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IMPLEMENTATION OF COST EFFECTIVE REMOTE CONTROLLED ARTIFICIAL DRIVERLESS AUTOMOBILE

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ABSTRACT

Everyone in this world likes to make life easy. Research is being carried out in producing eco-friendly and user-friendly sophisticated vehicles. Eco-friendly vehicles will reduce pollution. Gasoline vehicles, Electric motor vehicles, Hybrid vehicles, solar vehicles and fuel cell vehicles are some examples of eco-friendly vehicles. User-friendly sophisticated vehicles are those that aim at improving the vehicle standard by providing luxury features like Auto transmission, Auto brakes, Auto clutch, Clutch lock, Power window, remote start, Climate sensor, Global positioning system, Drive by wire and many more. A new theme of Driverless riding has fascinated researchers that many concepts are being tried out for the same. At present Driverless vehicles designed by some leading companies, have the problem that the entire road has to be fitted with sensors. This requires very high investment and takes a long time for implementation. In our proposal, we attempt a mechanism of Artificial Driver Agent (ADA) for vehicle that can use the existing roads without any modification and cost effective.

Keywords: driverless riding, artificial driver agent, auto transmission, user-friendly sophisticated vehicles.

1. INTRODUCTION

Our proposal deals with controlling ADA driving automobile from a remote location. The human driver is not present in the automobile; instead, he is in the controlling Centre from where he controls the automobile by means of Wireless communication [1]. Here automobile is modified for this purpose and made to run on the existing roads. Online Human- Automobile Interface (OHAI): The OHAI could be one of the most ambiguous systems within a Driverless car. The OHAI refers to the arrangement of systems including the entertainment and infotainment system in the interior of the vehicle [2] Component panel, and controls that act as abridge between the automobile and the human. The OHAI in an independent automobile will be distinguishing from that of an ordinary automobile today. The preference for the OHAI will move away the controls from inside of an automobile to a remote location and toward infotainment and safety journey [3]. Though, the OHAI needs to be conscious of the interior environment and component of the car. In exceptional cases, like emergency situations the automobile may need to alert the passengers that it needs to be manually controlled. The OHAI is likely to be comprised of cameras, monitors and various control units. The driver in the controlling centre views the road traffic in a monitor, which is transmitted from the automobile. Then he controls the automobile by pressing the respective control switches, just like playing a video game [4]. These control signals are transmitted to the automobile. The microprocessor present inside it rotates the appropriate motor thus controlling the required control.

The video signals are transmitted from the automobile to the controlling centre and the control signals are transmitted from controlling centre to the automobile. Thus the automobile can be controlled from a remote place.

The functional implementation Controlling mechanism of our proposal to achieve the objective is described with help of the Figure-1.

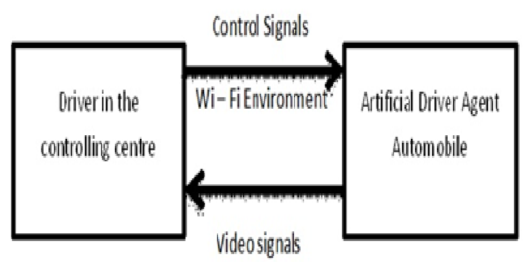

Figure-1. Overview of controlling mechanism on ADA automobile.

The overview diagram consists of three sections.

a) Wi-Fi environment
b) Artificial Diver Agent Automobile
c) Controlling Centre

The communication between the automobile and the controlling centre is made through Wi-Fi Technologies. Three types of signals are to be transmitted between the automobile and the controlling centre. They are video signals, audio signal and control signals.

Video signals: These represent the entire view of the road traffic, which is necessary for controlling the automobile. The video signals are taken from the video camera presented in the automobile. The bandwidth for the monochrome video signal is 1.5 Mhz. This video signal is transmitted and received by wireless video equipment's.

Audio signals: These represent the audio external and internal to the automobile .External audio is the sound from other automobile. External audio is the sound from other automobiles. This includes horn sound, other automobile sound and warning sound signals. Internal audio is the speech signal of the passengers. These are captured by the microphone present in the video camera and are transmitted using the wireless equipment's.

