Design and Development of Smart Car

Arwaa Mahmood Khalifa Al Rashdi and G. R. Rameshkumar

Abstract—**Traffic jam is one of the most important global problems. Diversity and evolution of the economy increase the traffic jam in every country. This smart car system will reduce the number of car accidents during the traffic jam. And helps the driver by driving the car automatically during traffic jam, by keeping the car in one lane and make safe distance between the two cars. This system is developed using the open-source Arduino software (IDC) and three sensors. The IR sharp sensor is to control the distance and BlackWhite sensors to measures the two road lines.**

Index Terms—**Accidents, Smart Car, Sensors and Traffic**

I. INTRODUCTION

Traffic jam is one of the most important global problems and increasing in each year. There are many factors helps to increasing the traffic jam in the roads such as diversity and the evolution. The traffic jam makes the cars moves in slower speeds and longer trip times, which will effect on the driver. Sometimes the driver spends more than three hours in the road because of the traffic jam. Advanced driver assistance systems (ADAS) are systems designed [1] to help the driver during the driving process. These systems are developed to adapt/automate/enhance the car systems for better and safety driving. Safety features are mound to avoid accidents and collision by implementing safeguards and taking over control of the car to avoid the collision, or by give technologies that warning the driver to possible the problems [2]. Adaptive features may provide adaptive cruise, automate lighting, automate breaking, GPS, warning to the places of the traffic jam connect the smartphones, keep the car in the correct lane, and shown the blind spots. The ADAS are available in many terms; some features are put inside the car or can be add later. The advanced assistance systems are fastest growing segments [3]. The ADAS technology based on sensor technology, (VZV) vehicle to vehicle, camera system, car data network. There are may application for the ADAS for example; on March 2014 the NHTSA in USA announced that all new car under 10,000 dollar to have rear view cameras before May 2018 that because the number of accident happened to the driver because he/she can't see the back of the car and the GM offered the first vibrating seat warning, this seat will works when driver begins drifting out of the road in the highway and the seat will start to vibrate [4]. Also to not allow the driver to start driving the car when the breath alcohol level is high by addition alcohol ignition interlock devices, this system used by the DADSS that addition this system in all cars [5]. Based on the camera images used the detection system to obstacle detection for the self-driving. Also to take 3D model of the view use the stereo vision techniques, this techniques is rely when any small think facing on the cameras and the VIO system to give accurate information to the car. These systems are in the front of the vehicle and they are used for many main curves [6]. All of these systems use wheel odometry and monocular fisheye cameras [7].

The designed system works in two main stages, firstly, was using the multi-view stereo that will extract the depth map from each camera. Secondly, extract and detect both free space and obstacles for each map [8]. Designed smart vehicle [9] using instrumentation system and is depends on GORS protocol which depends on GSM technology and a wireless sensing modules network, to send and the received data from the wireless module to the host server. This system is developed to register information data, such as temperature of the engine, speed of vehicle, etc. with the help of GSM and GPS technology; it also can be used for accident alert and vehicle mapping. Smart car [10] is designed using DC motor to move the smart car with closed loop control system, speed control system and measuring system circuit design. To test the cars speeds, they used the measurement sensors. They conducted testing by three speed measurements that are hall sensor, infrared light pulses the encoder and rotary encode. The car racing in active research field to the automatic driving, designed [11] an automatic controller that find out the rules with a genetic algorithm, done in Hong Kong during the car racing competition. The starting point for this test is buy car with electronic systems, such as automatically decelerating or accelerating, lane change aids, etc., to integral automatic vehicle control. The V-Charge project [12] has been applied in engine VW Golf VI. The hardware modifications integration of a sensor array to be used as data source, to control the car installation a computer and added a safety elements. So the car consists from twelve solar sensors for obstacle detection, stereo camera for obstacle perception and to get 360 imagery of the car used four fish eye cameras. The car also has a GPS receiver with other sensors (gyroscopes, accelerometers and odometers). The test of this car achieved

Arwaa Mahmood Khalifa Al Rashdi is with the Caledonian College of Engineering, Muscat, Oman. Phone: +968 96052200; fax: +968 24535675; (Email: arwaa11022@cceoman.net)

Associate Professor G. R. Rameshkumar is with the Caledonian College of Engineering, Muscat, Oman. Phone: +968 94889468; fax: +968 24535675; (Email: grrameshkumar@yahoo.com)

by using stock actuators and they are some important modifications to the car. These [13], [14], [15] teams modified the serial-production sensor setup formerly in the S-Class car as follows: to test intersection monitoring added 120^0 short range radars and to monitor traffic they added in the sides of the car two long radar [16] Also to increased distance coverage and precision they used the Bertha's existing camera to 35 cm. For pedestrian recognition and traffic light recognition, a wide angled monocular color camera was used [17]. Another wide-angle camera added to looking backward for the same goals of the first camera [18].

