 0.0185$ volt.

3.5 CALCULATION OF THE RANGE SENSOR

The range time to the ultrasonic is calculated by,

$$d = t * v \text{ [35].} \qquad (2.3)$$

Where d is the distance, high level time is denoted as t, velocity of sound is v.

Here we consider the vehicle is travelling at 100 miles per hour so the sensor recognise the vehicle at the distance

$D = t * v$

D= 1*100;

D= 16 meters

Therefore, the sensor recognise the vehicle at 16 meters away.

4 CONTROL SYSTEM

4.1 FLOW CHART REPRESENTATION

In the below Figure 12, drawn a flow chart the process of the thesis is shown step by step,here the steering wheel starts with the rotation and it has potentiometer attached to it to regulate the volts and the potentiometer is attached to the PIC microcontroller to transfer the processs to the servomotor which is connected to the side view mirror where the mirrors position show the blind spot to the driver and also the PIC is connected with the range sensors to indicate the danger alerts in the side view mirror through blinking led’s.

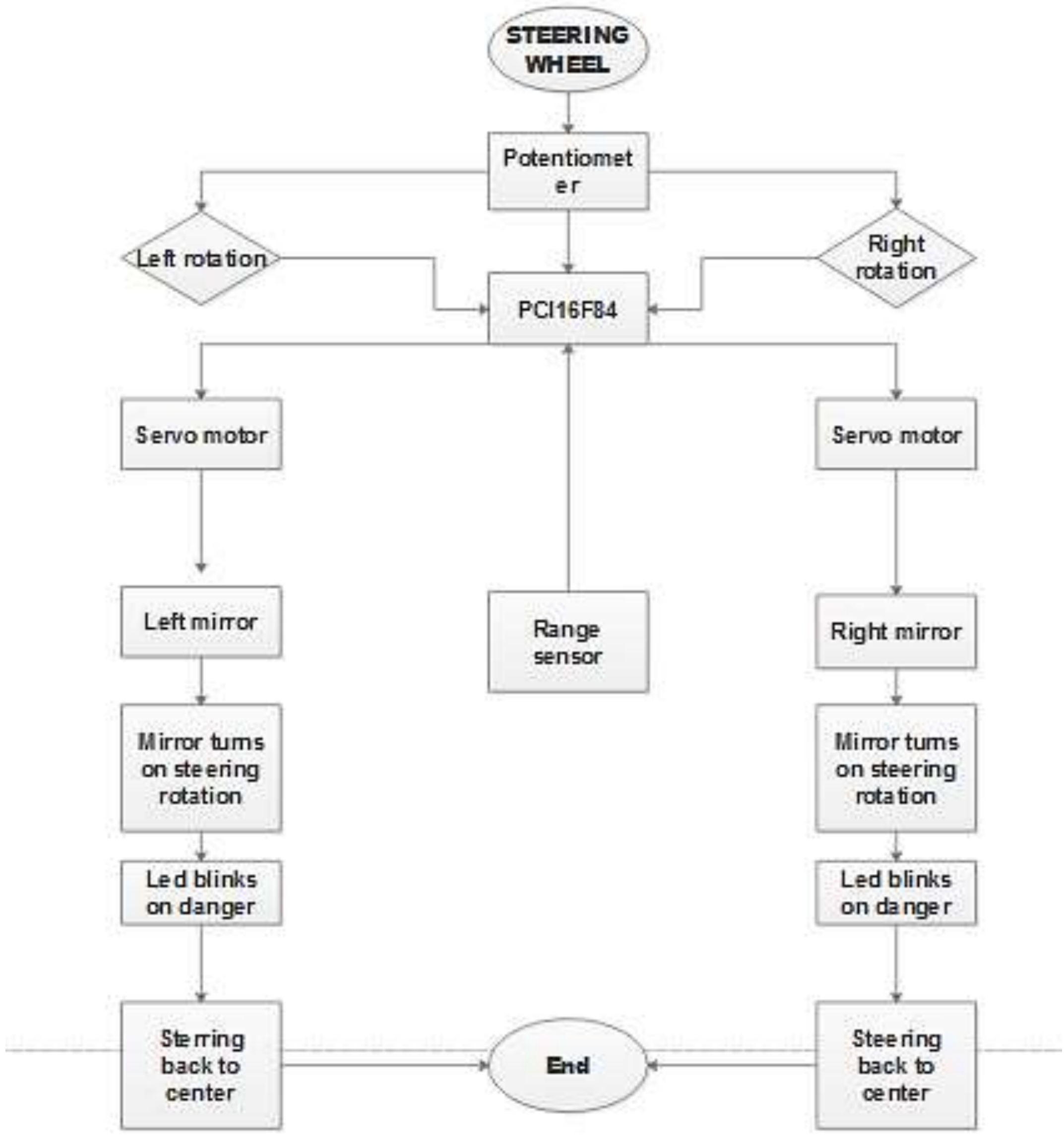

Figure 25 Flow Chart Representation of Thesis

4.2 SIDE VIEW MIRROR

The average length and width of the mirror according to my work is altered into, width 170mm and the height 98mm.The mirror has been portioned into 60:40 ratio, in this ratio the 40% part relates to the servo motor which helps to bend the mirror according to the drivers steering angle with the help of potentiometer. And the mirror is coated with the hydrophilic material, this is the coating which helps the driver to view the mirror without any blur or water marks in it and the remaining 60% of the mirror stays stable, it has the led blinkers which shows the danger alert symbols like blind spot warning, lane keeping assistant, lane departure warning and rear cross traffic alert [25].

4.2.1 REASON

The angle of the side view mirror is decided based upon the regular usage of the automobile. Basically, the mirror shows only the objects which is coming behind the vehicle and while driving we can feel the trouble to see the vehicles which are hidden by the a and b pillars in the car so to rectify that if the mirror shows the blind spot without placing any costly equipment it will be very easy and available to all class of people so it has been designed in such a way as shown in the figure 13 and the mirror has been connected to the control systems as shown in the flow chart [26]

4.3 DC MOTOR SPECIFICATIONS

Rated voltage: 10V DC, Rated power: 525W, Rated speed: 1250rpm, Rated torque: 4.0N x m, Rated current: 98A, Line resistance: 0.022Ω, Torque constant: 0.041N x m/A, Rated duty: S2/3 minutes, Rotation direction: two-direction rotating, Insulation grade: F level, Protection grade (IP grade): IP66, Noise level: <65dB, Withstanding voltage (against ground): >1000V, Pole number: 8 poles, Wire connection mode: Y-type, Storage environment: -50 to 135°C, working temperature:-50 to140°C, Current: 9 to 16V DC, Wire-leading specification type: car wire AWG10 [8].

