Automatic Seatbelt

B. ARUN VIJAYAKUMAR[1], M.E., R. BALAJI[2], P. DHANUSHRAJ[3], P. INBARAJ[4]

[1] *Assistant Professor, Department of Electronics and Communication Engineering, Jeppiaar Engineering College, Chennai.*

[2, 3, 4] *Student, Department of Electronics and Communication Engineering, Jeppiaar Engineering College, Chennai.*

Abstract— The system consists of a ring gear setup which lies below the seat. The seat belt is mounted on the ring gear which is meshed with a pinion driven by a motor. Provisions are made to adjust the ring gear setup based on the position of the buckle which can be altered according to the convenience of the passenger. The ring gear is designed to follow maximum possible projectile to accommodate passengers of different size. Once the passenger occupies the seat, the motor is switched on in the forward direction. The belt is carried by the curved ring gear and locked with the buckle. Once the seat belt is locked with the buckle, the motor runs in the backward direction till the ring gear is brought back to its initial position. In the existing scenario of automatic seat belts, belts are attached to doors. A crash that causes the doors to open leaves the passenger unprotected. The foremost advantage of this type of automatic seat belt is that it is attached to a sturdier portion i.e. frame of the car instead of doors.

Indexed Terms—Automatic seatbelt lock mechanism, object detect using IR sensor, reduce automobile accident injuries, object recognition.

I. INTRODUCTION

Seats belts play a vital role in the safety of passengers. Seat belts are designed to keep the passengers from being thrown from the car. They are also designed to absorb the impact of a crash. Seat belts also stretch slightly so our body doesn't stop abruptly, and they prevent us from colliding with a part of the car or another person. Death as a result of ejection of unrestrained occupants from the vehicle is the major cause of fatalities in vehicle crashes. However, the importance of wearing a seat belt is often overlooked. An automatic seatbelt system can go a long way in ensuring usage of seatbelts. Automatic seat belts have been introduced as early as 1975 but there is no such arrangement in the industry at present. Such belts were discarded because of various disadvantages. Also it gets in the way of side curtain air bags.

Why passengers fail to use seat belt?
Major cause of fatalities in road is due to non-usage of seatbelt by passengers which can be attributed to various reasons like

- Carelessness and forgetfulness of the passengers.
- Absence of concrete legislative laws for wearing seat belts.
- Ignoring the importance of seat belts.

Manual lap belt with automatic motorized shoulder belt.
When the door is opened, the shoulder belt moves from a fixed point near the sat back on a track mounted in the door frame of the car to a point at the other end of the track near the windshield. Once the door is closed and the car is started, the belt moves rearward along the track to its original position, thus securing the passenger. The lap belt must be fastened manually. Manual lap belt with automatic non-motorized shoulder belt this system was used in American-market vehicles such as the Hyundai excel and Volkswagen Jetta. The shoulder belt is fixed to the aft upper corner of the vehicle door, and is not motorized. The lap belt must be fastened manually.

II. LITERATURE SURVEY

1. Study on automatic seatbelt applying device
Authors: Ooka m, Sugiura F
Year: October 22,1974
Where the seat belt is fastened over the occupant automatically in correspondence with opening or closing of the door of a vehicle. A conventional seat

belt guide rail is arranged to form a virtually linear line along a diagonal connecting the lower section in the rear on the internal surface of a door.

2.Study on proposed automatic seatbelt
Authors: Masaharu Saji, KamiMigusa
Year: August 21, 1990
Lap seat belt and shoulder seat belt are automatically set to restrain a seated person end of each belt is in a guide ran diagonally disposed on the inner surface of the door.

Second ends of the belts are on the inner side of the bottom seat and on the inner side of the seat back respectively. Jesse R. Hollins proposed automatic seatbelt buckle and unlatching mechanism on June 15, 1976 and a seat belt buckle automatic unlatching mechanism including a seat belt arrangement comprised of a first seat belt strap and a second seat belt strap.

Attached to one end of the first seat belt strap is a latching tongue and attached to one end of the second seat belt strap is a tongue latching mechanism. Chris Lee, discussed Analysis of injury severity of drivers involved in single and two-vehicle crashes on highways in Ontario on 1st February 2014.

This study analyzed driver's injury severity in single and two-vehicle crashes using the 5-year crash records in Ontario, Canada. To account for variations in unobserved effects of variables on injury severity among observations, Heteroscedastic Ordered Logit (HOL) models were developed for identifying the association between injury severity and explanatory variables.