II. METHODOLOGY

This project is about a smart car, which has system that drive the car in the traffic jam by using the Arduino software and the system will control the car without any help from the driver. This system will be switched off and on by the driver. Also the components, which used in this smart car selected carefully to achieve the system without any problem.

A. Circuit Diagram

Using the Proteus program the circuit diagram is drawn and is represented in the Fig. 1. To make sure that the wires are connecting to the correct pins in each component in the circuit, to avoid burning and destruction the components.

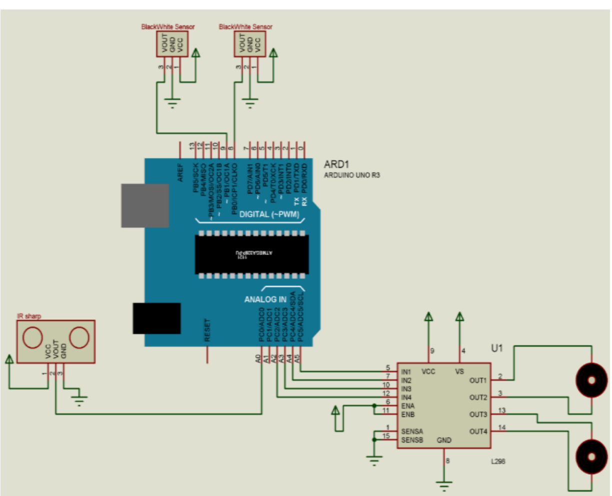

Fig. 1. The circuit diagram for the application

B. Fabrication of Smart Car

After writing the code in Arduino software and installed in the Arduino (ATmega328P), start of doing the fabrication by placing the two DC motors on wheels as shown in the Fig. 2, then the two wheels are attached to the body of the car as shown in Fig. 3. Secondly, paste the L298 Dual H-Bridge Motor Driver to the body frame as shown in Fig. 4.

Thirdly, two Black-White Sensors are fixed at the corners of the small car as shown in the Fig. 5. Later the IR Sharp Sensor is fixed in front of the car as shown in Fig. 6. And the Arduino (ATmega328P) panel is placed in the middle of the car frame body to make the wires connections as shown in Fig. 7.

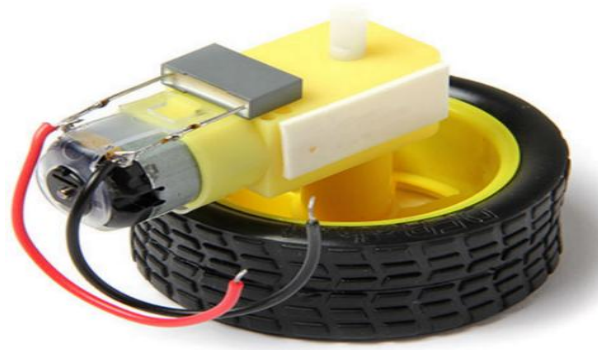

Fig. 2. The DC Motor attached to the wheel

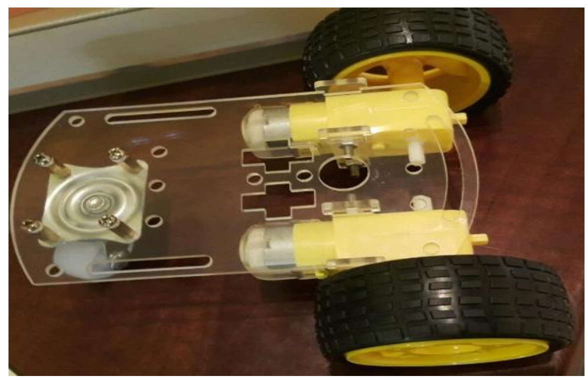

Fig. 3. The two DC Motors are attached to the frame body

Fig. 4. The L298 Dual H-Bridge Motor Driver fixed to the body frame

C. Components

This smart car works with three man sensors that are two BlackWhite sensors and one IR sharp sensor. These three sensors are connected to the Arduino (ATmega328P). Also to move the car wheel need two DC motors, these two motors controlled by L298 Dual H-Bridge Motor Driver. This is the main components that used in this system. The components and specification that used in this smart car are shown in Table 1.