Control signals: These represent the signals for various controls of the automobile. Oscillator present in the controlling centre generates, transmits and receives CB radio signals.

Artificial driver agent Automobile: These represent the automobile with our controlling system consist of equipments for capturing and transmitting video and audio signals. And equipments for receiving and processing control signals.

2. LITERATURE SURVEY

The motivation to build a safe and automated - driving automobile based on the fact, Google has already logged more than 200,000 miles in a fleet of self-driving cars retrofitted with sensors [5]. And not only Google other established automobile manufacturers and suppliers have also developed automated driving functionality using sensor-based solutions and have a host of new applications in the pipeline. Concurrently, some organizations, including high-tech companies and automotive, have been paying attention on the potential for using automated vehicle connected communication technologies for traffic management and collision avoidance. While termed "driverless," the vehicles are better classified as driver-optional, particularly under NHTSA Levels 2 and 3 of automated driving, where human operators are expected to have either primary or secondary control responsibilities. Although such vehicles are supposedly capable of driving through any traffic situation without requiring a human driver to apply pressure to the pedals, shifting, or steering, this driver may still choose to do so and may play a role in avoiding accidents. Google readily admits that, while testing, there remains a safety driver and a software operator in the vehicle at all times in the case of near accidents or software failures. Rather than the technology itself, we believe most of the concerns or obstacles to mass adoption of autonomous vehicles are largely practical or procedural in nature. What's more, these issues appear relatively easy to solve and we have suggested our own likely solutions to a number of the most pressing issues. In general, the research community agrees that human attention is a limited resource to be allocated, and that the human brain requires some level of stimulus to keep its attention and performance high. Lacking this input, they seek it elsewhere, leaving them susceptible to distraction either by external stimuli or by the wrong information. This means that operators may miss important cues from the automation or from the environment (Eastern Flight 401), or may see the cues but may not have all the appropriate information required to make a correct decision (Air France 447), or use their spare capacity to engage in distracting activities leading to a loss in situational awareness (Northwest 188). They might also enter a state of "mode confusion," where the operator makes decisions believing that the system is in a different state than it currently in [6] [7].

Volkswagen and a research team from Stanford University have created a driverless Audi sports car, which has been zipping around US race tracks [8].

The number of electronics in cars is increasing rapidly: the auto industry has the highest projected CAGR of any semiconductor market over the next five years. Much of the differentiation in the autonomous vehicle industry will come from the sophistication of the sensors, positioning systems, and software. The software will require more and more computing capacity. Additionally, passengers will desire more options for entertainment and productivity while their cars drive themselves.

Google's self-driving car uses Velodyne LIDAR to electronically "see" the environment. HDL-64E and HDL-32E modules use an array of either 64 or 32 lasers. On Google's car, the module is set inside a rotating drum. Its lasers complement Google's own mapping software and GPS data, which help orient the car on the road. The LIDAR provides additional positional data, but also identifies other cars, bicycles, pedestrians, and road hazards.

Autonomous cars bring obvious social benefits-fewer (if any) road accidents, reduced traffic congestion, higher occupant productivity, fuel savings, and many, many more. However, while the social benefits may be nice, autonomous vehicles need to generate a real economic return for both the consumers paying for the technology as well as the industry/governments that will invest billions of dollars in developing it. Happily, though, the economic benefits of these social gains promise to be great [9]. We have made a high-level attempt to quantify these gains-we believe the US economy can save $1.3 trillion per year, once autonomous cars become fully penetrated [10]. To put that number in context, it represents 8% of US GDP. Extrapolating these savings to a global level by applying the ratio of US savings / US GDP to global GDP, we estimate global savings from autonomous vehicles to be in the region of $5.6 trillion per year. We believe the promise of achieving this level of savings will compel the penetration of autonomous capability in vehicles [11], at a pace quicker than natural demand pull [12].

