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Arduino-MATLAB based Semi-Autonomous Car

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ABSTRACT: Self-driving cars might have been only subjects of science-fiction movies, yet the latest advances in computer technology and communication systems are promising to make this a reality during our lifetimes. Modern vehicles are increasingly adding features with the goal of simplifying the driver's job and automatizing parts of the driving process that can be safely translated into computer algorithms.

We are proposing a basic model of a semi-autonomous car. This car aims at taking control of certain aspects of their driving, whilst a human driver retains control of others. Autonomous systems are already being used in vehicles today, like cruise control, lane keeping, collision detection, park assists, and even blind spot warnings. Our proposed model is equipped with the features such as lane keeping, lane assist and cruise control. This car provides the driver freedom to engage in other activities while driving. The car can accelerate, brake and steer itself to a limited extent. In a semi-autonomous car the driver is expected to actively participate and side by side enjoy peace of mind and feeling of control.

KEYWORDS: Self-driving cars, lane keeping, lane assist, cruise control, Semi-Autonomous Car.

I.INTRODUCTION

Recent headlines have been awash with stories of self-driving cars and futuristic flying devices. Recent years have seen considerable progress towards the goal of autonomous vehicles. Such vehicles are an applied use of increasingly sophisticated artificial intelligence and robotics capabilities. These technological advances are allowing society to fundamentally reconsider the vehicles available to us, and the infrastructure which they are part of.

The forces behind the development of these technologies are diverse, and represent how traditional transport industries can undergo changes in response to a new generation of machinery. Taking part in the autonomy race, in addition to established car and aircraft manufacturers, are global technological and idea innovators such as Google and Amazon, components manufacturers such as Bosch and Continental, small start-ups and university researchers. Their achievements could represent the biggest change to vehicles since the motorcar replaced the horse and cart.

Autonomous vehicles are vehicles which are capable of driving themselves. In order to do this, the vehicle must be able to perceive its environment, make decisions about where is safe and desirable to move, and do so. It can also be possible for a vehicle to be only partially autonomous, so that some decisions are made by a human driver, and some by the machine itself.

One major area of autonomous vehicle development concerns an area where machines have already been used for over a century – the motor car. Cars are so widely used that there is already a coherent system in place to organise their operation, perhaps making it easier to understand the scope of autonomous cars. Road traffic could continue to be ordered in a similar way to current systems, and would be used for similar applications – primarily for transport of people and goods. The idea of transferring control from a human driver to the vehicle itself, however, is a quantum leap which some may struggle to accept.The average driver spends 235 hours driving every year. That is the equivalent of six working weeks. Despite the increasing sophistication of modern vehicles, and greater application of driver assistance technologies, the driver must still concentrate on driving 100% of the time. Highly and fully automated vehicles will change this, the 'driver' will be able to choose whether they want to be in control, or to hand the task of driving over to the vehicle itself. This represents a major opportunity – allowing drivers to safely use the journey timehowever they wish, from reading a book, to surfing the web, watching a film or just chatting face to face with other passengers.Human error is a factor in over 90% of collisions. Failing to look properly, misjudging other road users' movements, being distracted, careless or in too much of a hurry are the most common causes of collisions on our roads. Automated vehicles will not make these mistakes. They use a range of sensors which will constantly monitor their surroundings. We have come to rely on many technologies that assist the driver of a vehicle, for example cruise control. As these technologies evolve, they are reaching the point where a vehicle is capable of operating for periods of time with reduced, or in some instances without, driver input. Evidence from automated technologies available today already demonstrates significant safety benefits. For example automatic emergency braking, lane departure warning and electronic stability control have all been assessed to have improved safety based on existing evidence.By communicating with their environment and other vehicles, automated and driverless vehicles offer the promise of better use of road space, reducing congestion and providing more consistent journey times, through the use of “connected vehicle” technologies. “Connected vehicles” would communicate with each other and their surroundings to identify the optimum route, helping to spread demand for scarce road space. Vehicles could also communicate with roadside infrastructure such as traffic lights and use this information to minimise fuel consumption and emissions.