4.3.1 SIMULATING THE DC MOTOR

The simulation is done using the Simulink as shown in fig and it has efficient torque and speed characteristics in relative to the control of the Potentiometer. The initial torque is very high. The motor is proved to be well suited for this thesis work.

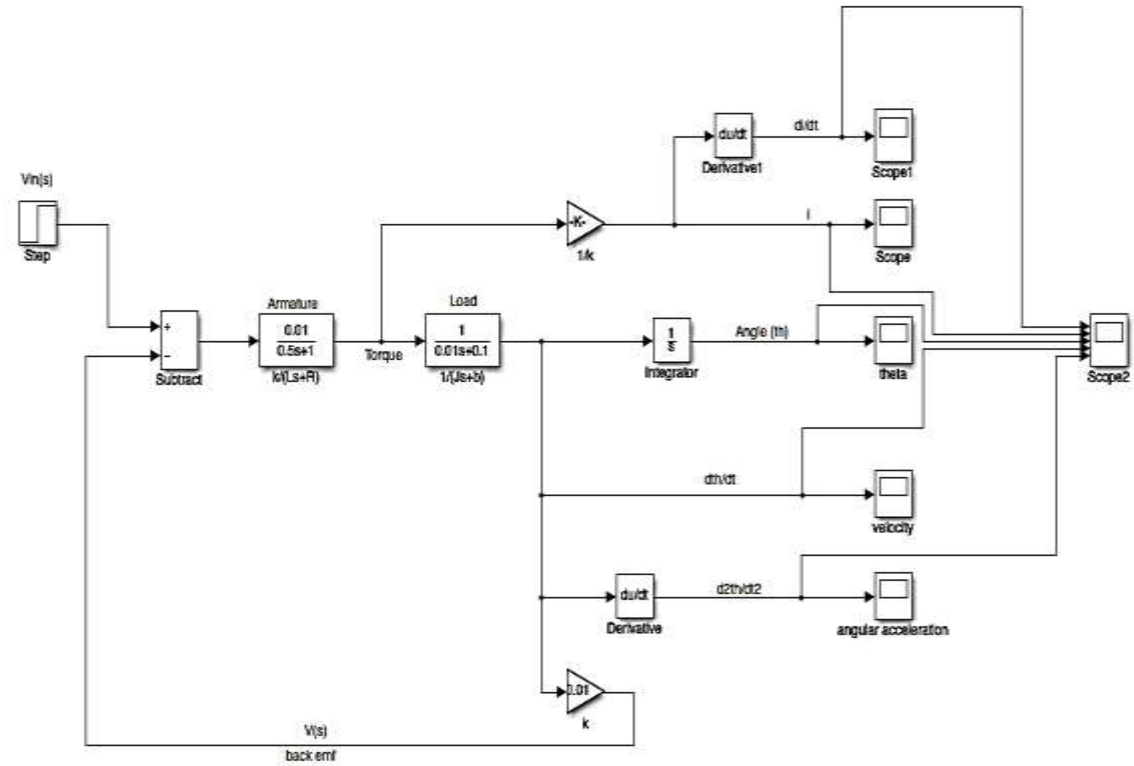

Figure 26 Simulink model of DC motor

Here the torque vs time graph is shown in the Figure 27;

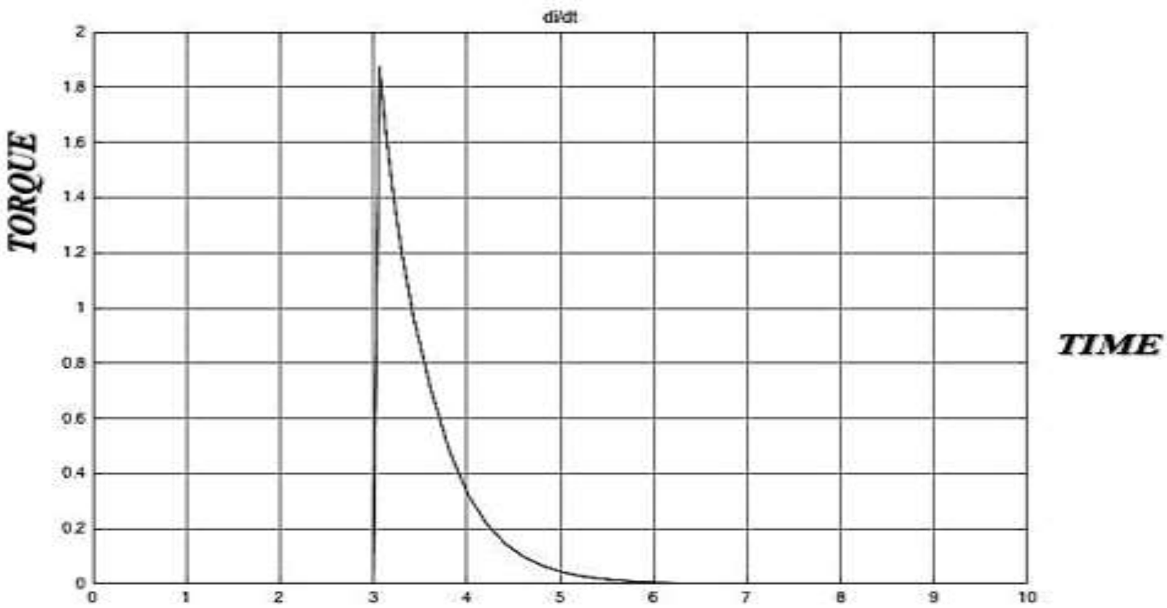

Figure 27 Torque vs time

Here the velocity vs time graph chart is shown where the velocity is at its good level