3. COST EFFECTIVE ARCHITECTURE OF ADA AUTOMOBILE

The equipment present in the automobile can be functionally classified into two modules. First one for capturing and transmitting video and audio signals and second module for receiving and processing control signals. Equipments for capturing and transmitting video and audio signals are as follows: two video cameras are fixed in the automobile, one is external and other is internal to the automobile. Among the two video cameras one is stationary for capturing front view and other one can be rotated to any required angle of view. The captured video signals are transmitted to the controlling centre by means of Wi-Fi video transmitter. Each video camera contains a microphone for capturing the audio signals. The external video camera captures the audio external to the automobile like horn sound from other automobiles. The internal video camera captures audio internal to the automobile on demand, that is, whenever the passengers want to communicate with the driver in the controlling centre.

Before going to the receiving and processing of the control signals in the automobile let us view the design of the cost effective Architecture of our proposed system using Figure-2 and Figure-3.

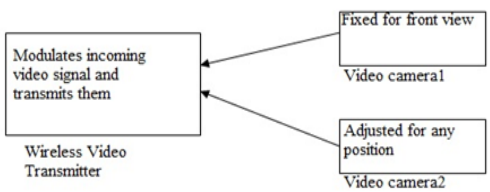

Figure-2. Transmitting video signals in ada automobile.

The transmitted modulated signal is received by the CB radio receiver which is placed inside the automobile this CB radio receiver does the process of demodulation and reproduces the transmitted control signal. This is given as input to the circuit, which distinguishes control signals. Then this distinguished control signal is given as input to the microprocessor through programmable peripheral Interface 8255.

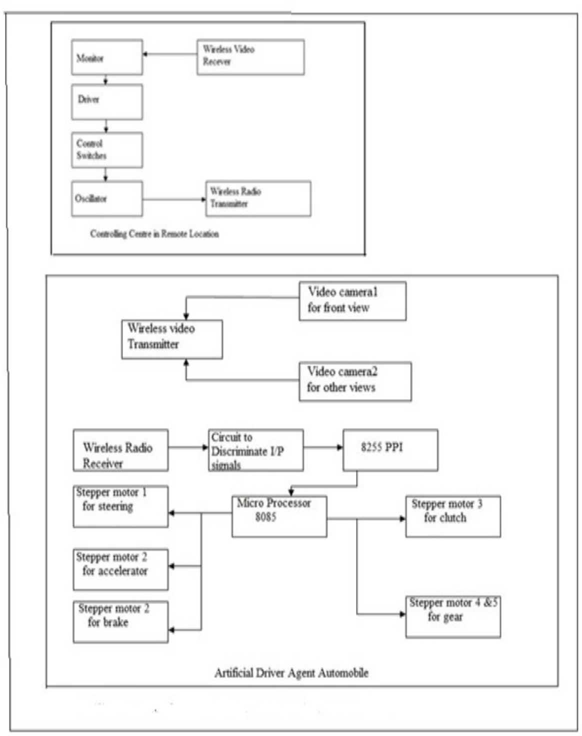

Figure-3. Cost effective architecture of proposed system (CAP).

4. MATERIALS AND METHODOLOGY

Controlling centre: This is the place from where the automobiles are controlled. This is in the remote location from the automobile and driver is present here. The equipments that are present inside the controlling centre are wireless video receiver, display unit, control switches, oscillator and wireless transmitter. All transmitted video signals from the automobile are received in the controlling centre with the help of wireless video receiver and displayed onmonitor. The driver in the controlling centre monitors the video and controls the automobile just like playing a video game. He controls the automobile by pressing the control switches which are allotted for each and every control. Different switches are used to perform different controls. When a switch is pressed a unique signal of predetermined frequency and amplitude is generated by the oscillator and the same is transmitted to the automobile by means of wireless radio transmitter this is shown in Figure-4.

