# AUTOMATED VEHICLE CONTROL SYSTEM

**By:**

M.Habibullah Pagarkar
Kaushal Parekh
Jogen Shah
Jignasa Desai
Prarthna Advani
Siddhesh Sarvankar
Nikhil Ghate

Third Year Information Technology Engineering
V.E.S.I.T.
Chembur, Mumbai 71.

# INTRODUCTION

We use intelligent instruments in every part of our lives. It won't take much time that we realize that most of our tasks are being done by electronics. Very soon, as we shall see, they will perform one of the most complicated tasks that a person does in a day, that of driving a vehicle.

This is for the better. As the days of manned driving are getting extremely numbered, so are those of **traffic jams**, **bad**, **dangerous and rough drivers** and more importantly, **accidents**. According to *Mr. Willie D. Jones* in the *IEEE SPECTRUM* magazine (September 2001), a person dies in a car crash every second.. Automation of the driving control of two-wheelers is one of the most vital need of the hour. This technology can very well implement what was absent before, controlled lane driving. Considering the hazards of driving and their more pronounced effect on two-wheelers our **OPTICALLY GUIDED VEHICLE CONTROL SYSTEM** is exactly what is required.

These systems have been implemented in France, Japan & U.S.A. by many companies, but only for cars and mass transport networks. In those systems, the acceleration and brake controls are left to the driver while the micro-processor simply handles the steering and the collision detection mechanism. **Our system is superior** in the sense that **ALL** the tasks related to driving are automated. The driver just has to sit back and enjoy the ride.

This system has a large number of **advantages**:

1) Smooth traffic flow due to **lane driving**.

2) Speed is maintained at a constant 30 km/h This speed is fast enough for travelling and slow enough for the driver to escape unhurt in a highly unlikely accident.

3) Driving for the **physically challenged**.

4) **Transport of goods and personell** in sensitive areas like nuclear stations, military installations, industrial hazard-areas or even in large companies.

5) **Tireless driving** devoid of the stress involved in long distance driving.

6) **Accident prevention** due to automatic collision control.

7) Only a **few components** are added to get all these extra advantages.

8) Extremely **cost effective**.

9) **Easily implementable** as the parts required are available in any garage.

This system is not without **limitations** in it's present form.

1) This system is available only for **gear-less two-wheelers**.

2) The tracking mechanism involves painting two white strips along the length of the road.

We have excluded geared two-wheelers from the scope of this project because it complicates the control mechanism. At present, we do not have the resources available with us to work with a geared vehicle. The **second disadvantage can be nullified** by using a paint which is sensitive only to a particular type of radiation which emanates only from the two-wheeler. This can prevent any individual from painting his own set of lines on the road. This idea too was left out from the final project idea due to cost constraints. A large company can use this in it's factory or **B.E.S.T. can incorporate it in it's buses**. Primary emphasis has been given to passenger safety. The driver has the ability to call in this circuit whenever he feels it necessary and the option of shifting to manual control is at his discretion.

Software and mechanical hardware are seamlessly integrated in this project. The cost of making the entire system is **less than Rs. 5000**, so this idea is **feasible**. Once a person sits on a vehicle fitted with this kit, he can be assured that he will reach his destination, **safely**. Moreover, this system can be suitably changed so that it is used in a different setting. **For example**, we can feed in a particular map into the system so that it can be used only in that particular area. To explain this, let's consider a handicapped person sitting in a wheelchair fitted with this kit. He will be able to goto any room of his house without bumping into any object by using this kit.

This project involves the use of **elementary robotics, digital imaging and image processing and artificial intelligence**. It's main parts are

1) **Steering control circuits**

2) **Speed control circuits**

3) **Collision detection systems**

All these blocks are centered around a central **control system**. Let us take a look at the block diagram and the internal working of this Optically guided vehicle control system.

# BLOCK DIAGRAM

The basic block diagram is shown in the figure below.