For two-vehicle crashes, crash records were separated into nine data sets of different combinations of vehicle types considering the differential impacts of the collision on vehicles due to difference in their size and weight. Vehicles were classified into cars, light trucks, and heavy trucks.

III. PROPOSED SYSTEM

Existing system
Active Seatbelt Systems

The Active Buckle Lifter (ABL) makes buckling the seat belt easier and more convenient by electrically lifting the seat belt buckle.

The ABL lifts the buckle past the center console between the seats, and beyond the jacket or other objects that can hide the buckle. The more "reachable," ABL can assist elderly or other occupants with reduced mobility due to health/disability challenges.

During dynamic maneuvers the ABL acts as a reversible buckle pre-tensioner and adjusts the seat belt slack to better position occupants in their seats. This pre-pre-tensioning can be activated using data from active safety systems, such as ESC and BAS, as well as environmental sensor.

Active seatbelt systems utilize a motor that retracts seat belt webbing in critical situations before a crash occurs.

The active seat belt can be activated using data from active safety systems, such as the Electronic Stability Control or Brake Assist systems. It can also be triggered by data from environmental sensors, such as radar that provides the relative speed and distance to the vehicles ahead.

Once activated, it puts front seat occupants in a better position by keeping them more snug to the seat and lessening the forward movement of the body and is a great example of the integration of active and passive safety systems.

Proposed design
The linear actuator on its extension brings the belt forward along with the clip. Now the linear actuator 2 whish is attached to the bottom left of the seat and which holds the locking part extends upwards for the capturing of the clip. Hence now all mechanisms ends up with their zero position and so the seat belt is locked.

Fig 3.1 View of normal seat belt

IV.   BLOCK DIAGRAM OF DESIGNED SYSTEM

In the proposed system, the button is activated by a person sits on the car, belt extender and linear actuator 1 runs forward simultaneously after few seconds angular shifter and linear actuator 2 also runs forward making the clip gets locked. When the switch 2 is activated after the lock, linear actuator 1 & 2 and angular shifter runs in the reverse direction to make the set go to its initial position. Fig 3.1 shown below describes the block diagram of the designed system.
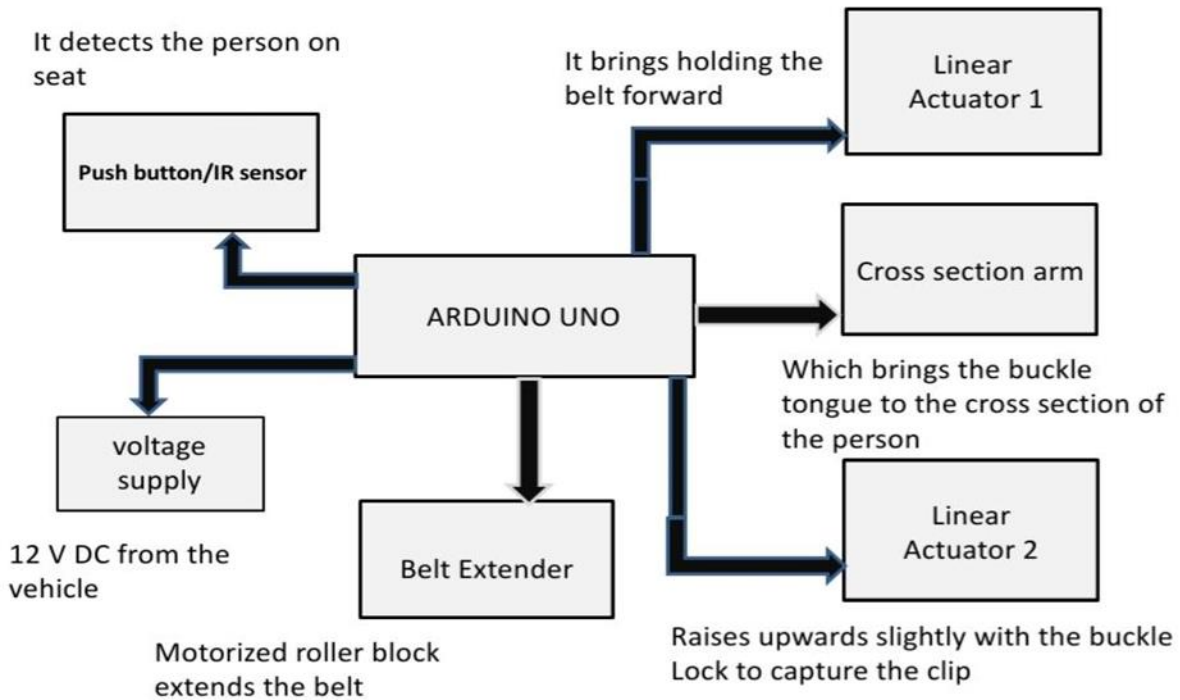
- Design of Linear actuator