II. REVIEW AND ANALYSIS OF LITERATURE ON AUTONOMOUS DRIVING

In order to understand the development of research in autonomous driving in the last years, it is important to conduct a literature review to understand the different fields of application through which autonomous driving has evolved as well as to identify research gaps. Therefore in the next sections the research process, methodology and findings of the literature review are presented.

The research conducted focused in a systematic keyword search in the topic section of literature databases, including EBSCO, Science Direct, Emerald and ISI web of knowledge. The search conducted included the specific terms, “Autonomous driving”, “Self driving car” and “Driverless car” either in the title, keywords or abstract and including only academic journals listed in the mentioned databases. Hence, the aim of this research was not to find all literature regarding Autonomous Driving that because of its size would lead to an enormous amount of results due to the extensive applications, testing and research in other fields (robotics, underwater vehicles, military, aeronautics, space vehicles, etc.), but to achieve an overview and overall classification to identify current gaps in the scientific literature body. Therefore taking into consideration only the literature publications relevant for roads, traffic, crossroads and studies related to commuting, transportation or production, and including all relevant publications found related to the automotive industry, as well as also considering papers in other topics that acknowledge that the application could be relevant for self-driving cars.

There is very little current activity that addresses fully automated driving of passenger cars (other than the autonomous vehicle research that is outside the scope of this review). In recent literature, there appears to be only one significant project that points entirely in this direction, which is Toyota’s research on a tightly coupled platoon of automated cars.(48,49) In this research, Toyota has concentrated on fuel saving; thus, they have designed their car– following control to maximize smoothness while also maintaining a small gap among cars and have, as a result, shown better fuel–saving results than in earlier work. Toyota in Europe has produced an animation that showcases their future vision of fully automated driving, which is posted on YouTube.

BMW presented a paper that mentioned vehicle automation for special purposes, such as remotely controlled parking of vehicles in a garage and training race car drivers to make an optimal drive around a race track, but these are not mainstream driving applications.

FIAT created a concept car called the Mio in late 2010, based on ideas submitted from members of the general public throughout the world. This car, which was presented at the 2010 auto show in Torino, Italy, included not only fully automated driving on a dedicated lane, but also inductive recharging of the batteries that were used by its electric power train, representing a very advanced vision for future mobility

III. SYSTEM DESIGN AND WORKING

This Semi-Autonomous car having the function of detecting the lanes of the road and keep itself in the lane, also having the feature of detecting obstacles and presence of human that help it to drive slow or fast or brake. The figures below show the block diagram of this car. The figure 1 below is showing the block diagram of the functioning in MATLAB. Here the live video is capturing with help of the camera and then this video is transmitted to MATLAB Software through Camera-MATLAB interface. After which various sub programs are applied on this signal, such as: Hough Transform, Local Maxima Finder, Colour Space Converter, etc. Than this signal is displayed through Video Out

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function of MATLAB Software and also the resultant action on the basis of these sub programs are sent to the Arduino for controlling and further processing.