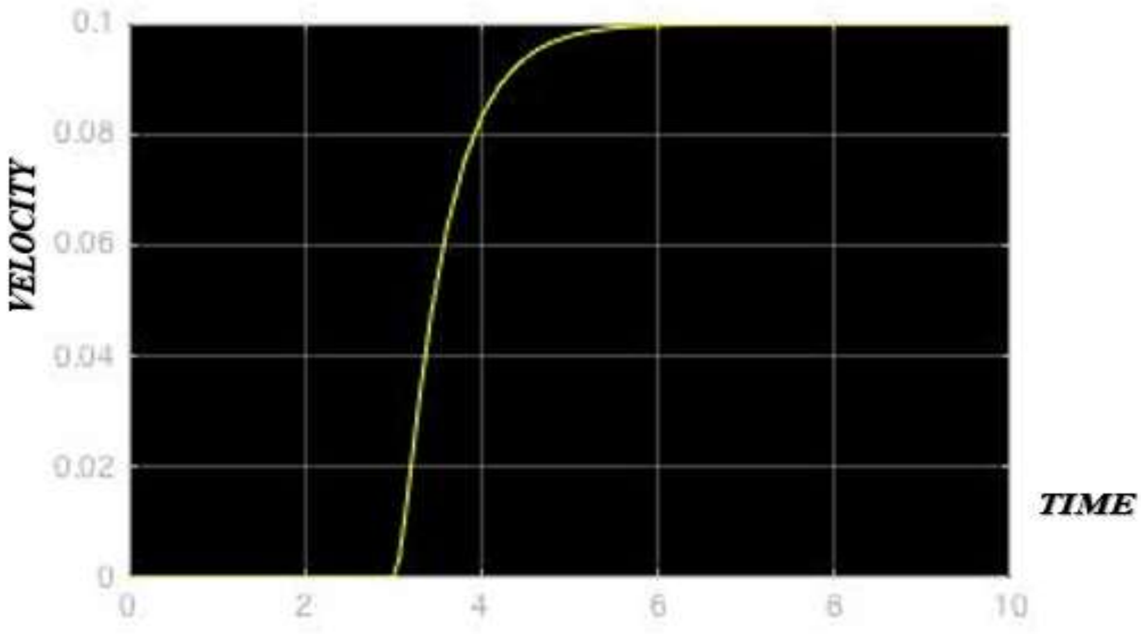

Figure 28 Time vs velocity

Here the representation of the Angular accelaration vs time is show where the acceleration rises up at the start and deaccelarate gradually.

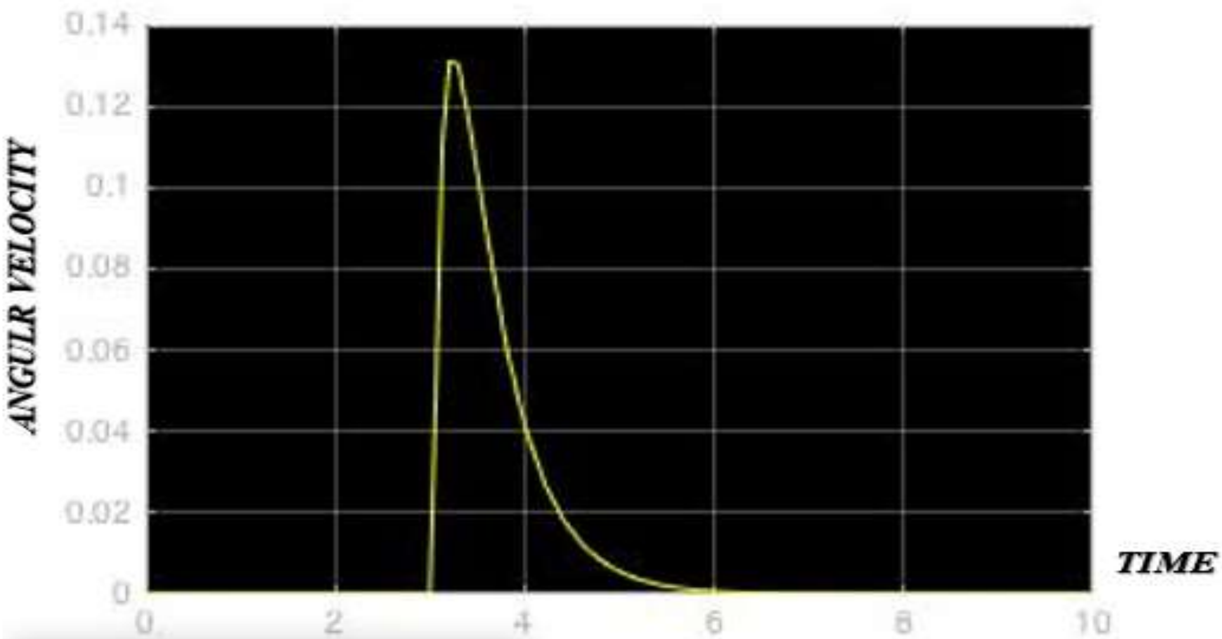

Figure 29 Time vs angular accelaration

4.4 PIC16F84 CONTROLLER

The simulation of the left side view mirror using the microcontroller is shown in the Figure 30 Simulation of the left side mirror here below,