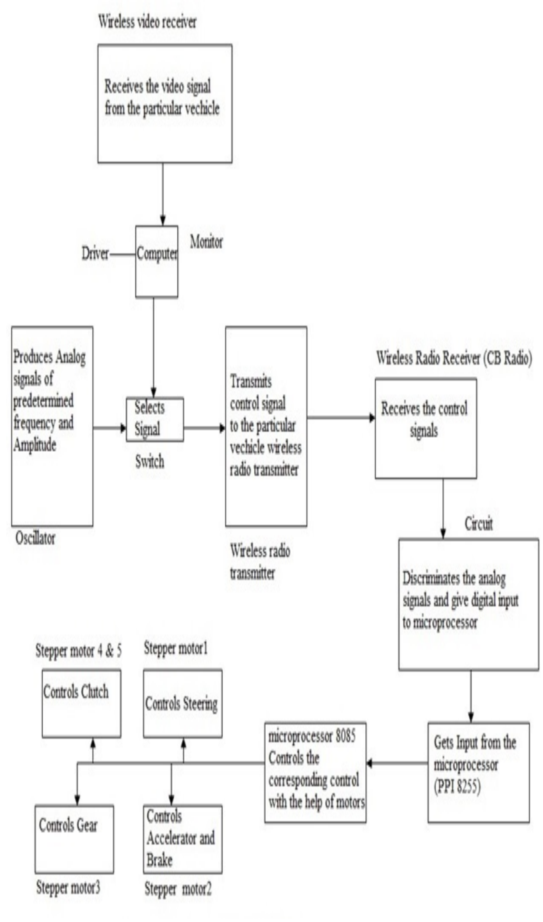

Figure-4. Devices used in controlling centre.

Circuit to distinguish control signals: The received control signal is of AC form. The AC signal is converted into DC signal by means of a bridge rectifier shown in Figure-5. The DC output from the bridge

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rectifier is given as input to two comparators (C1 & C2). Among the two, one has the reference voltage level of t 3 volts and the second has the reference voltage level of 6 volts. When the incoming signal is lesser than the reference voltage the output from the comparator is low. When it is greater than the reference voltage the output will be high. Now let us see the steering control (left turn and right turn) alone. The DC output from the bridge rectifier may be.

a) Less than 3 volts: In this case no signal is received in the automobile and the output from bridge rectifier is due to noise. Here the output of C1 and C2 is low or zero.
b) More than 3 volts but less than 6 volts: Here the output of C1 is high and output of C2 is low.
c) More than 6 volts: Here the output of C1 is high and the output of C2 is also high.

The output from comparators C1 and C2 are given as input to the AND gate and EX-OR gate.
Input to AND gate in this case:

Table-1. Output of AND gate for different Comparator outputs.

Input1 from (C1)	Input2 from (C2)	Output
Low	Low	Low
High	Low	Low
High	High	High

Then the output of the AND gate is given to 8255.
Input to EX-OR gate in this case:

Table-2. Output of EX-OR gate for different Comparator outputs.

Input1 from (C1)	Input2 from (C2)	Output
Low	Low	Low
High	Low	High
High	High	Low

There are two inputs given to 8255PPI. One is AND gate o/p and another is EX-OR gate o/p.

From the above cases which is represented in Table-1 and Table-2:

a) The AND gate o/p is low and EX-OR gate o/p is also low, thus the PPI makes both inputs low for the microprocessor.
b) The AND gate o/p is low and EX-OR gate o/p is high, thus the PPI makes one input high and other low for the microprocessor.
c) The AND gate o/p high and EX-OR gate o/p is low, thus the PPI gives the inverse of the previous input to the microprocessor.

Table-3. Direction of stepper motor for steering.

First input to the PPI 8255	Second input to the PPI 8255	Direction of stepper motor rotation
Low	High	Right
High	Low	Left

According to the type of the input from the 8255 PPI shown in table 3 the microprocessor calls and executes the subroutine to turn the corresponding motor either clockwise or anti clockwise in stepwise or continuous rotation for the particular control. More than one motor can interfaced with a microprocessor for the different controls and control circuit shown in Table-6.

Here we used Bridge rectifier circuit to convert square wave into DC.

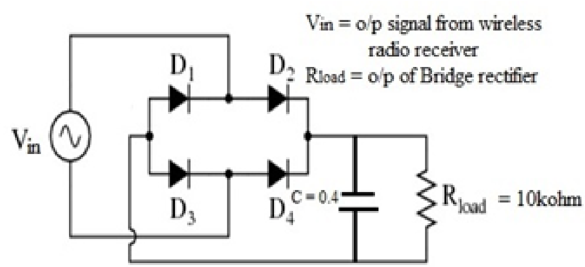

Figure-5. Bridge rectifier circuit for convert Square wave into DC.