A linear actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor. Fig 3.2 shows the design of main linear actuator

Fig 3.2 linear actuator

- Design of Belt Extender

A Belt extender is a motorized roller design which is connected to a DC motor for its forward and reverse

run as needed. Fig 3.3 shows the picture of belt extender

The belt extender extends the belt from its roll with spring action of its own. This mechanism helps both the primary linear actuator on bringing the belt forward and across section for locking One of the roller in Extender is connected to the knob of a servo motor for the push and pull of the roller to tighten the belt for outer push and loosen the roller for belt to roll back itself. Fig 3.6 shows the roller of the extender.
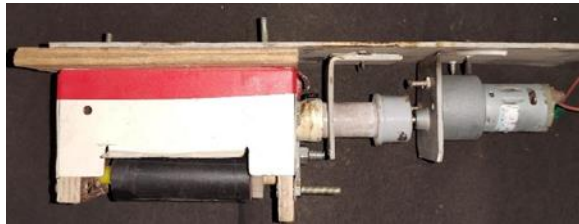

Fig 3.3 belt extender

- Design of Handrest Lock

The hand rest of the seat is attached with the seatbelt lock part on its arm and the handrest raises and lowers with motor action attached to it.

Fig 3.4 Handrest with buckle lock

- Working of IR Sensor

An IR sensor is a device which detects IR radiation falling on it. There are numerous types of IR sensors that are built and can be built depending on the application. Proximity sensors (Used in Touch Screen phones and Edge Avoiding Robots), contrast sensors (Used in Line Following Robots) and obstruction counters/sensors (Used for counting goods and in Burglar Alarms) are some examples, which use IR sensors. Fig 3.11 shows IR sensor module used
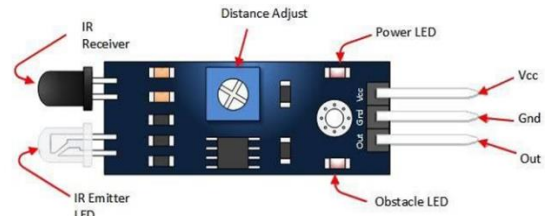

Fig 3.5:IR sensor

An IR sensor is basically a device which consists of a pair of an IR LED and a photodiode which are collectively called a photo-coupler or an op to coupler.

The IR LED emits IR radiation, reception and/or intensity of reception of which by the photodiode dictates the output of the sensor. Now, there are so many ways by which the radiation may or may not be able to reach the photo diode. Fig 3.6 shows the circuit diagram of IR sensor
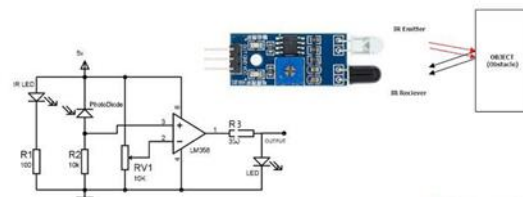

Fig 3.6 Curcuit Diagram of IR Sensor

- ULN2003 Relay Driver

The circuit used for driving a relay can be termed as a relay driver circuit and it can be designed using various integrated circuits. These relays are needed to be driven for activating or to turn ON. So, relays require some driver circuitry to turn ON or OFF (based on the requirement). The relay driver circuit can be realized using different integrated circuits such as ULN2003, CS1107, MAX4896, FAN3240, A2550, and so on. Here, in this article let us discuss about relay driver circuit using ULN2003. Before discussing in detail about a relay driver circuit, let us know about IC ULN2003.

Relay Driver IC ULN2003 Internal Schematic Diagram

The pin diagram of IC ULN2003A is shown in the above figure which consists of 16 pins. The IC ULN2003A comprises of 7-NPN Darlington pairs as shown in the internal schematic diagram and is

typically used to switch inductive loads (dissipates voltage spikes if any using suppression diode) and to drive stepper motors. Fig 3.13 shows the circuit diagram of ULN2003 relay driver
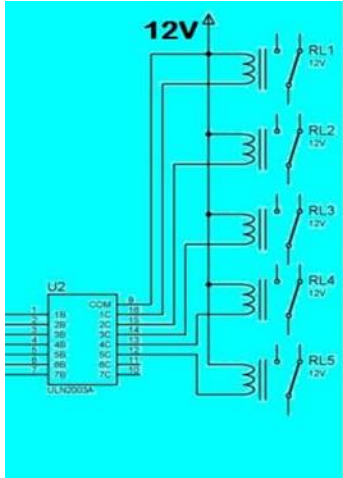