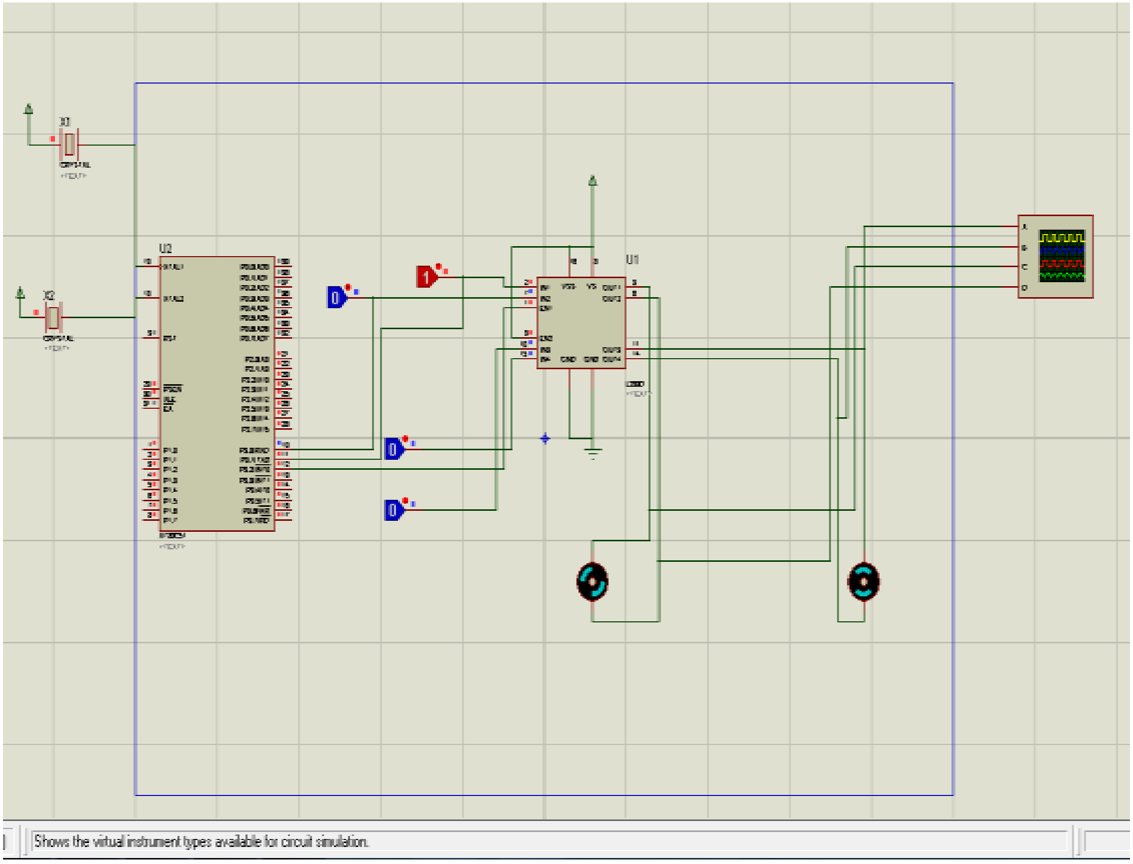

Figure 30 Simulation of the left side mirror

The simulation of the right side mirror using the microcontroller is shown in the Figure 31 Simulation of the right-side mirror,

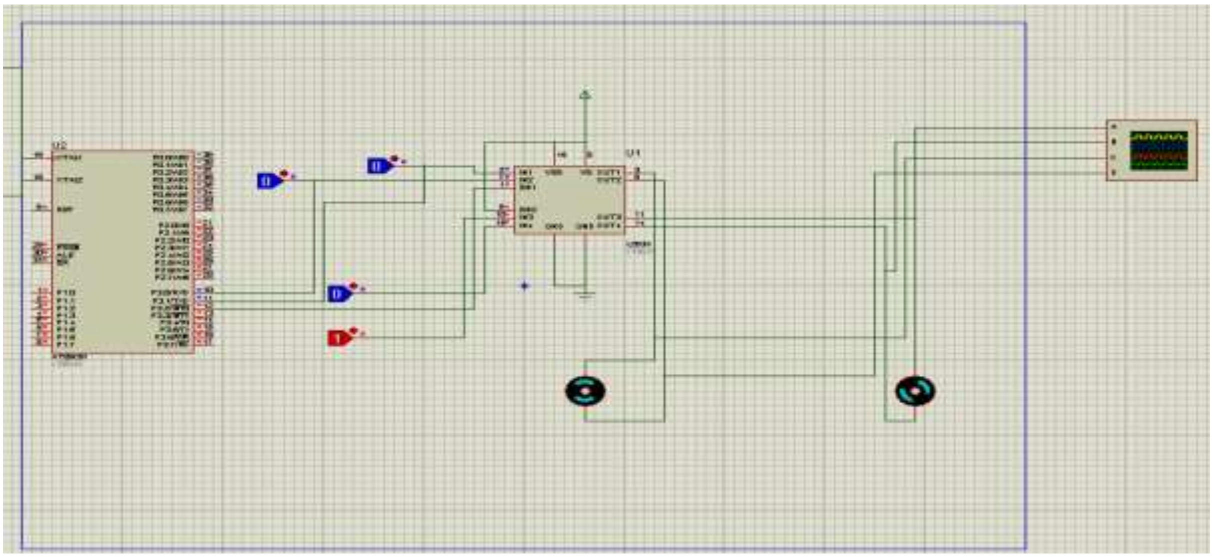

Figure 31 Simulation of the right-side mirror

The controller used in this thesis is PIC16F84,the specifications of this controller is [31] [32] [33] [34],

35 single word instruction
Working speed: DC-20Mhz
Time input: DC- 200ns
1024 words of program memory
RAM-68 bytes
EEPROM data 64 byte
14-bit wide instruction word
Hardware registrations-15 special function
10000 erase/write flash Memory
Power consumption - <2mA typically
Standby current @2V

Figure 32 Specifications of PIC Controller

The structure of the controller is shown in the Figure 33 below,

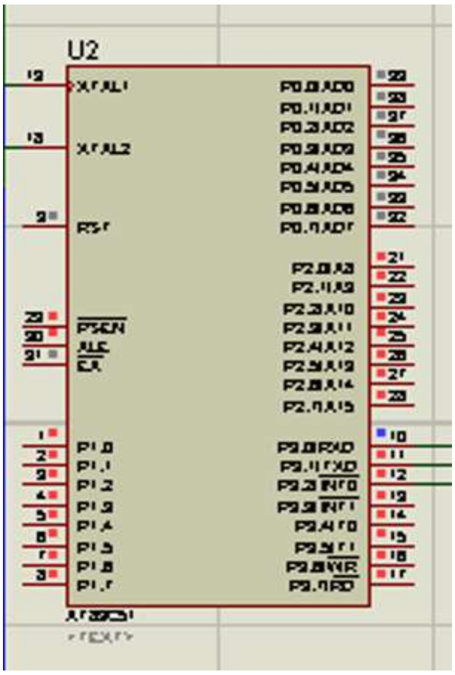

Figure 33 Structure of the PIC controller

The block diagram of the PIC microcontroller shows the input,output and the circuits of the structure clearly which is shown below in the Figure 34,