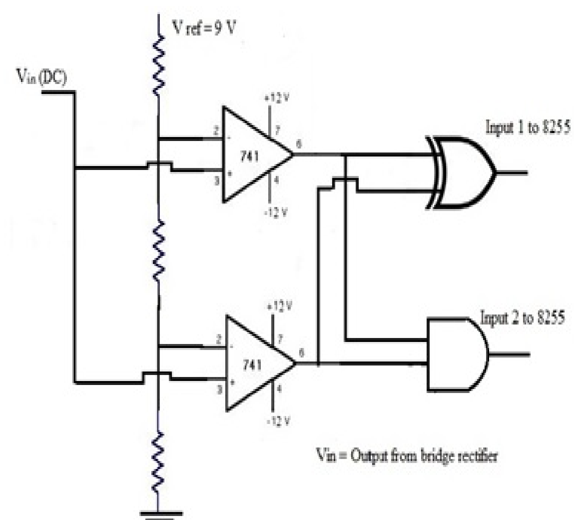

Figure-6. Circuit of distinguish control signals.

Types of controls and implementation

There are different types of controls in the automobile. They are classified into two types.

a) Basic Controls: In order to move the automobile the following controls are to be used. Steering Control, Accelerator control, Brake Control, Clutch Control

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and Gear Control. These controls are declared as basic controls because they are to be controlled necessarily. These are Mechanical controls, while all other controls are electrical controls.

b) Electric controls or non essential controls: The controls other than these five basic controls are all electric controls: for example wiper, head light, indicators and horn.

These controls can be controlled by using electric signals as they does not require the movement of mechanical parts as in previous basic controls.

Now let us see how these basic controls are controlled one by one.

Steering control: The steering of the automobile controls the direction in which the automobile moves. Thus it is one of the most important controls. Mechanism behind the steering has to be turned is as follows; Generally the direction of the automobile can be controlled by turning the steering wheel either right or left. Thus the motion required in this control is an angular motion. The motor also posses angular motion, so that it can be directly connected steering column.

There are two types of fixing motor to the automobile:

a) In between the steering wheel and the steering rod a high torque motor is fixed. Two joints one for connecting motor and steering rod another for connecting motor and steering wheel.
b) Here a gear is fixed between the steering wheel and steering rod. The mating gear for this particular gear is fixed on the motor shaft. So that whenever the motor rotates the steering action is performed. By using method we can use motor of less torque, but the designing becomes a bit complex.

Generally the steering column (for a power steering) when turned by hand requires torque of 2kgcm. But the torque required at the centre of the steering rod as high. The torque required at the centre of steering wheel of automobile comes about 36kgcm. This is the average value of torque found required for all power steering automobiles shown in figure 7. The calculation is as follows;

The motor is selected with torque higher than the required torque (36kgcm) say 40kgcm. There may be some loses while transferring the torque to the steering rod. So the motor is selected with slightly high torque than required.

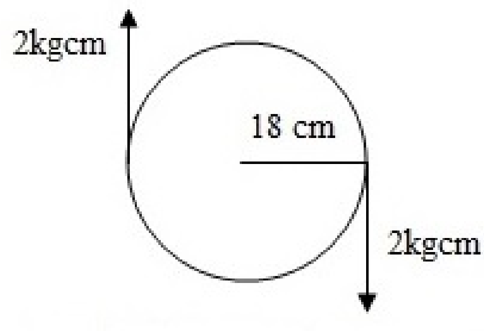

Figure-7. Top view steering wheel.

Radius of steering wheel = 18 cm
Torque at outer edge of the steering wheel=2kgcm
Torque at centre of the steering wheel = centrifugal Torque of the steering wheel x radius of the steering wheel
Therefore Torque at centre = 2 x 18 = 36 kgcm.

By turning the motor clockwise or anticlockwise steering rod can be turned accordingly left or right. The motors are made to rotate with the help of a microprocessor. Here we are using 8085 microprocessor to turn the motor. The motor is interfaced with the processor by means of interfacing cards. The motor is programmed for 4 conditions.

a) To turn stepwise right.
b) To turn stepwise left.
c) Predefined or continuous turn for some angle (say 45/90 degree) in left.
d) Predefined or continuous turn for some angle (say 45/90 degree) in right.