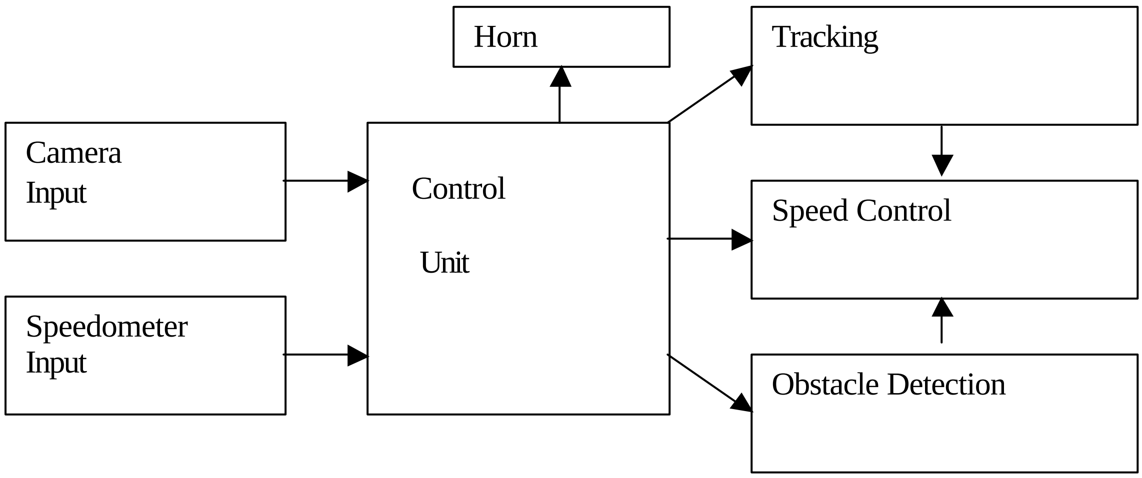



Fig: 1 Basic block diagram

As can be seen, the various circuits answer directly to the control unit. We intend to use an 80486 based system. The primary reason is that this control unit has to perform a lot of graphics based calculations. Let’s start the explanation of the different blocks:

## 1) Camera

We intend to use a camera with a large field of vision. This F.O.V. should extend from 0.5 m before the two-wheeler to 30 m ahead. This camera is located just about the front tire hood. It is angled in order to get this F.O.V. The camera has the following properties:

1) It is a high resolution camera so that it sees clearly in it’s F.O.V.
2) It captures images at intervals of 0.1 ms.
3) The images have a depth of 2 bits. i.e. the camera can detect only four colours at the most. This is a significant point because it reduces the cost of the camera.

The most practical way to implement this type of camera is to use a small grayscale video camera which generates an AVI file. Obviously the audio part is useless to us, so we will leave it out. We can sample this AVI file at particular time intervals (0.1 ms) and get a BMP file. This BMP file has a particular size in pixels and is called “frame”. All the graphical manipulations will be done using this frame. This frame is passed onto the control circuit.

## 2) Speedometer

We have a speedometer on the two wheeler. This analog input is digitized and given as an input to the control circuit. The speedometer on many two-wheelers is highly inaccurate. So we intend to use a better quality speedometer as it's readings are very crucial in the collision detection circuit.

## 3) Control Circuit

This is the heart of the system and runs a program written in a high level language, C. The program written in C will have the image processing as it's main part. The image processing is the most time consuming task of the CPU. Hence and Intel 80486 based chip will be used. This image processing program takes the sampled frame from the camera and analyzes it as explained further in the algorithm. Depending upon the difference from the standard picture stored in the memory, the speed control, the tracking and obstacle detection sub-routines will be called. If either the tracking or the obstacle detection sub-routines are called, then the speed control program will not be called as the other two sub-programs will call the speed control programs in their own way. When none of the two, the obstacle or the tracking program have to be called for, the control circuit engages the speed control circuitry so that the two wheeler travels in a straight line at a constant speed of 30 km/h. The two subroutines are called along with the necessary daat as explained in the algorithm.

## 4) Tracking Circuit

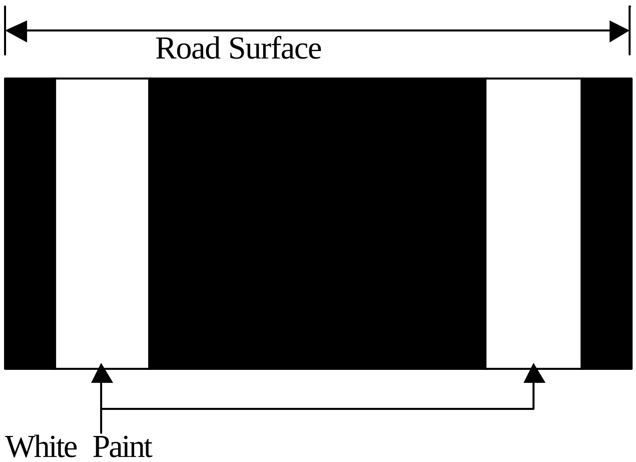



Fig: 2

The track is painted as above in white on the black road. This is how the road would look like ideally at the output of a camera. This paint forms the basic principle on which the system works. By looking at the paint marks the 2-wheeler is able to steer itself. The detailed explanation is given below:

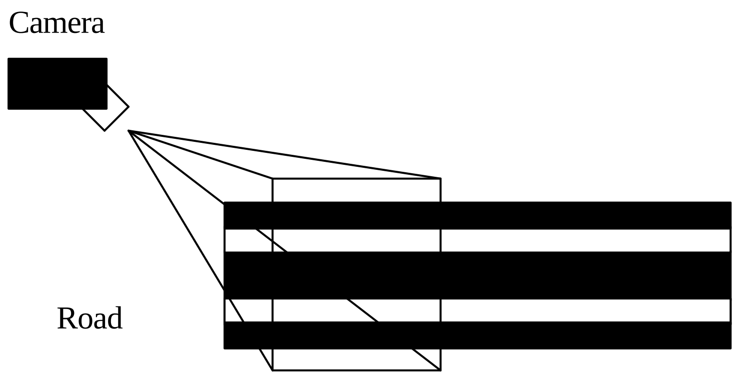



Fig: 3

The camera focus on the road will be as shown. Thus the image obtained from a camera will be as shown in fig 1. In reality it will be a perspective image as shown in fig .4. The camera can see long distance images as well as the nearer path. The distant path is used for the obstacle detection program, while the nearer part of the image shows the computer where to turn the two-wheeler.

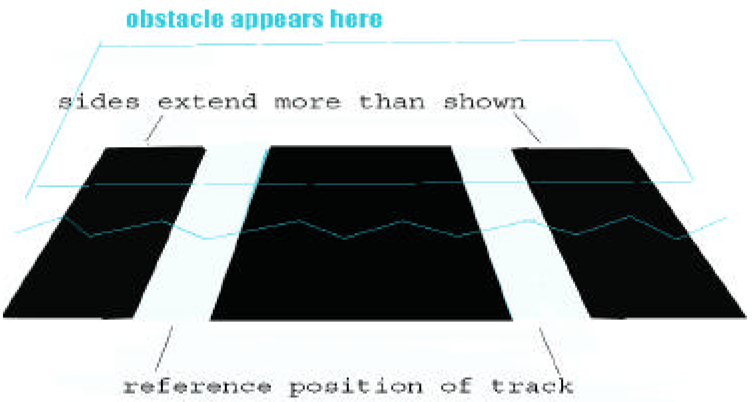



Fig: 4

The painted tracks on the road form a reference for the vehicle to move. Refer fig: 1. The two-wheeler is to move along an imaginary line exactly in-between these two paths. Any deviations are detected by image-processing software. Those differences are minimized by a feedback control system that drives a servomotor on the steering column. Also during turns, the input to image processor will change so accordingly the steering has

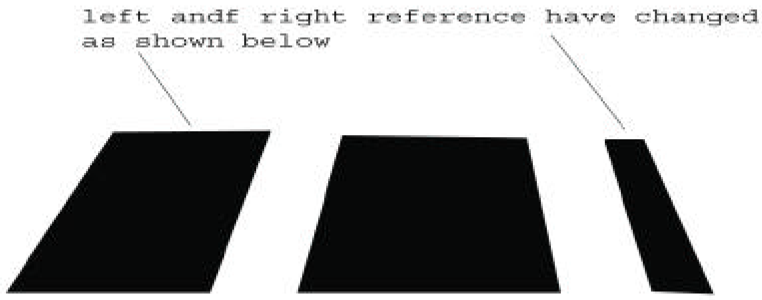



Fig: 5

to be controlled. Also the speed has to be decreased at the turns to facilitate easy turning. i.e. when it turns, it needs to slow down by decreasing the speed and if for a particular time there is no change in position of steering column again increase it to a certain maximum limit by gradual increase in the throttle and leaving the brakes.