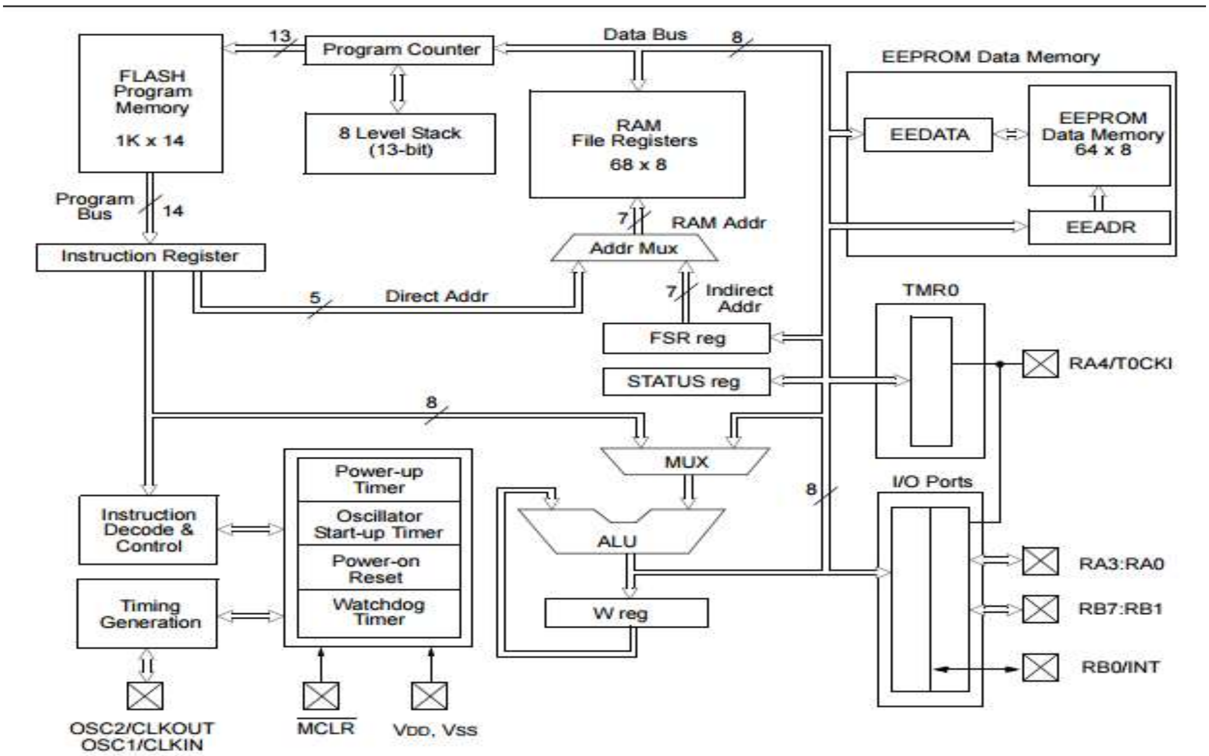

Figure 34 Block diagram of the PIC16F84 [31]

4.5 POTENTIOMETER

The potentiometer is used in this thesis work because it is the cheapest and a good regulater which transforms Mechanical energy into Electrical energy and the consumption of battery will be very low, here the potentiometer is connected to the steering wheel to calculate the radians and the voltage drop to control the mirror according to the steering rotation with the help of the micro controller the potentiometer passes the information to the controller and the controller make it to the servo motor which makes the mirror motion possible[30].

4.5.1 REASON

The potentiometer that is used in this thesis is adjustable,beacaus the placement of the potentiometer is in the steering.wheel knob,the main job of this potentiometer is to turn along the steering wheel and regulates the voltage according to its motion respectfully.

Figure 35 Simple potentiometer used in this thesis

The potentiometer used in this thesis is shown in the Figure 35 above it has a three pots each one has its charactricts as one is input and the other two are output and ground respectfully.

4.6 RANGE SENSOR

The range sensor is placed in the vehicle which indicates the driver about the vehicle which is in the nearby lane at higher speed than the self-vehicle so the driver could take precaution before lane changing or starting the vehicle from a stop in highway rest lane, the range sensor covers major four distractions those are Blind spot, lane departure, lane keeping assist, Rear cross traffic alert. The placement of the sensor is at the rear end of the vehicle as shown in the figure 36,

Figure 36 Placement of range sensor [35]

4.6.1 PRINCIPLE

The range of the obstacles are measured and fed into the PCI16F84 controller to take the needed action. The ultra-sonic sensing sensor HC-SR04 gives 2m-40m measurement range, the accuracy of ranging can also reach up to 5mm [35],

- IO trigger pin is used for about 20US high level signal [35]
- Then the module automatically transmits eight forty kilohertz and once obstacle is detected a plus wave is transmitted back. [35]
- If signal return is receiving at the echo pin, through the high level, the time of high output level is indicated [35].

4.6.2 FLOW CHART REPRESENTATION OF RANGE SENSOR

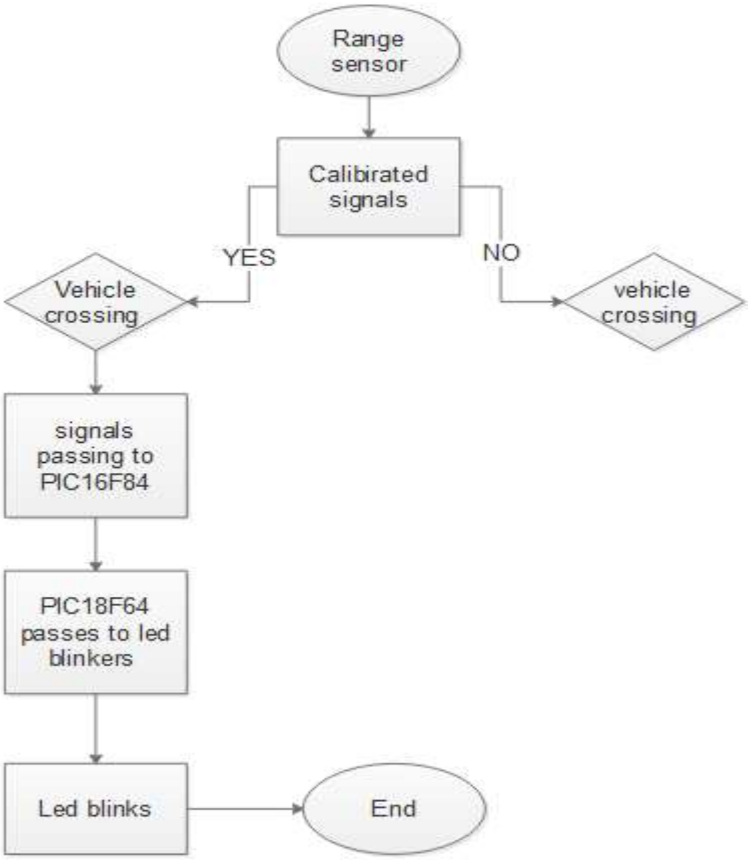

Figure 37 Flow chart of the range sensor

The flowchart above gives a basic idea how the range sensor works, the placement of the sensor will be in the rear end of the vehicle and the process is like if the vehicle which is coming behind crosses our vehicle faster than ours then the sensor receives signal as explained above and send to the microcontroller and the controller attached to the mirror makes the mirror blink like the marks pasted in the mirror. The process is as simple as that.