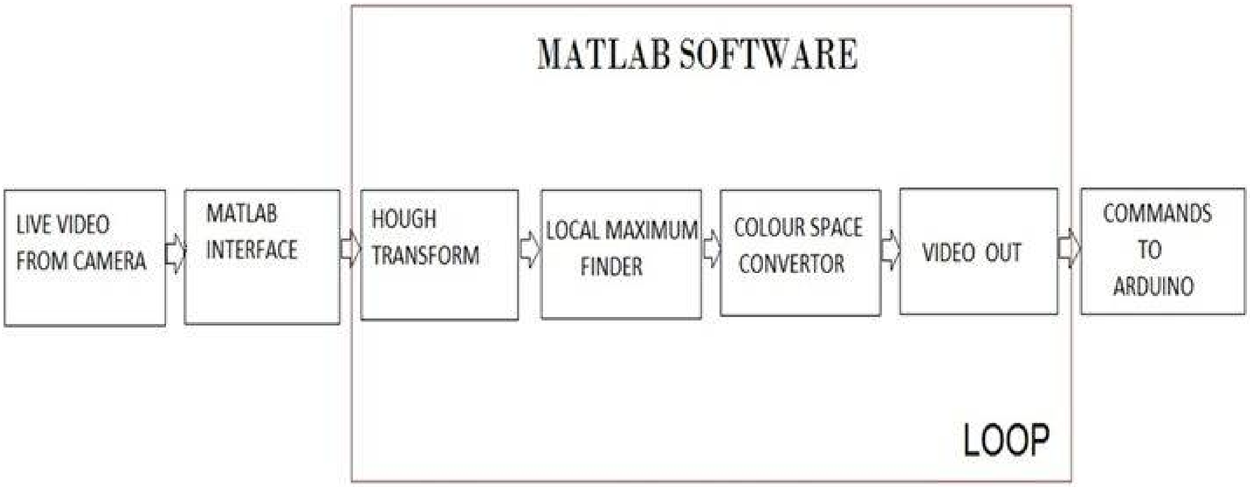

Fig1: Block Diagram of Functioning in MATLAB

Now, Arduino receive the command from the MATLAB and based on that data it checks the condition, so based on the conditions it perform the corresponding task to keep the car in lane. The figure 2 is showing the block diagram of the functioning of Arduino based on the data/command received from the MATLAB Software. First of all the data/command received from the MATLAB goes under the loop of the Conditional Statements that generates the control signal for the servo to control the steering on the basis of finding match in the sequence of conditional statements.

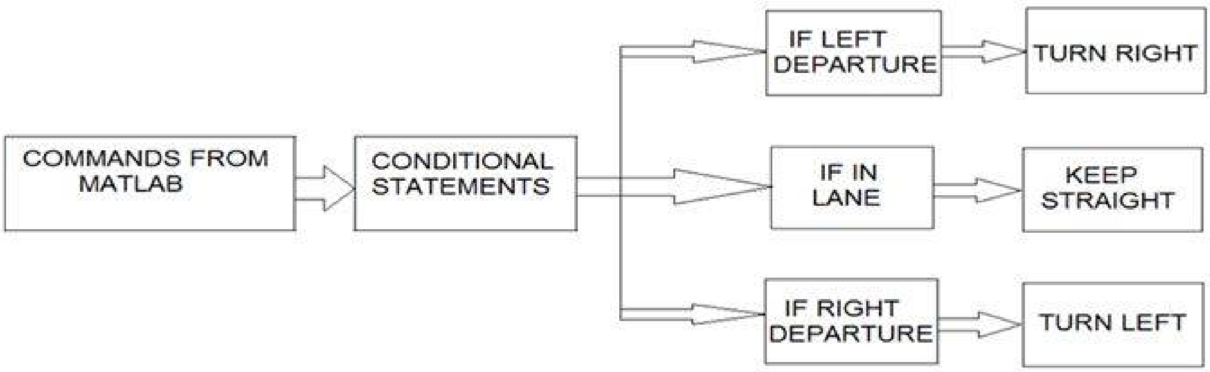

Fig2: Block Diagram of Functioning of Arduino

The figure 3 below is showing the complete block diagram of the system.Here the live video is capturing with help of the camera and then this video is transmitted to MATLAB Software through Camera-MATLAB interface, after that this signal is forwarded to the Arduino which then provides the steering command to servo motor. The other Arduino works simultaneously with first Arduino for providing the Cruise Control to this Semi-Autonomous Car. This Arduino is also responsible for the backlight system of the car. On the basis of the data received from the Radar and Pyroelectric sensor Arduino executes the corresponding command in the sequence of the program burned into it.Based on the information collected with the radar sensor and pyroelectric sensor, Arduino controls the speed of the DC motors and backlight of the car. When there is no obstacle in front of the car the Arduino will run the DC motors with full speed,

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and if there is an obstacle at a distance in front of the car then the Arduino will run the DC motors with slow speed, and if car is reached very near to the obstacle then Arduino will stop the DC motors i.e. car stops. In parallel pyroelectric sensor will continuously taking care of presence of the humans, if there is any Human is detected in front of the car the car will stop immediately.