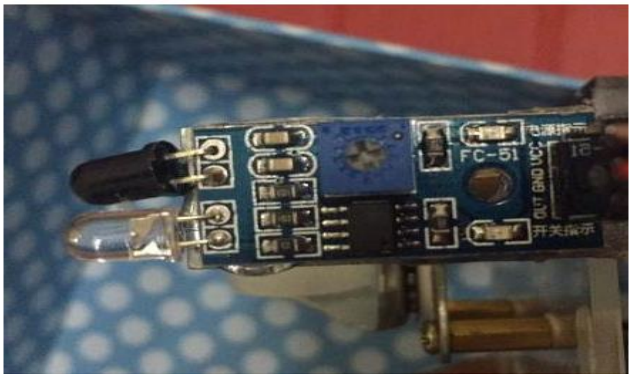

Fig. 5. The two BlackWhite Sensors fixed at the corners of the small car

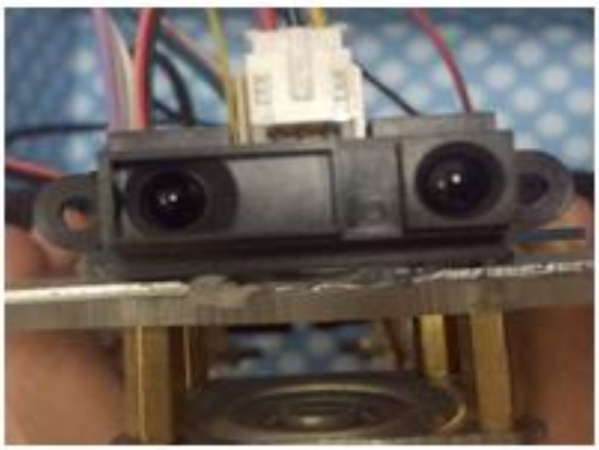

Fig. 6. The IR Sharp Sensor fixed at the front

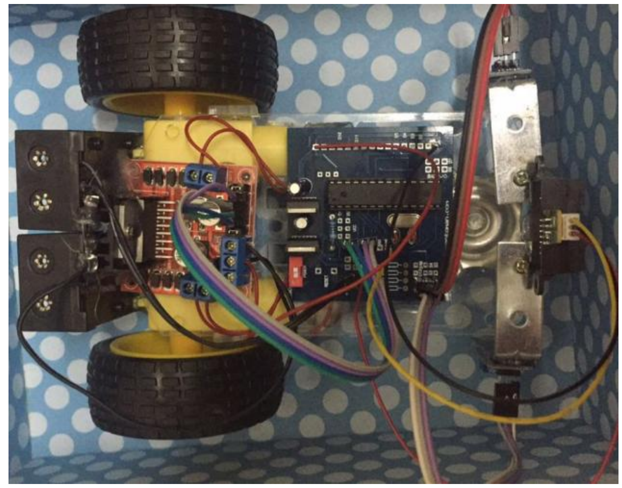

Fig. 7. The Arduino (ATmega328P) panel

III. RESULT AND DISCUSSION

This developed smart car system can be used in the traffic jam for long driving hours, the driver will switch one of the systems then the car will drive automatically without any help from the driver. The testing for this smart car is carried out in two parts. The first part was testing the car without traffic jam and the second part testing carried out in the traffic jam. The first part of the testing was done at the end of the fabrication to check the working of the Black-White sensors and Ultrasonic sensor which change to the IR sharp sensor. Also to check the code accuracy and if required it can be edited. The first part done in three section which are:

Table 1: The specifications of components used in this smart car

No.	Component	Specification
1	Arduino (ATmega328P)	• Operating voltage is 5V. • 14 I/O digital pins. • 32KB of flash memory.
2	IR Sharp Sensor	• Measuring from 20 to 150cm. • Analog output type. • Supply voltage from 4.5 to 5.5V
3	BlackWhite Sensor (two)	• Measure by TCS230 RGB sensor chip and four LEDs. • Supply voltage from 2.7 to 5.5V
4	L298 Dual H-Bridge Motor Driver	• Drive two DC motors in one time. • Power supply from 5V-46V. • 36mA logic current
5	DC Motor	• Voltage from 6 to 9V • Load current ≤280mA • Shaft gap from 0.05 to 0.35mm.
6	Small Car	• Dimensions of this car is 29.5 cm x 13.8 cm x 0.3 cm and weigh is 675 g
7	7805 Voltage regulator	• +5V regulated power supply. • Output current up to A1
8	Ceramic capacitors	• Working with voltage up to 50V. • Range from 1pF to 220nF.
9	Aluminum Electrolytic Capacitors	• Dielectric thickness (μm)0.0013 to 0.0015/V. • Range from 1uF to 47,000uF.

1- Straight road: the road length 100cm and the width 7cm. The first test for the smart car fail within the car distance move even 1 cm and Black-White sensor not be able to check because the Ultrasonic sensor measured the body of the car effect in the Ultrasonic sensor signal as shown in Figures the sensor will read the signal and give an order to the DC motor to be stopped. So, the Ultrasonic sensor stopped the two DC motor and that effect in the Black-White sensors will not be allowable to check. To solve this problem change the Ultrasonic sensor to the IR sharp sensor and conduct the test once again, the result was good it is found that all of the sensors works in good way.
2- Curve road: the road length 100cm and the width 7cm, this road have curves going to the left and right to check the right and left Black-White sensors. The result from this test that the BlackWhite sensors turn left and right almost in the same time. Also the result from this to add important part in code, which 60ms turn delay to measure response speed for the Black-White sensors and this delay will use in the IR sharp sensor to give the sensor chance to check again if there is something near to the smart car before the two DC motor will go forward. This delay will stop the two DC motor for 60ms than forward until the three sensors check for any white lane or for any car.
3- Running track: the track length is 200cm and the width 7cm. This test is carried out to check this system for how many hours can be run because this system is carried out to be use in the traffic jam and in some contrary the traffic jam takes more than three hours. So, the result that this system can be run for more than three hours because this system no need for any extra part to run.

The second part is carried out by making traffic jam in one way road, two way road and three way road this three test road have combination between the three forms car in straight road, Curve road to check and running track to test the system properly.

A. Highway Test – With Two lanes

The road test is carried out in two parts. The first road consist most of curves in the left side for a length of 200cm also there is a small curve in right side. Secondly, the road test is carried out in the road consisting with most of the curves in the right side and road length of 220cm also there is a small curve in the left side. This test is carried out to test the left and right Black-White sensors in all of the required position so that the smart car can drive and can be directed. The result and dictions from this test are:

Road test with left curves: The results from testing the smart car in the high way with two lanes are show in Table 2; the road length started from 100cm and end with 220cm by increased the length of the road 20cm in each time as shown in the second column and this road test carried out with curves in the left side. Also the last two columns show the response of the IR sharp sensor and the left Black-White sensor.

Table 2: Test results of in the high way with two lanes

	Road length in cm	Response	
		IR sharp sensor in v	Black-White sensor (left) in ms
High way- two lanes	80	1.44	50
	100	1.44	50
	120	1.45	51
	140	1.45	52
	160	1.45	52
	180	1.46	52
	200	1.46	52
	220	1.46	52

The response of the left Black-White sensor in road white length 80cm was 50ms and the same response for 100cm road length as shown in Fig. 8. But in road with length 120cm the response of the left Black-White sensor was 51ms, after that the response of the sensor was constant. The right Black-White sensor is response for one time in road with length 200cm was 52ms, because this road test has curves in the left said. So the right Black-White sensor is not measuring white line in this road test. In the beginning of the test the smart car was not straight in the road because of that the response of the Black-White sensor was from 50 to 51ms. After that the smart car stay in the center of the road because of that the response of the sensor was constant. Also the right Black-White sensor was not response any white lanes except at the road white length of 200 and 200cm because there is a small curve in the right side.