The desired controls are selected according to the requirement when being driven on existing roads. The programming in the motor is given in the later section. All these above mentioned 4 controls are allotted for controlling the steering part.

Accelerator and brake control: The accelerator present in the automobile is used to accelerate the speed of the automobile as required. The brake which is present to the left of accelerator is used to decelerate the speed or to stop the automobile as desired [13]. To control both these controls we are using a single stepper motor. When we drive the automobile manually we use the same leg to control both these controls. Thus we can control these by using a single motor. Here both these controls require only linear motion, that is, to be moved forward and backward. But in our case the motor which we use provides only circular motion. So to convert the angular motion of the stepper motor into linear motion we are attaching a shaft which is connected perpendicular to the stepper motor. To control both these controls by using a single motor we are using a see-saw setup. In see-saw if one side of see-saw is applied with more load that particular side is brought down and theother side is lifted up. This principle is used

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in controlling these controls. Both accelerator and brake are connected by a "U" shaped rod. Thus when the brake switch is pressed the corresponding motor rotates anti-clockwise, pressing the brake and releasing the accelerator in the automobile. When the accelerator switch is pressed the motor rotates clockwise, thus pressing the accelerator and releasing the brake in the automobile.

Clutch control: This control has to be applied before shifting any gear similar to the accelerator and the clutch control this control also posses linear movement (forward and backward). A separate motor is used to do this function. To convert the angular motion of the motor into the required linear motion we are connecting a shaft perpendicular to the motor. Thus, when the motor rotates clockwise or anti-clockwise the shaft moves the clutch forward or backward accordingly. To do this control the torque required is less when compared to brake control.

Gear control: The control of gear determines the speed of the automobile for different road conditions such as in plains surface, hill and etc. There are up to six or seven gears in a automobile. Shifting of gears is done with the help of the gear rod present in the automobile. The movement of the gear rod is of two types

a) Horizontal movement
b) Vertical movement

Now let us see the position arrangement of gears in an automobile. This arrangement and gear position is shown in Figure-8. The distance between A and C is equal the D1 and that of 1 and 3 is equal to D2. The distance between A and B is equal to the distance between B and C let this be denoted by M and the distance between 1 and 2 is equal to the distance between 2 and 3 and let this be denoted by N. For any gear change the distance traveled by the gear rod will be equal to integral multiple of these basic displacements M and N. To put a gear or to move the gear rod to its respective gear positions we are using slider method. Let us how see the arrangement of sliders L1 and L2. This arrangement is shown in Figure-8. The sliders are hollow in their physical structure and the diameter of each slider is equal to the diameter of the gear rod. The length of the slider L1 is equal to D1and the length of the slider L2 is equal to D2. Both the sliders are fixed in their respective center position one over the other on the top of gear rod. Now let us see how their method is used to shift the gears in the automobile. When the driver wants to change the gear, he applies clutch for which a signal of unique frequency is transmitted to the automobile and then he presses the appropriate control switch for the required gear, which produces a signal of another unique frequency and is transmitted wirelessly to the automobile. Then the received signal after processing is given as input to the microprocessor. Then the microprocessor executes the gear action by executing the corresponding subroutine.

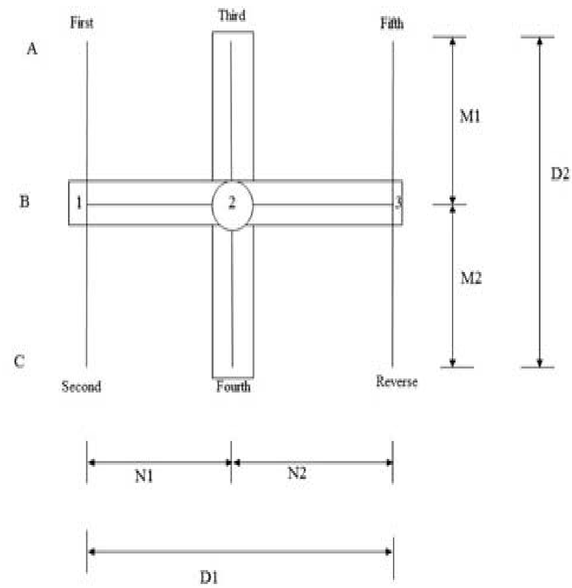

Figure-8. Position arrangement of the Gears in an automobile.