Fig 3.7 circuit diagram of Relay Driver

- Arduino UNO

Arduino Uno consists of 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button

Power Jack: Arduino can be powered either from the pc through a USB or through external source like adaptor or a battery. It can operate on an external supply of 7 to 12V. Power can be applied externally through the pin Vin or by giving voltage reference through the IORef pin. Fig 3.14 shows the Arduino microcontroller
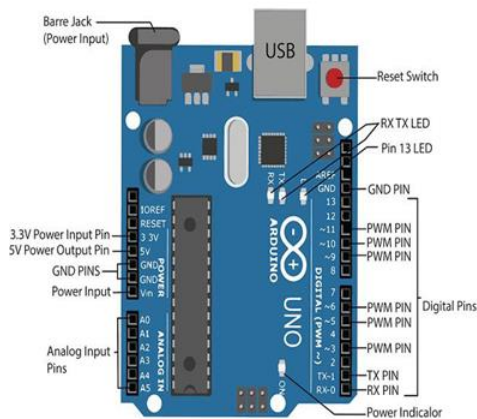
Digital Inputs: It consists of 14 digital inputs/output pins, each of which provide or take up 40mA current. Some of them have special functions like pins 0 and 1, which act as Rx and Tx pins 3,5,6,9,11 which provides pwm output and pin 13 where LED is connected.

Analog inputs: It has 6 analog input/output pins, each providing a resolution of 10 bits.
ARef: It provides reference to the analog inputs Reset: It resets the microcontroller when low.

- HARDWARE DESCRIPTION

When a person sits on the seat , Sensor gives the output to the microcontroller and the buzzer sounds for 2 seconds indicating the process is to begin , firstly the servo motor that is attached to the extander gets activated and tightens the roller of the extender and then both the belt extender and linear actuator moves forward for certain time as given in the program and followed by the cross section arm that carries the belt clip activates and also gradually the handrest set raises with the lock reaches the height for the clip to get locked . After the process gets over and the clip gets locked , The handrest set lowers down making the lock to position where it should be normally and then other reverse program begins for all the hardware unit to get to its initial position and hence the belt remains locked with the body of the person

Thus the process lines up and works as per the timings feed for respective part Fig. 3.9 shows the work flow .

Fig 3.8: Arduino UNO microcontroller
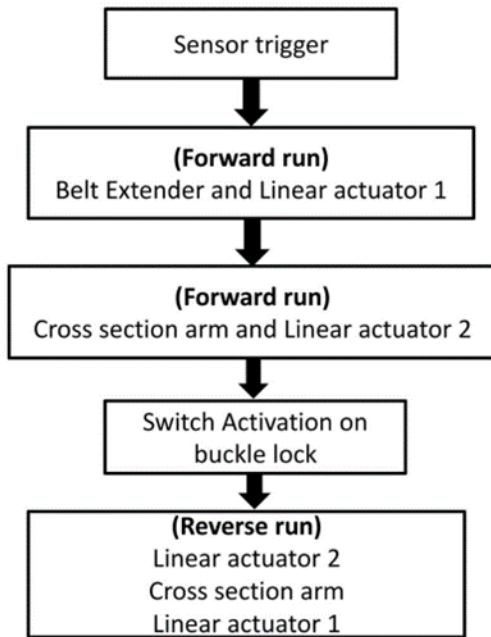
WORK FLOW

Fig 3.9 Working Flow Chart

V.   RESULT AND DISCUSSION

The initial position from which the process begins, with each of the steps given.

Once all the process for locking is done and the clip is locked all the steps reversed to make the hardware unit to get to its initial position Figs 4.1, 4.2, 4.3 Shows the working steps of the hardware process.

Fig 4.1: Working of Linear actuator

Fig 4.2: Working of Single scissor mechanism

Fig 4.3: Working of Arm

- CIRCUIT SUMMARY

For the circuit the microcontroller used is Arduino UNO connected with four of motor driver circuit to all its pin connections. Infra-red sensor is used for the detection and to begin the program. Fig 4.4 shows the block diagram of the circuit