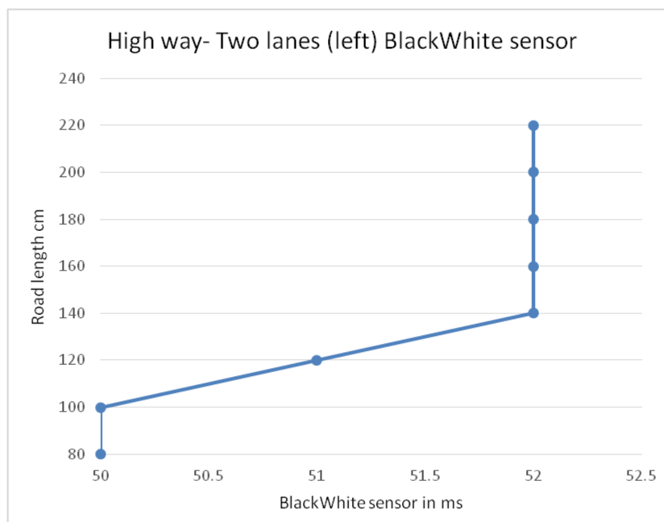

Fig. 8. Highway – Two lanes (left) Black-White sensor

The response of the IR sharp sensor are almost constant as shown in Fig. 9, because the response of the sensor was 1.44v in first test and the same response in the road with length 100cm. Also as shown in Fig. 9 that the response from 1.45 to 1.46 in the remaining reading, which equal to 15cm. That means the smart car stopped if the IR sharp sensor measures any car across 15cm from the front of the car.

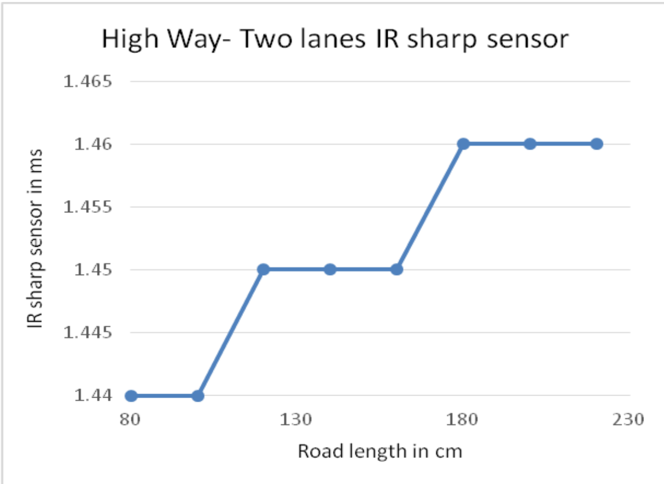

Fig. 9. Highway – Two lanes (left) IR Sharp Sensor

Road test with right curves: The results from testing this smart car in the high way with two lanes are shown in Table 3. This road has right curves; the road length is same as the first test which started from 100cm and end with 220cm by increased the length of the road 20cm in each time as shown in the second column. Also the last two columns show the response of the IR sharp sensor and the right Black-White sensor.

Table 3: Test results of in the high way with two lanes

	Road length in cm	Response	
		IR sharp sensor in v	Black-White sensor (Right) in ms
High way- two lanes	80	1.45	51
	100	1.44	51
	120	1.45	52
	140	1.45	52
	160	1.45	52
	180	1.44	52
	200	1.45	52
	220	1.45	52

The response of the right Black-White sensor in road white length 80cm was 51ms and the same response for 100cm road length as shown in Fig. 10. Then the response of the sensor was 52ms for the road length from 120 to 220cm. The left Black-White sensor is response for one time in road with length 220cm was 52ms, because this road test has carves in the left side because of that the left Black-White sensor is not measuring white line in this road test. In this test the smart car was almost in the center of the road test because of that just there is difference in the beginning of the test that was the response of the Black-White sensor was 51ms, after that the response was constant because the smart car was in the center of the road.