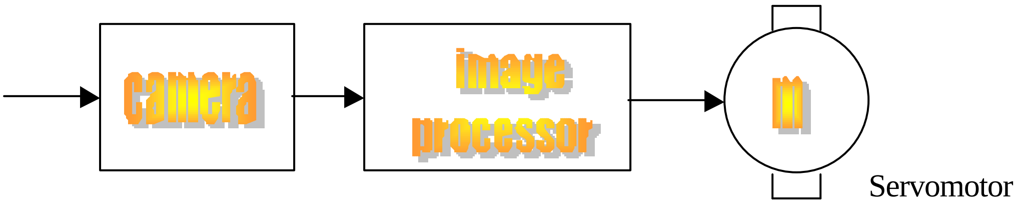



Fig. 6

The image processor works on the camera image as shown in fig: 4. The steering is controlled by using a servomotor. Thus the servomotor will turn the disc just above the front wheel and the steering is controlled. This operation is performed only once in one loop of execution of the program. In the next loop, if the two-wheeler is still not on the path, then the servomotor is used to turn the steering even more and reduce the speed further.

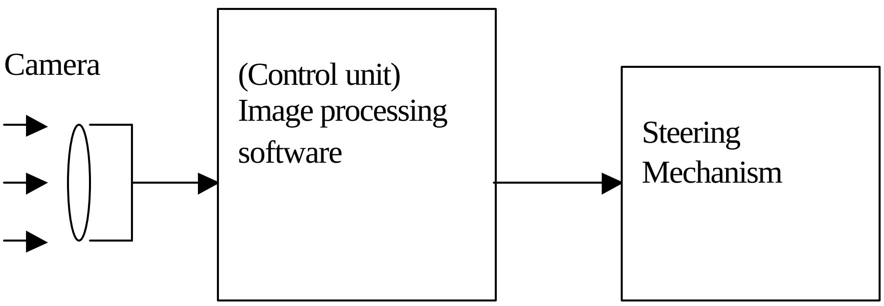



Fig: 7 Block Diagram for steering control

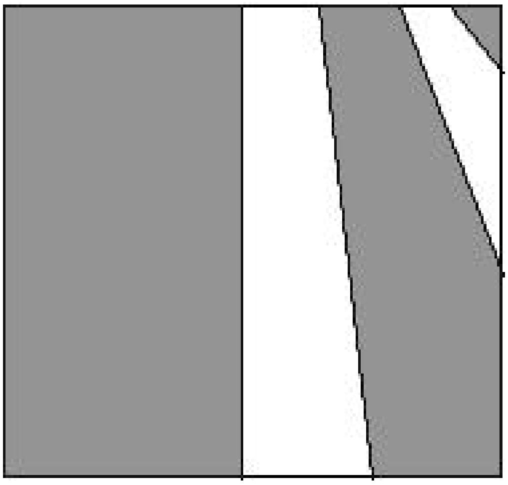


Image if the vehicle has moved left
Hence right turn needed

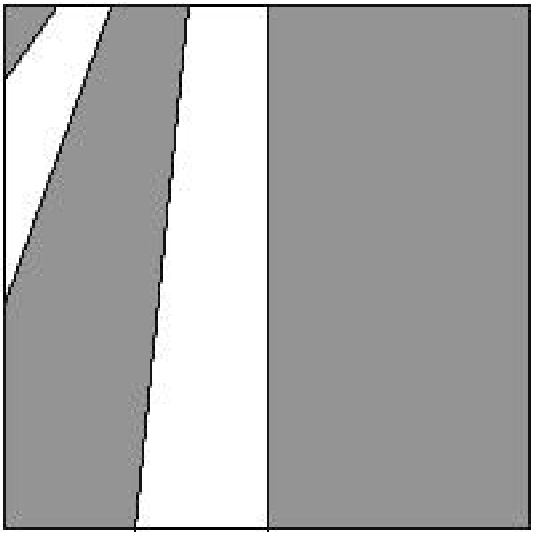


Fig: 8

Similarly for right turn

In case the two-wheeler has veered away from the track, ie. the track cannot be seen in the frame, after a few frames the emergency brakes are applied and the vehicle is brought to a stop. This is done to protect the vehicle and the passenger from any damage.