5 ECONOMICAL DESCRIPTION

The economical ways of making safety is the main motive of this thesis, here we use the most efficient and economical way of blind spot viewing system through the regular side view mirror by just designing a simple split in it and attaching it with the steering wheel to show the blind spot to the driver, the component used mainly in this thesis is,

Figure 38 Market Blind spot mirror [36]

Potentiometer which cost only 2€,Servo motor which costs 8€,PCI16F84 controller is just 1€,the side view mirror which comes with the OEM is 8€ basically but designed mirror is based on the vehicle the starting price will be approximately 5€,the range sensor kit will cost around 50€ to 700€ but we have taken the average kit which come along with all the safety sensors that we required it costs 65€,with extra we can provide hydrophilic coating to the mirror it prevents from the blur after rain, snow and also it will now shine in drivers face it costs around 5€,So totally it will come around 107€ which is way cheaper compared to all other systems in the market. For example, we compare,

5.1 COST CALCULATION

Small Manufacturer's Pricing Sheet				
1. Components	**Quantity**	**Cost**	**Total**	
Potentiometer	1.0000	€2.00	€ 4.00	
servo motor	2.0000	€ 8.00	€ 16.00	
PCI controller	1.0000	€1.00	€ 1.00	
Side view mirror	2.0000	€ 8.00	€16.00	
safety kit	1.0000	€65.00	€ 65.00	
Hydrophilic coating	1.0000	€ 5.00	€ 5.00	
Indirect costs (5% of all material)	components	5%	€5.30	
Components			€112.30	
2. LABOR	**Set Up (# of Min)**	**Run (# of Min)**	**Cost/Hour**	**Total**
Fitting	60	5.00	€10.00	€10.00
Labor				€10.00
			Subtotal	€20
			4. Price	€132.30

Figure 39 Cost calculation

6 DISCUSSION AND FUTURE IMPLEMENTATION

Simulation tool does once advanced modelling it is possible to check accuracy and repeatability of the system. From the above results, the position of the control system is relevant so that the side view mirror is moving with the desired rate of angle and it is concluded as it should not exceed more than the desired angle. From this, each part of the system has been studied, modelled and simulated, some simplification process also taken place in mirror angles. As a consequence, it is important to implement in real time vehicles by applying the rate of angles and sources. The simplification model from the designed thesis are to convert to machine language in order to implement in vehicles. However, the intelligent control system which done in this thesis work is good enough to apply in the real-time vehicle. As it contains electric parts only the potentiometer is added to the Steering wheel and control system to control the side view mirror.

CONCLUSION

Considering the results and the discussions made in this paper, the following conclusions are made,

- The split Side view mirror is designed in solid work as shown in the Figure 18.
- The camshaft is designed as shown in Figure 19 which is placed inside the split sideview mirror. The size of the shaft is 102.35mm because the size of the pivoting mirror is 43.9mm and its angle is 25°.
- The connecting motor is selected as servomotor because of its efficiency and power.
- The angles of the side view mirror for 540° steering rotation is 25°, for 432° rotation is 20°, for 324° is 15°, for 216° is 10° and for 108° is 5° which is calculated through the test taken manually which is explained in this thesis work through references.
- The control system for the mirror is simulated using proteas software for both side view mirror, left and right as shown in the figures 28 and 29 respectfully, the programme code for the software is in appendix.
- Cost is estimated for the whole system is 107€ excluding the fixing cost which proves to be more economical to install in all vehicles when compared to the latest gadgets.

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APPENDIX

```
#include<pic.h>

#include<htc.h>

#define _XTAL_FREQ 20000000

__CONFIG (FOSC_HS &WDTE_OFF &  PWRTE_ON & CP_OFF & BOREN_ON & LVP_OFF
& CPD_OFF);

void delay();

void delay1();

void delay4(int);

void lcd_data(unsigned char);

void lcd_com(unsigned char);

void comn_data(unsigned char,unsigned char*);

void lcd_init();

void adc1();

void adc2();

void val(unsigned int);

void vall(unsigned int);

#define lcd PORTB

#define rs RD6

#define en RD7

#define in1 RD0

#define input2 RD1

#define input3 RD2
```

```
#define m1 RD4

#define m2 RD5

int flag2,flag1,flag3;

unsigned int a,b,d1,d2,d3,d4,d,a1,b1,d11,d21,d31,d41;

void msdelay(unsigned int time)  // Function for creating delay in milliseconds.

{

   unsigned i,j ;

   for(i=0;i<time;i++)

   for(j=0;j<12;j++);

}

void main()

{

PORTB=0X00;

TRISB=0X00;

PORTD=0X00;

TRISD=0X00;

PORTC=0X00;

TRISC=0X80;

PORTA=0X00;

TRISA=0XFF;

CCP1CON=0x0c;

CCPR1L=0;
```

```
CCPR1H=0x00;
CCP2CON=0x0c;
CCPR2L=0;
CCPR2H=0x00;
INTCON=0xc0;
T2CON=0x06;
PR2=0xff;
TMR2=0x00;
//TMR1L=0x00;
//TMR1H=0x00;
//T1CON=0x03;
lcd_init();
while(1)
{
adc1();
adc2();
a1=(a/2);
b1=(b/2);
if(a<155)
{
CCPR1L=a1;
}
```

```
else
{
CCPR1L=-a1;
}
if(b<155)
{
in1=1;
CCPR2L=b1;
}
else
{
in1=0;
msdelay(500);
CCPR2L=-b1;
}
/*in1=1;
msdelay(b1/16);
in1=0;
msdelay(b1/16);
in1=1;
msdelay(b1/16);
in1=0;
```

```
msdelay(b1/16);
in1=1;
msdelay(b1/16);
in1=0;
msdelay(b1/16);
in1=1;
msdelay(b1/16);
in1=0;
msdelay(b1/16);
in1=1;
msdelay(b1/16);
in1=0;*/
PR2=0xff;
}
}
void adc1()
{
comn_data(0x80,"GAS  ");
ADRESH=0X00;
ADRESL=0X00;
ADCON0=0X81;
ADCON1=0X80;
```