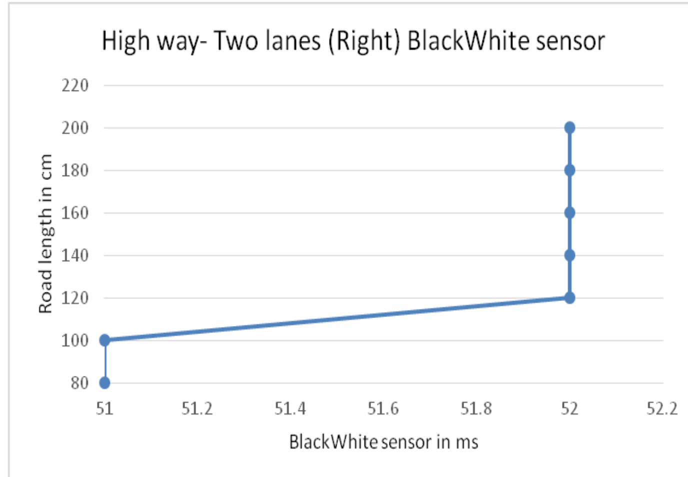

Fig. 10. Highway – Two lanes (Right) Black-White sensor

The response of the IR sharp sensor, which is between 1.45v and 1.44v is shown in Fig. 11. In the entire road test the IR sharp sensor is very sensitive and accurate. That means the smart car stopped if the sensor measures any car across 15cm from the front of the car.

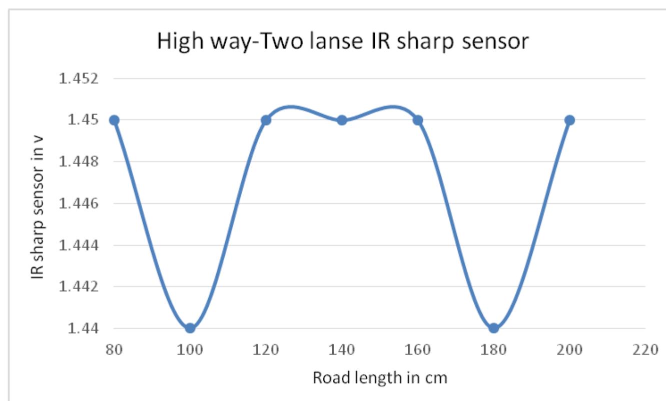

Fig. 11. Highway – Two lanes (Right) IR Sharp sensor

B. Highway Test – With Three lanes

This road test is carried out from length 100 to 200cm as shown in the Table 4, to test the response of the two Black-White sensors at one time and the IR sharp sensor. The second column shows the road length and the last two columns shows the response of two Black-White sensors and IR sharp sensor.

Table 4: Test results of in the high way with three lanes

	Road length in cm	Response	
		IR sharp sensor in v	Black-White sensor (Right) in ms
High way- three lanes	100	1.45	52
	120	1.45	52
	140	1.45	52
	160	1.45	52
	180	1.44	52
	200	1.45	52

The response of the Black-White sensors was constant as shown in Fig. 12. Also the response of the IR sharp sensor was constant except at length 180cm was one point the different as shown in Fig. 13. These results go out because this road designs to be a straight-line with small curve will not affect in the response of the three sensors.