A gear can be shifted in three steps.

i) The horizontal rod L2 is moved to the neutral (B) position.
ii) The vertical rod L1 is moved to the position 1, 2, 3 depending on where the required gear is positioned.
iii) Thirdly the horizontal rod L2 is moved to the desired gear position either A or C.

To shift to the neutral gear position only the step is done-step (i) thus in this manner all gears changes can be done to achieve the required gear. The super imposition of sliders over the gear rod along with gears position is shown in the Figure-8.

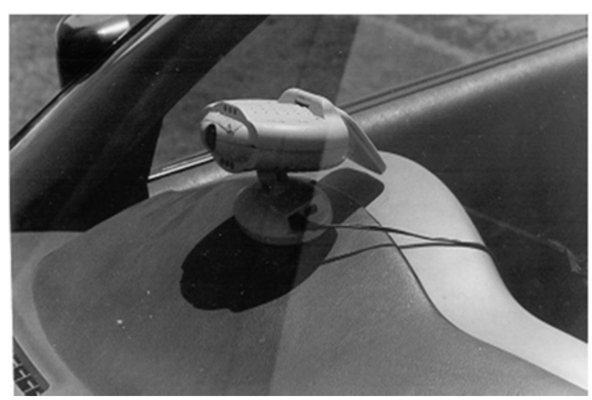

Figure-9. Front view camera of ADA Automobile.

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Figure-10. Microcontroller steering in ADA automobile.

Figure-11. Automated driverless agent kit.

The Figure-9 shown the camera fixed in automobile to perceive front view of the traffic and Figures 10 and 11 has shown the integration of automated driverless agent kit in the automobile. This replaces manual transmission and manual steering.

5. BASIC CONTROLLING ACTIONS

The various controlling actions to be performed are as follows:

a) To turn the steering right – stepwise
b) To turn the steering left – stepwise
c) To turn the steering right – for 45^0
d) To turn the steering left – for 45^0
e) Apply clutch – Full
f) Release clutch – stepwise
g) Release clutch – Full
h) Apply brake - stepwise
i) Release brake – stepwise
j) Apply brake - Full
k) Release brake – full
l) Release accelerator – Full
m) Apply accelerator – stepwise
n) Release Accelerate – stepwise
o) First Gear
p) Second Gear
q) Third Gear
r) Fourth Gear
s) Neutral and
t) Reverse Gear

The above mentioned are the 20 different basic controlling actions to be controlled for each of these controls a different control switch is presented in the controlling centre.

6. RESULTS AND DISCUSSIONS

Table-4. Comparison between existing and proposed automobiles.

Characteristic	Existing automobile	Fully Automatic Automobiles	Proposed System (Remote controlled ADA Automobile)
Time taken for implementing	Short time	Very long time	Short time
Applicability of the idea	Without modifying existing roads	With the modification of existing roads	Without modifying existing roads
Cost for implementing	moderate	Very high	moderate
Evidence	no	no	The video stands as an evidence which will be useful for police
Presence of the driver in the car	Necessary	Not necessary	Present only in the controlling centre
Changing of drivers in midst of journey	Not possible	--	Possible
Privacy	Not possible	Possible	Possible
Prevention of crimes (robbery, hijacking, etc.)[14]	Not possible	Not possible	Possible
Misuse of automobile	Possible	Not possible	Not possible

7. CONCLUSION AND FUTURE WORK

Thus the existing ordinary automobiles can be automated without changing the existing roads. Our proposed methods of automation are practically feasible and effective. It controlled from the remote location to provide safe and pleasant journey. We have done remote control for start, all types of gears, steering control, accelerator and applying brake only. All the other controls can be controlled from remote location will implement in future. For doing more than one control in future the following things have to be taken care; firstly embedded systems with real time operating system must be used, because at particular instant of time more than one control has to be controlled. Secondly suitable techniques must be used so that more than one control signal can be transmitted at the same time.

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