ULN2003 relay driver for motors are activated, after the lock process is done servo motor runs for the given degree and followed by reverse program feed into the circuit and ends. Fig 4.5shows the circuit module
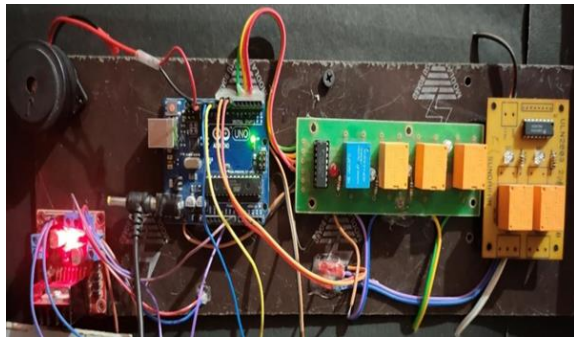

Fig 4.4: Block diagram of Circuit

Fig 4.5: Working module of Circuit

4.1 HARDWARE RESULTS

When the program starts servo motor tightens the Extender roller together for a constant belt push ,
Seat Belt is being taken form its initial position by the hardware design, the clip is moved to cross section from right to left of the driver and gets locked to the lock set which is attached and raised by the hand rest design. Every set returns to its initial position after the process and good to go.

VI. CONCLUSION AND FUTURE SCOPE

CONCLUSION
Occupant safety has been a subject of intense debate for nearly as long as automobiles have been on the roads. Seatbelts, credited with being the most important and effective safety feature currently available in cars, have been both a point of contention among and a focal point of efforts undertaken by advocates, manufacturers, and government in improving traffic safety.

FUTURE SCOPE
Sleek model for the Structure will be made.
Full set Adjustments should change for various vehicle interior measurements accordingly .
Lock will be installed on a Hand rest setup.
Motor speed control for personal convenience should be made.

REFERENCES

[1] Nissan Motor (Oct 28, 1975), "Passive seat belt arrangement for automotive vehicles" Publication date- Jul 22, 1980. Patent No: US4213637.

[2] Juichiro Takada, "Movable inboard belt guide for use in passive vehicle occupant restraint system" Publication date – Mar 2, 1982. Patent No: US 4258933.

[3] Toyota- Jidosha, KogyoKabushiki ,"Automatic seatbelt system" Publication date: Feb 15, 1983. Patent No: US4372580.

[4] Nissan motor co. Ltd, "Seatbelt device for an automotive seat occupant" Publication date: Sep 20, 1983. Patent No: US4413841.

[5] Honda - *Giken Kogyo*and *Kabushiki Kaisha*"Seatbelt device" Publication date: Jan 13, 1987. US4635963.

[6] John Barker, "Safety enhancement for a safety belt" Publication date: Apr 29, 2014. Patent No: US8708370.

[7] AsmoCo,Ltd , "Auxiliary mechanism for seat belt apparatus" Publication date: Jul 19, 2011. Patent No: US7980635.

[8] Michael Bouju," Seat belt security release mechanism" Publication date: Sep 20, 1977. Patent No: US4049293.

[9] GeorgeCoulombe,"Automatic releasing seat belt" Publication date: Jul 31, 1979, Patent No: US4162715.

[10] Nippon Soken , "Automobile seat belt system with automatic unlocking function" Published date: Nov 19, 1985. Patent No: US4553625.

[11] Fleming JosepA, "Thermally actuated seat belt fastener" Publication date: Dec 19, 1987. Patent No: US4715096.

[12] MeckewJames,"Automatic time-delayed release buckle" Publication date: Mar 14, 1991. Patent No:US5014810.

[13] Wesley T, Leedy" Automatic restraint belt release system" Publication date: Nov 26, 2013. Patent No:US8590935.

[14] Bilyeu&Dant, "Child-proof seat belt locking assembly" Publication date: May 12, 1998. Patent No: US5749130.

[15] Tk Holdings Inc," Remotely actuated seat belt buckle" Publication date: Aug 14, 2012. Patent No: US7905789.

[16] GavriHerzl , "A self-releasable safety belt" Publication date: Dec 12, 1996. Patent No: WO1996039316A1.

[17] BayerischeMotorenWerkeAg,"Safety-belt buckle in a motor vehicle" Publication date: Dec 28, 1989. Patent No: DE3821066A1.

[18] Trw Inc., "Seat belt tightening apparatus" Publication date: Apr 10, 2001. Patent No: US6213512.

[19] Joseph A Tabe, "Smart seatbelt control system" publication date: Nov 4, 1999. Patent No: WO19999055560A1.

[20] Daimler Chrysler Ag, "Motor vehicle comprising means for vehicle occupants" publication date: Oct 27, 2005.Patent No: WO2005100102A1.

[21] Hughes A, "Compulsory seat belts" Publication date: Jun 4, 1974. Patent No: US3815086.

[22] Lindblad O L has published a patent of "Safety belt arrangement for individuals" Publication date: Dec 23, 1975. Patent No: US3927902