# 5) <u>Obstacle Detection</u>

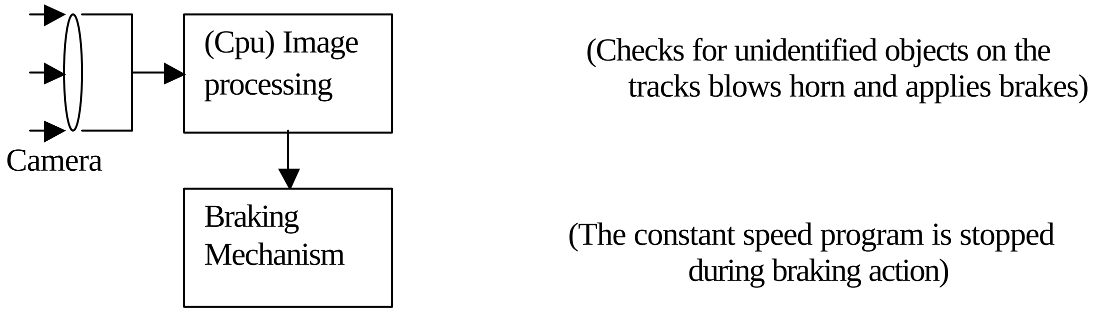
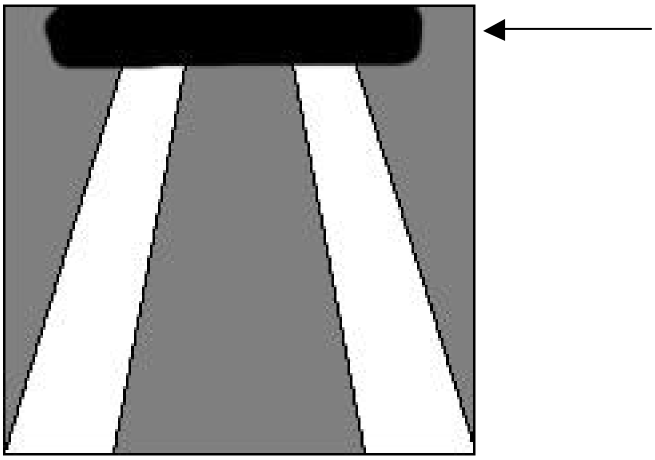



Fig: 9 Block Diagram of obstacle detection

Fig: 10 Some obstacle on the path




Suppose some vehicle comes within the F.O.V. of the camera, it enters the critical distance (not safe distance for driving) then the image obtained from the camera will be as shown in fig .10. The image processor detects it. It also finds the approximate distance of the object from the user by counting the row number from the bottom half of the image. It then signals the braking mechanism to start working. The braking force to be applied depends upon the distance. In this there are three cases discussed below

**Case 1**: The obstacle is stationary on the path

In this case, the two-wheeler detects the obstacle at a particular distance. The image processing program determines the approximate distance of the obstacle from the two-wheeler. In the first frame, it calculates the approximate distance. The accelerator is left. So the speed decreases automatically. In the subsequent frames, the position of the two-wheeler is estimated. Also, the tracking program keeps the two-wheeler on the track. In the later frames, the braking mechanism is activated and the horn is pressed. The horn has a two fold advantage; One if the obstacle is a living creature, it might move out of the path and secondly, it brings the user's attention. Since the obstacle is not moving, the speed is kept on decreasing in such a way that the two-wheeler is brought to a stop 0.5 m before the obstacle.

**Case 2**: The obstacle is traveling towards the user

This case is similar to the first case. Only now, the brakes will be pressed harder as the obstacle is coming towards the user at a faster rate.