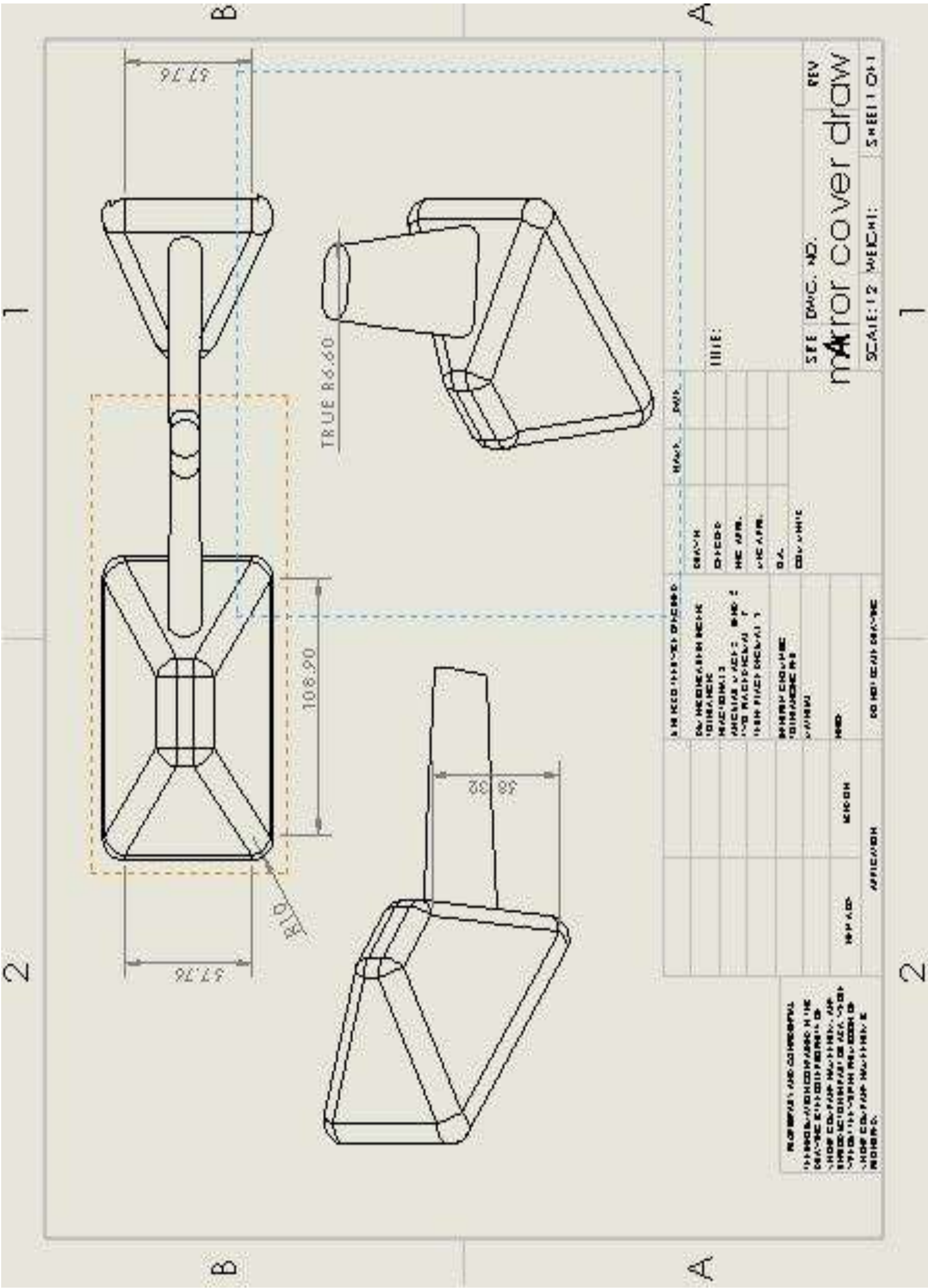
```
delay();

ADCON0=0X85;

while(ADCON0==0X85);

a=((ADRESH<<8)+ADRESL);

val(a);

}

void adc2()

{

comn_data(0x86,"CH4");

ADRESH=0X00;

ADRESL=0X00;

ADCON0=0X89;

ADCON1=0X80;

ADCON0=0X8d;

while(ADCON0==0X8d);

b=((ADRESH<<8)+ADRESL);

vall(b);

}

void lcd_init()

{

lcd_com(0x38);

lcd_com(0x0c);
```

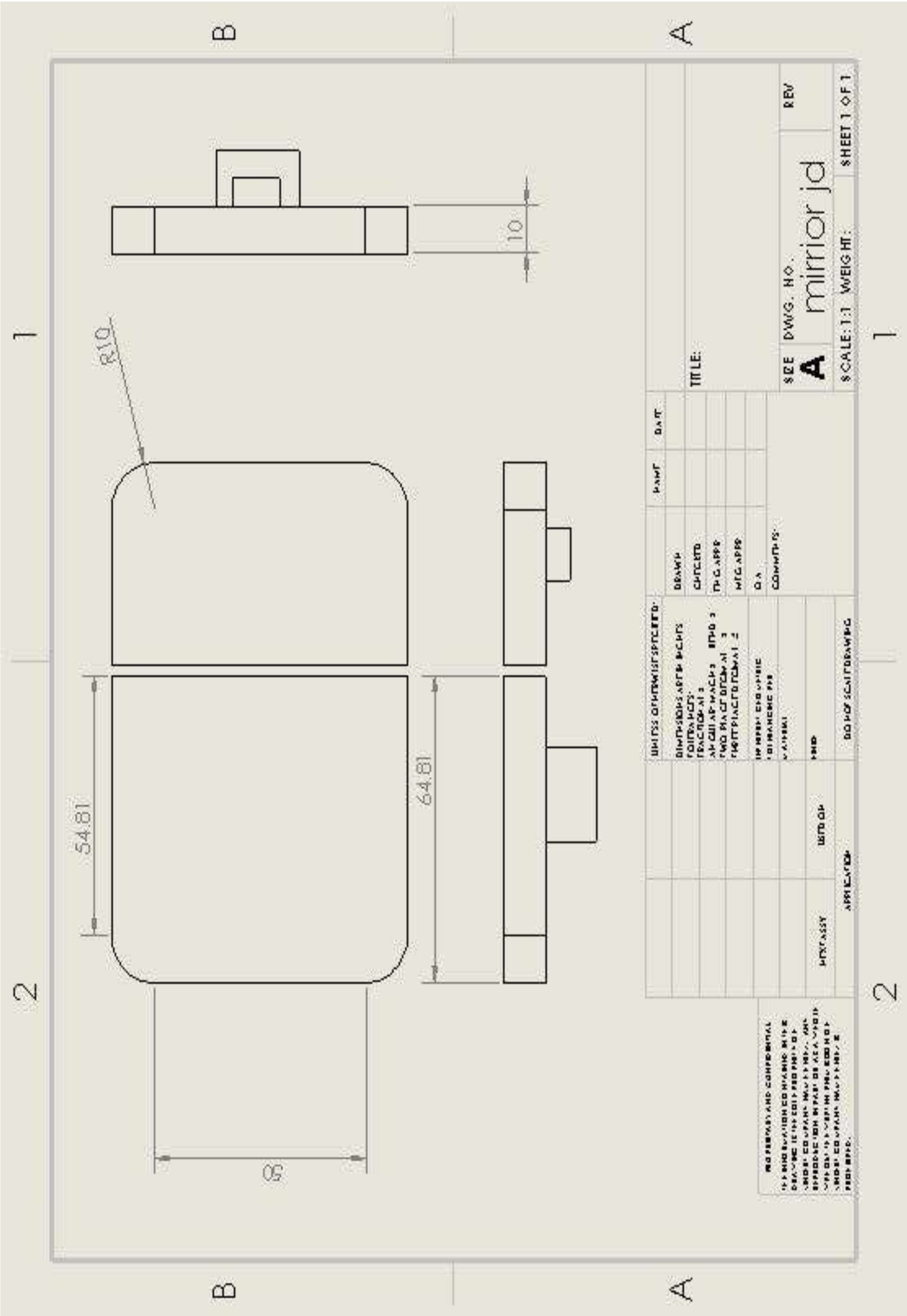
```
lcd_com(0x06);

lcd_com(0x80);

lcd_com(0x01);

}

void val(unsigned int re)

{

lcd_com(0xC0);

d1=(re/1000);

d2=((re-d1*1000)/100);

d3=((re-(d1*1000+d2*100))/10);

d4=(re-(d1*1000+d2*100+d3*10));

lcd_data(d1+0x30);

lcd_data(d2+0x30);

lcd_data(d3+0x30);

lcd_data(d4+0x30);

}

void vall(unsigned int ree)

{

d11=(ree/1000);

d21=((ree-d11*1000)/100);

d31=((ree-(d11*1000+d21*100))/10);

d41=(ree-(d11*1000+d21*100+d31*10));
```

```
//lcd_data(d11+0x30);
lcd_com(0xc6);
lcd_data(d21+0x30);
lcd_data(d31+0x30);
lcd_data(d41+0x30);
}

void lcd_com(unsigned char com)
{
lcd=com;
rs=0;
en=1;
delay();
en=0;
delay();
}
void lcd_data(unsigned char dat)
{
lcd=dat;
rs=1;
en=1;
delay();
```

```
en=0;
delay();
}
void comn_data(unsigned char com,unsigned char *dat)
{
lcd_com(com);
while(*dat)
{
lcd_data(*dat++);
}
}
void delay()
{
unsigned char i;
for(i=0;i<255;i++);
}
void delay1()
{
unsigned int i,j;
for(i=0;i<65535;i++);
}
void delay4(int z)
```

```
{
unsigned int i,j;
for(i=0;i<z;i++)
{
for(j=0;j<65535;j++);
}
}
```