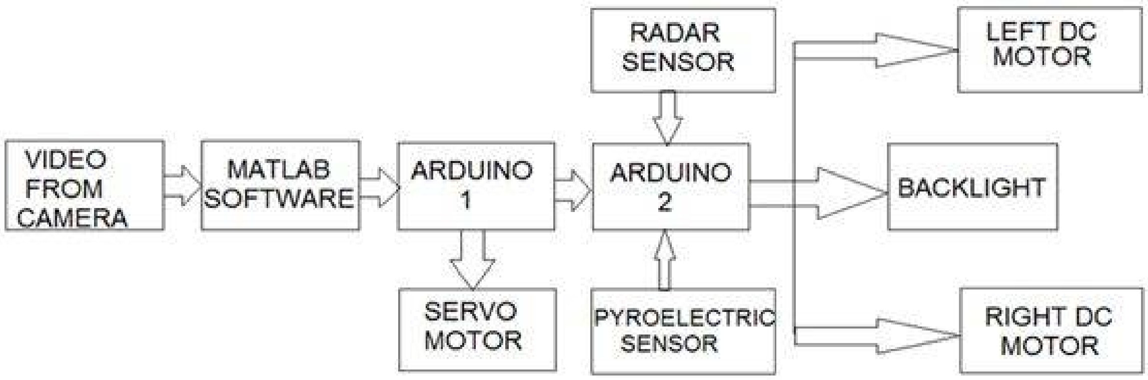

Fig 3: Complete Block Diagram of the System

The figure 4 below is showing the complete circuit diagram of the Semi-Autonomous Car.