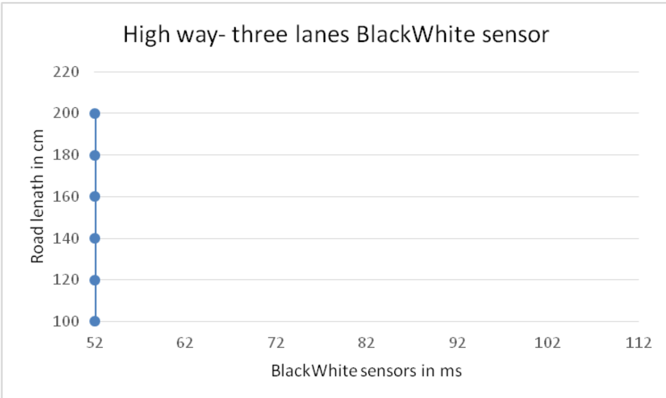

Fig. 12. Highway – Three lanes Black-White sensor

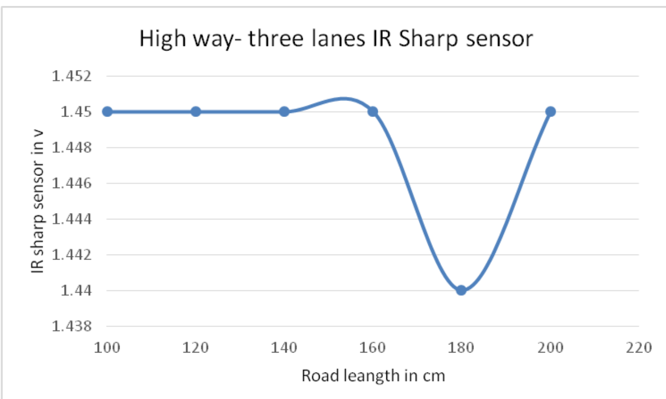

Fig. 13. Highway – Three lanes IR Sharp sensor

Table 5: Test results of in the high way with four lanes

	Road length in cm	Response	
		IR sharp sensor in v	Black-White sensor (Right) in ms
High way- Four lanes	80	1.44	52
	100	1.44	52
	120	1.45	52
	140	1.45	52
	160	1.45	52
	180	1.46	52
	200	1.46	52
	220	1.46	52
	240	1.44	52
	260	1.45	52

C. Highway Test – With Three lanes

In Oman there is no high way with four lanes for more than 2km, but this test done for the future use and to use this system in any country. The results from this test are shown in Table 5. The second column shows the road length, which started with 80cm and end whit 260cm. Also the last two columns show the response of the IR sharp sensor and the right Black-White sensor.

The response of the Black-White sensors was 52ms in any road length as shown in Fig. 14. The smart car was in the center of the road from the beginning of the test because of that the response of the Black-White sensors was constant. Also the width of the road was proper for this test.

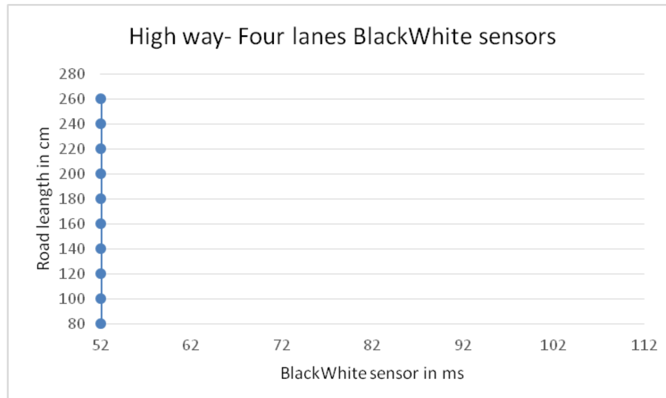

Fig. 14. Highway – Four lanes Black-White sensor

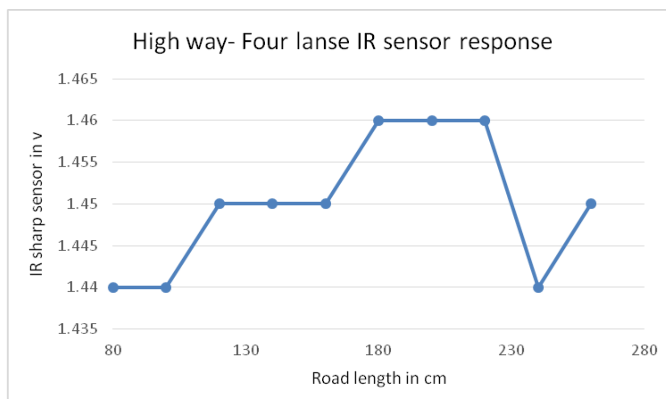

Fig. 15. Highway – Four lanes IR Sharp sensor

The IR sharp sensor let the smart car stopped if the signal of the sensor affected by any car from the front. The response of the sensor was from 1.44 to 1.46v as shown in Fig. 15 that equal to 15cm and this good safety distance for the smart car.

IV. CONCLUSION

Design and fabrication of smart car addressed the automatic driving system while driving in the traffic jam, and it is carried out using Arduino software to programming the IR sharp sensor and Black-White to drive the car automatically without any help from the driver. This system meet the main aim of work that the car can drive in the traffic jam without any help from the driver, by controlling the speed of the car, keep one safety distance between the cars using the IR sharp sensor. And maintain the car in the real road all of the time using the Black-White sensors one in the right and one in the left. The future work of this smart car is the improvement in changing the lane of the road and full automatic driving in any speeds.

REFERENCES

[1] D.Sivaraj, R.Radhakrishnan, A.Kandaswamy, J.Prithiviraj, S.Dinesh, & J.Krishanth. (2011). Design of Automatic Steering Control and Adaptive. *International Journal of Computer Applications, 3*, 12-17.