57.76
TRUE R6.60
106.90
58.32
R10
57.76
DWG. NO.
mirror cover draw
SCALE: 1:2
WEIGHT:
SHEET 1 OF 1
REV
TITLE:


R10
54.81
64.81
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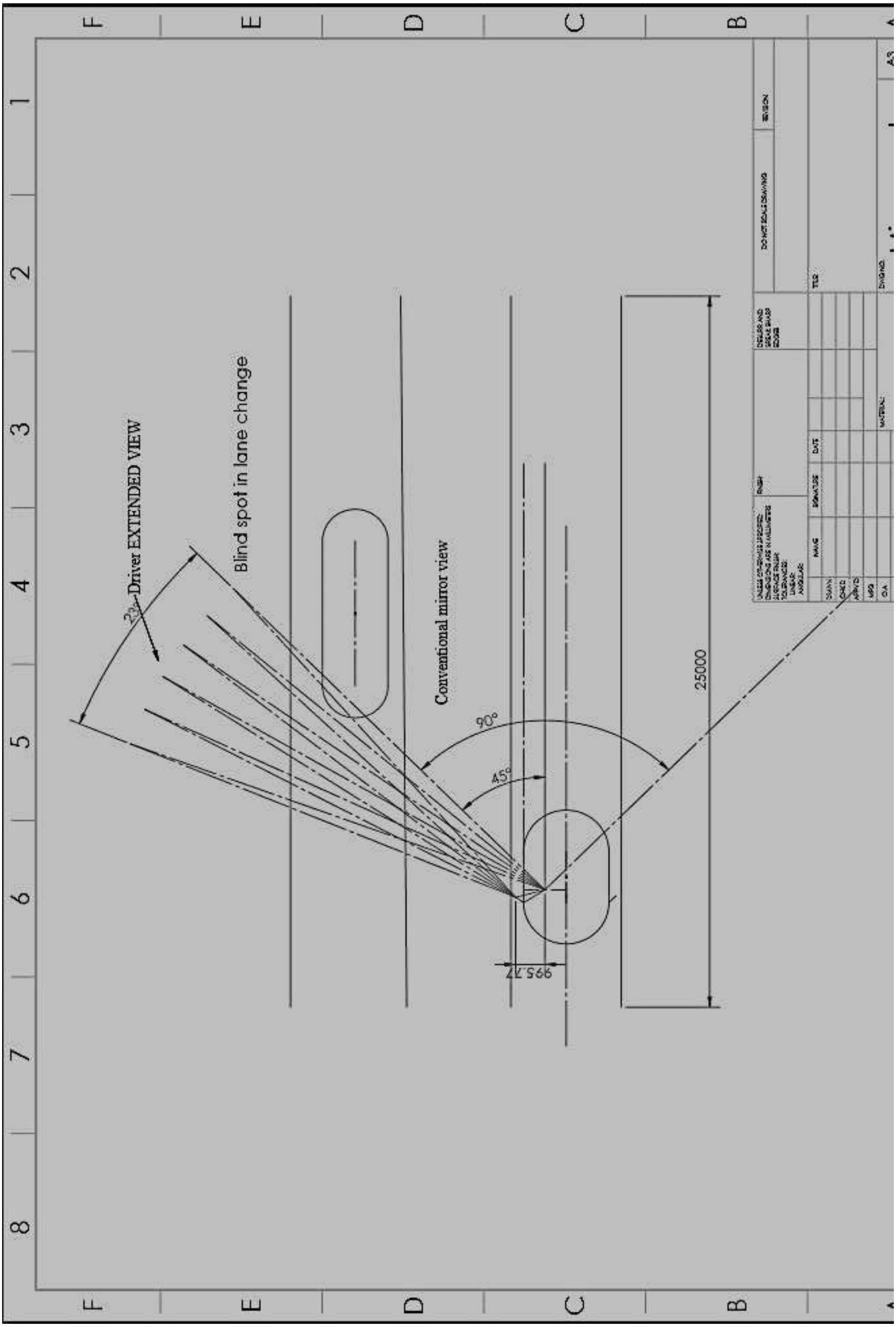
DWG. NO.
mirrior jd
SIZE
A
REV
SCALE: 1:1
WEIGHT:
SHEET 1 OF 1



23
Driver EXTENDED VIEW
Blind spot in lane change
Conventional mirror view
90°
45°
25000
995.77