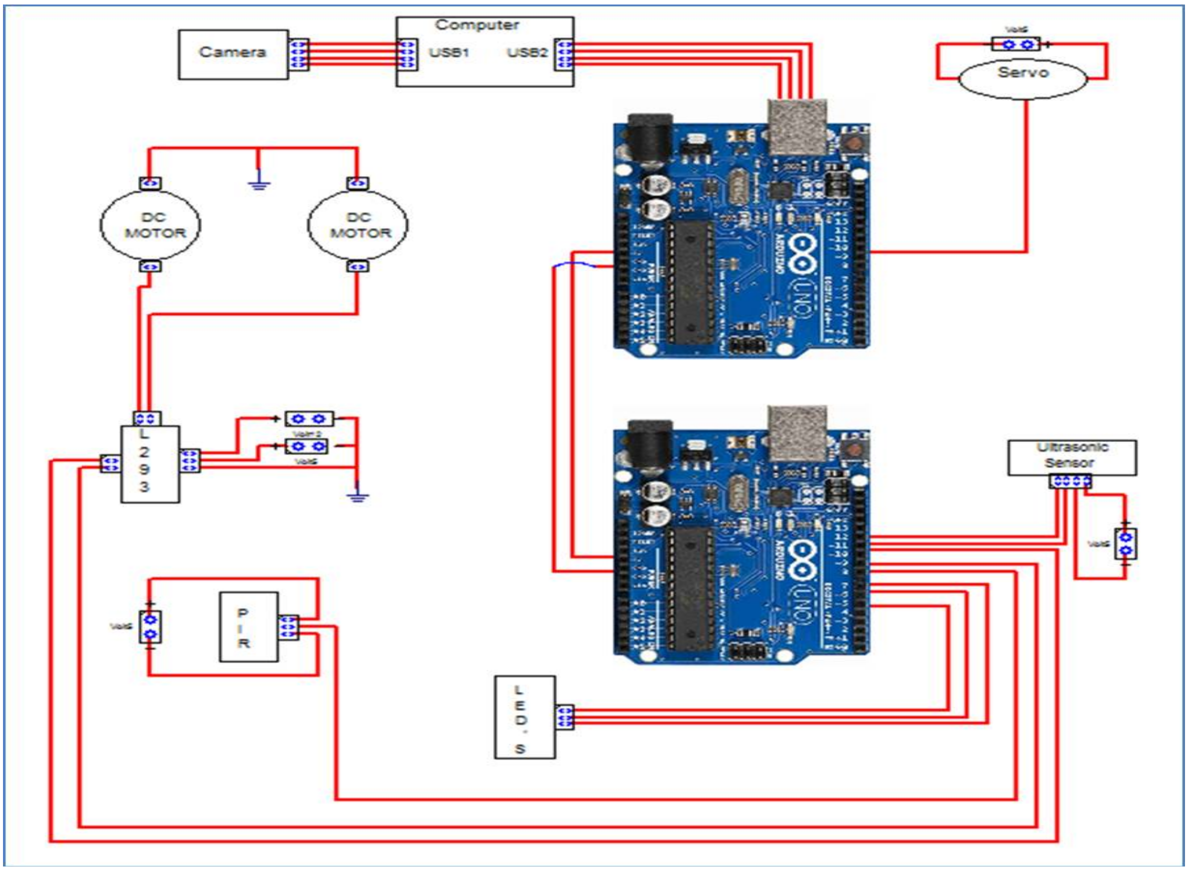

Fig 4: Circuit diagram of Semi-autonomous Car

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IV. RESULT AND DISCUSSION

In the first picture, it shows the graph of timeVs throughput of receiving packet. Throughput is the average rate of successful message delivery over a communication channel. The figure 5 below is showing the screenshot of the video output from the MATLAB which is showing the detected lane onto the road on which the Semi-Autonomous Car will drive itself. Here yellow line is showing the fully marked boundary lane whereas white line is showing the broken lane of the road.

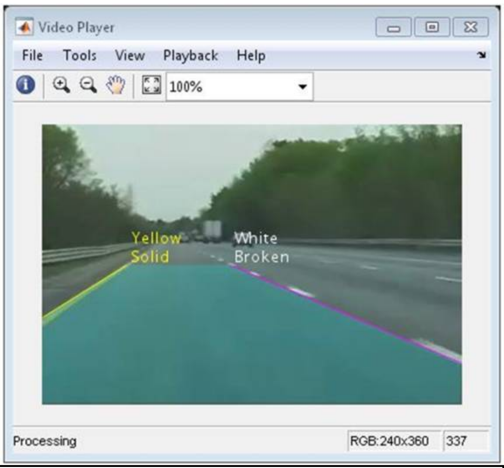

Fig 5: Circuit diagram of Semi-autonomous Car

The figure 6 below is showing the model of the Semi-Autonomous Car. This picture of the model consist all the component of the system except the laptop at which the MATLAB Software will run to provide the necessary commands to handle the steering of the Semi-Autonomous Car.