[2] M.Narasimhulu, G.Subrahmanya, & B.Naresh. (2012). DESIGNING OF A SMART CAR USING ARM7. *International Journal of Advances in Engineering & Technology, 3*(2), 185-191.

[3] N.Amal, & N.Eman. (2013). Design of SMART Car. *Universal Journal of Mechanical Engineering, 1*(1), 1-12.

[4] Obstacle Detection for Self-Driving Cars Using Only Monocular. (2013). *Framework Programme, II*(12), 1-8.

[5] Komar. (2015, December 12). *ADVANCED DRIVER ASSISTANCE SYSTEMS*. Retrieved from Nvidia: http://www.nvidia.com/object/advanced-driver-assistance-systems.html

[6] Kramer. (2015, December 2). *DC motor 6/9V*. Retrieved from Arduino: https://www.arduino.cc/documents/datasheets/DCmotor6_9V.pdf

[7] Doer. (2015, December 3). *Color Sensor User Manual*. Retrieved from Chipdip: http://lib.chipdip.ru/184/DOC001184049.pdf

[8] H.Christian, T.Sattler, & M.Pollefeys. (2013). Obstacle Detection for Self-Driving Cars Using Only Monocular. *Framework Programme, II*(12), 1-8.

[9] A. Aher, M. Turkane, S.Turakne, N. Kadu, & S. Taware. (2011). Smart Vehicl. *International Journal of Computer Technology and Electronics Engineering, 2*(1), 208-212.

[10] L.Jun, L.Min, & Z.Chu. (2012). Design and Developement of Smart car DC Motor Speed Control System. *Electrical and Information Engineering, 2*(3), 4916-4919.

[11] P.Diego, S.Yago, R.Gustavo, & I.Pedro. (2008). Evolving a rule system controller for automatic driving in a car. *IEEE Symposium on Computational Intelligence and Games, III*(10), 336-342.

[12] P.Furgale, U.Schwesinger, M.Rufli, W.Derendarz, H.Grimmett, P.M¨uhlfellner, . . . E.Cardarelli. (2008). Toward Automated Driving in Cities using Close-to-Market Sensors. *European Union Seventh Framework Programme, II*(8), 1-8.

[13] J.Ziegler, T.Dang, U.Franke, H.Lategahn, P.Bender, M.Schreiber, . . . G. Herrtwich. (2012). Making Bertha Drive — An Autonomous Journey. *IEEE Intelligent Transportation Systems Magazine, 6*(2), 8-20.

[14] F.Yuezhen, Z.Fu, D.Feng, & Q.Hua. (2012). Design of a Smart Car based on Wireless Image Acquisition. *International Conference on Machine Learning and Computing, 25*, 194-199.

[15] Chen. (2015, December 3). *Arduino car*. Retrieved from DX: http://www.dx.com/p/arduino-compatible-bluetooth-controlled-robot-car-kits-146418#.Vna6b9I715c

[16] Chen. (2015, December 2). *Arduino Ultrasonic Range Detection Sensor*. Retrieved from Parsicitalia: http://www.parsicitalia.it/files/HC-SR04-Datasheet.pdf

[17] James. (2015, December 2). *Arduino*. Retrieved from Gravitech: http://www.gravitech.us/arna30wiatp.html

[18] Reich. (2015, December 3). *Arduino Modules - L298N Dual H-Bridge Motor Controller*. Retrieved from Instructables: http://www.instructables.com/id/Arduino-Modules-L298N-Dual-H-Bridge-Motor-Controll/

Ms. **Arwaa Mahmood Khalifa Al Rashdi** is pursuing her Bachelor degree in Mechatronics engineering at Caledonian College of Engineering, Muscat, Sultanate of Oman. Her research interest is Mechatronic System Design.

Associate Professor Dr. G. R. Rameshkumar is presently working as Senior lecturer at Caledonian College of Engineering, Muscat. He received his B.E (Mechanical) and M.Tech (PEST) degrees from Mysore University (India) in 1984 and 1995 respectively. He received his PhD degree from VIT University, Vellore, India. His research interests are in the field of Vibration Monitoring, Condition Monitoring, Mechatronics and Computer Aided Design & Manufacturing.