**Case 3**: The obstacle is traveling away from the user

**a**) The speed is less than 30 km/h

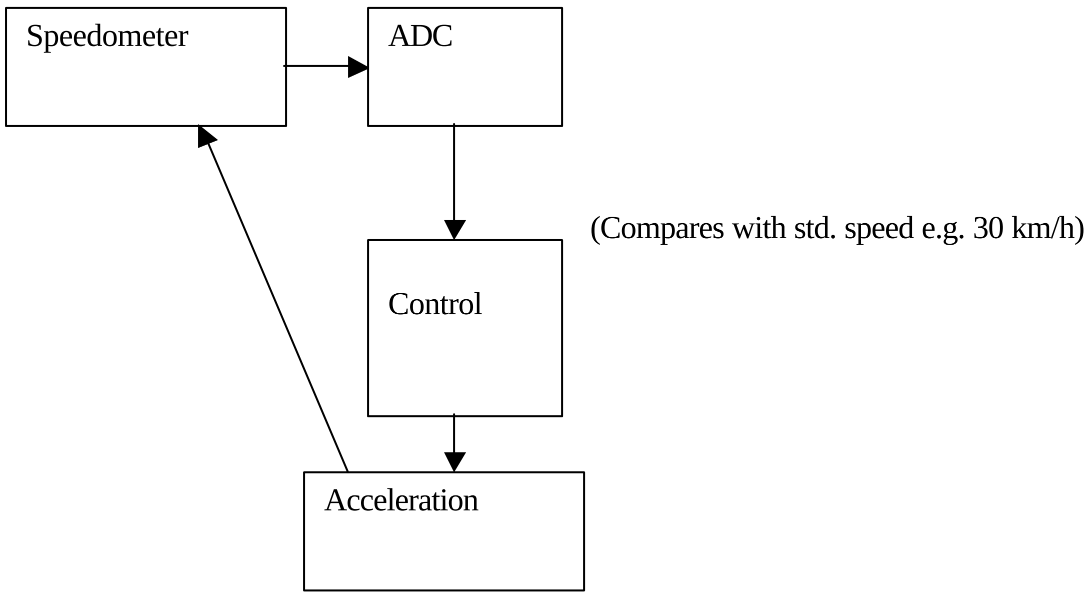
In this case the obstacle is detected, and the speed is reduced till it goes out of view, i.e. the obstacle is more than 30 m away from the user. Then the two-wheeler accelerates again till it catches up with the obstacle. Thus the two-wheeler follows the slow moving obstacle at a distance of 30 m. If the obstacle slows even further, then the vehicle follows behind at that speed 30 m behind.

**b**) The speed is more that 30 km/h

In this the obstacle remains in the field of view of the camera for just a small amount of time. Till then, the speed will be reduced. After every frame, the amount by which the speed is decreased is reduced every time till it reaches the optimal speed.

# 6) Speed Control Circuit

Fig: 11 Speed control block diagram




The speed control circuit is activated only when there is no difference in the image captured and the ideal image. At this point of time, the vehicle is traveling in a straight line. The speed of the vehicle has to be regulated to maintain safety. Hence the input of the speedometer is compared with the ideal value of the speed. If the speed is less, then the accelerator is used to increase the speed by a particular value. The amount of acceleration given depends upon the difference in the ideal and the present speeds. After making this small change, the control shifts back to the main image processing program.

# ALGORITHM

***Main Algorithm***

1) The system is switched on by the user when the specified reference speed is reached & the two-wheeler is on the track.
2) The image is captured by the camera & sent to the image processing software.
3) The image processing program starts executing.
4) The lower half of the image is compared with the reference image & the amount by which the path has shifted is calculated.
5) Find the row number from the bottom at which the white paths are not visible.
6) If there is a shift in the path then the **tracking subroutine** is called.
7) If the row number is less than maximum rows then the **obstacle handling subroutine** is called.
8) If the values from 4 & 5 are in the acceptable limit **ONLY** then activate the speed control program.
9) The control goes back to step 2.

***Tracking Algorithm***

1) The amount by which the image of the path is shifted is received from the main program.
2) Depending on the value, the speed is decreased.
3) The required signals are sent to the turning mechanism.

***Obstacle Handling Algorithm***

1) Values passed by the main program are accepted(row number)
2) The output of the speedometer is digitized & read.
3) The approximate distance from the obstacle is calculated using the row number.
4) The amount by which the speed is to be reduced is proportional to the current speed & the distance from the obstacle.
5) The acceleration is stopped & the signal to apply the brakes is sent.
6) The control is returned to the main program.

# CONCLUSION

Collision detection and avoidance systems should become more commonplace with the passage of time. People are living in a networked world and constantly feel that they have less time on their hands. It has been jokingly said, that “The more developed a country is, the more time it’s citizens waste behind the steering wheel.” To perfect this technique, it might take several years, but this project is surely a **step in the right direction**. Prevention is better than cure. So instead of treating patients after an accident, accidents should be prevented by incorporating this system.

This project is **very feasible** as very less expensive parts are used. The most expensive component is the micro-processor which is available in the second hand market at a very low cost.

This project can be improved upon in many ways. For example: Including an overtaking feature. Hopefully we will implement them in the future.