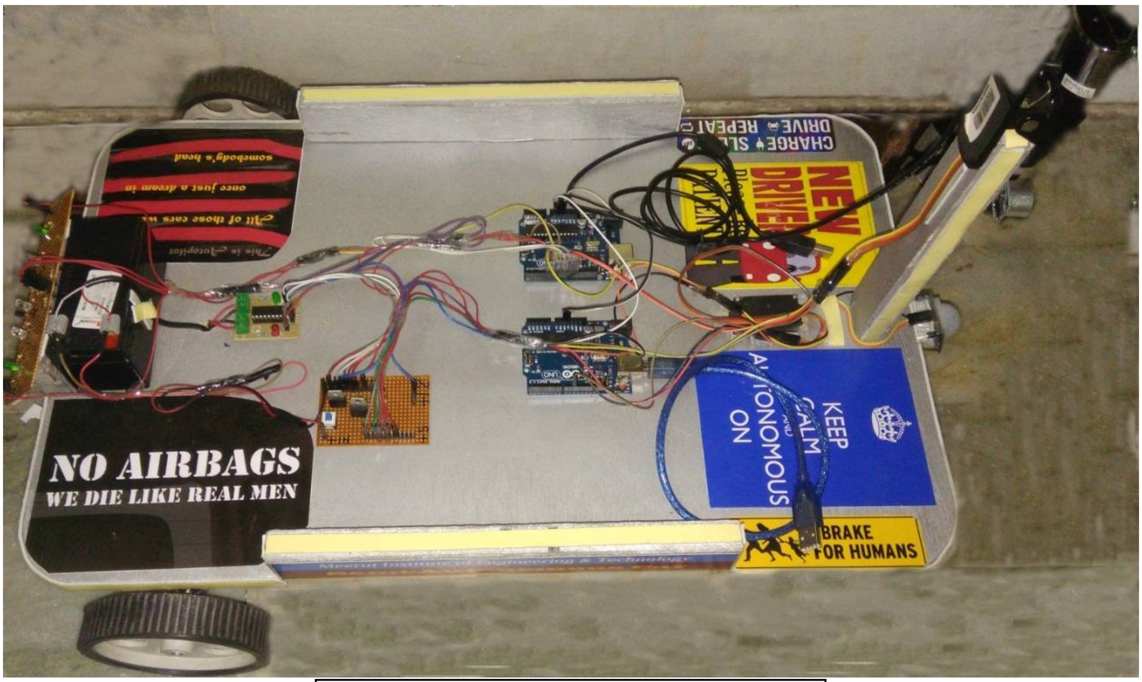

Fig 6: Model of Semi-autonomous Car

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V.CONCLUSION

Whether it is through transport, industry or research applications, autonomous and unmanned vehicles have great potential to change the world we live in. In order to achieve a widespread take-up of this machinery, the hurdles to overcome are not so much technological but questions of safe and practical implementation. Developing adequate regulation and codes of practice may take time, and public trust is not always forthcoming for new technology, but achieving this is likely to mean creating new business opportunities.

LIMITATIONS

Although the development of autonomous technologies is rapidly under way, and in many ways they are commercially available, there are also barriers to a shift to autonomous driving.

Cost

At present most ADAS features are not available as standard fittings to a new car, but as part of an optional safety package. The extra cost and optionality of this could restrict ADAS feature take-up, although as the technologies become more established, standard fitment is increasing and prices are decreasing. Cost is not just a concern for consumers, however. Many manufacturers already have tight profit margins, and making new features part of a standard package may not be appealing. A former General Motors executive has said that while the technology looks inevitable, it may not deliver much value for shareholders.

Persistence of driven cars

Older cars are not likely to be retrofitted to keep up with modern standards, meaning that the roads, and the laws of the roads, could have to accommodate both autonomous and manually driven cars. There are also people who enjoy driving in itself – for example, it is estimated that there are more than half a million classic cars in the UK. A study conducted by the UK's Automobile Association found that 65% of people liked driving too much to want an autonomous car, although other reports have shown more enthusiasm.

Legal and licensing considerations

Increasing autonomy of cars provokes theoretical considerations of who should be liable in the event of a crash caused by the car itself. At present in the UK at least, primary liability rests with the user of the car, regardless of whether their actions cause the accident or not. If defective technology caused the accident, the user (or their insurer) has to pursue this legally with the manufacturer. In addition, at present drivers are expected to maintain awareness and supervision of their car, even if they are not in control of driving because semi-autonomous features are engaged, for example both Lane Keeping Assist and ACC.

FUTURE SCOPE

Over the next five to ten years, ADAS add-ons are likely to become more standard, and people are likely to become more familiar with their capabilities. AEB in particular may become a widespread feature, either by mandate, or as a de facto requirement to be seen as a competitive market option. Drivers are likely to become accustomed to semi-autonomous driving, particularly in certain conditions such as stop-start traffic jams or flowing motorway traffic. Cars are expected to become increasingly digitised, and their computerised functions are likely to be better integrated, with a view to developing fully autonomous capabilities.

Industry predictions for autonomous cars range from the near-future of 2020, to a more cautious second half of the twenty-first century. Although driving is likely to become ever more automated, it may still take a long time for it to be feasible that all journeys can be driven autonomously. The development of autonomous navigation systems will be significant in moving towards this goal, but it may also take time for developers to achieve adequate safety standards, widespread user adoption, and institutions to adapt frameworks such as legal and licensing procedures to accommodate a whole new generation of technology. It is hard to predict how long these things could take, and they may take time, but autonomous driving is likely to become progressively more advanced and commonplace.

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