Fully Automated Robotic Vehicle with Real Time Image Detection and Collusion Avoiding Features

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Abstract: ***Due to the simplicity and ability to change according to our needs, the robotics and automation are being used widely in industries. The project is intended to build an automatic vehicle using GPS which is based on computer to generate its path coordinate. GPS module is used to obtain GPS data. Mobile camera detects the obstacles and machine learning algorithm is used to avoid it and performs real time object detection. The vehicles we developed uses electric motor to run wheels and has full control of the throttle, steering and breaking. An Arduino device controls the vehicle following the command generated by the computer. Traffic has risen by quite a huge number. Excessive number of vehicles occur vehicle accident every day. Driver issue is also a great problem. Our goal is to decrease the possibilities of accidents and to ensure the safety of the passengers. Besides the vehicles can be useful for blind and handicraft people. But our main target is to serve this device to our military so that they can be helpful at the time of danger. The vehicle contains sensors to observe the environment. Besides it can be operated by human manually.***

Index Term: Fully automated robotic vehicle, Collusion avoiding agent, Realtime image objects identification.

1. Introduction

Every year more than one million people die all over the world because of road accident. According to the accident research every year more than ten thousand people become injured or disable in Bangladesh. It causes five to seven thousand crores national loss every year. 2% of national GDP is used behind road crash victims. Fully automated robotic vehicle can be a solution for this problem. Here we are discussing some ways through which out automated vehicle will change the situation.

Due to rough driving, illegal overtaking and drunk driving every year 1.25 million of people are killed all over the world. Automated vehicle will never drive drunk, never take illegal overtake and follow the traffic rules. The vehicle never gets angry or energy less like a human driver. So, the vehicle ensures safety of its passengers.

Automated vehicle is cheaper than a car. Besides there is no cost for hiring a driver. The vehicle can be used for drive sharing like a taxi cab. It will be cost effective. Government like Bangladesh has adopted strict rule in case of parking. Illegal parking causes high amount of fine. Out automated vehicle can be separated into small parts and user can fold it up. It can be kept in front of door because it takes small space. This will take shorter space on road also. Thus, it will solve parking and space problem.

Driving in long distance takes a lot of time. If we calculate our driving time then we must be shocked. We have wasted a lot of time for driving. We could do our official or other important work easily within that time. The driverless automated vehicle will save the time and one can make the proper use of his driving time by doing important official work or reading.

Driving causes a lot of energy loss. Sometimes it causes bad impact on health of driver. Our automated vehicle runs automatically following the map and it will save the energy of its user. User can have sleep or can take rest
while the vehicle will run.

Google planned to make autonomous car which will be used for personal and medical purpose. Google worked on it and made demo model of their car. They performed many test cases and the car passed most of the cases.

Fig. 1: Google Autonomous Car

Figure 1 showing a Google autonomous car. The car was fantastic but it was expensive and people like Bangladesh cannot buy such type of expensive automated car. That one thing paves the way to work on it. We tried to make a model which will work like google autonomous car but will be cheap.

2. Related Works

Self-sufficient vehicle development started in 1980s with projects such as the EUREKA Prometheus Project in Europe and the Autonomous Land Vehicle Project of the United States. The DARPA Grand Challenges in 2004 and 2005 saw the exploration of a desert domain by groups of self-governing vehicles, while the 2007 Urban Challenge required a road-based course and adherence to movement conventions. The VisLab Intercontinental Autonomous Challenge in Europe in 2010 included a self-governing drive from Italy to China following a pioneering vehicle. These rivalries saw gigantic field improvement, with cutting edge advancements effectively getting to be accessible for car use. Self-governing driving technology is rapidly developing for market use in coming years. Google discovered that without human intercession their self-sufficient vehicles had driven 140,000 miles on open streets in the US.[1][2]

During the last decade, aid frameworks for drivers have gradually become standard in new cars, but there was limited refinement. Toyota initially offered flexible travel control using a laser sensor in 1998. Most frameworks are insignificantly obtrusive and are outlined solely to widen the human driver's inadequacies. The eventual fate of this innovation is a notable guarantee for improving the well-being of the streets and is illustrated by Daimler's exploration which offers novel usefulness, for example, the location of risky circumstances in roundabouts.[3][4]

The ability of self-sufficient cars started to be developed and investigated, with events such as the autonomous Audi TTS at Stanford University, which was able to execute and also qualified hustling drivers. This activity is particularly notable as its points are like our role in using electronic control mechanisms to push the mechanical capabilities of the auto "at the breaking points." Using a new suite of track sensors, the auto drive mind has been boggling, long (20 km) race tracks.[5]

3. Methodology

3.1. Arduino Programming Language

Arduino programs are written in the Arduino Integrated Development Environment (IDE). Arduino IDE is a special software running on your system that allows you to write sketches (synonym for program in Arduino language) for different Arduino boards. The Arduino programming language is based on a very simple hardware programming language called processing, which is similar to the C language. After the sketch is written in the Arduino IDE, it should be uploaded on the Arduino board for execution.

3.2. Proposed Circuit Description

The vehicle's block diagram is shown at Fig. 2. It has two main sections: (a) transmitter (b) receiver and driver of engine. The transmitter circuit (Fig. 2) consists of the IC HT12E (IC1) encoder, the 433MHz RF transmitter module (TX1) and a few discrete components. The receiver and motor driver circuit are built with the Arduino UNO board, IC decoder HT12D (IC2), 433MHz RF receiver module (RX1), IC L293D (IC3) motor driver, IC 7805 (IC4) regulator and a few discrete components.

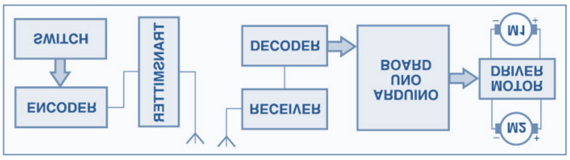

Fig. 2: Block diagram of Arduino-based RF controlled robot

3.3. Arduino Board

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards and other circuits. The board has 14 digital I/O pins, 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. The short description of the components has been shown in Table 1.

Table 1: Components in Arduino Board

Component name	**Configuration**
Microcontroller	ATmega32u4
Operating Voltage	5V
Input Voltage	5V through flat cable
Digital I/O Pins	5
PWM Channels	6
Analog Input Channels	4 (of the Digital I/O pins)
Analog Input Channels (multiplexed)	8
DC Current per I/O Pin	40 mA
Flash Memory	32 KB (ATmega32u4) of which 4 KB used by boot loader
SRAM	2.5 KB (ATmega32u4)
EEPROM (internal)	1 KB (ATmega32u4)
EEPROM (external)	16 MHz
Clock Speed	16 MHz
Keypad	5 keys
Knob	potentiometer attached to analog pin
Full color LCD	over SPI communication
SD card reader	for FAT16 formatted cards
Speaker	8 Ohm
Digital Compass	provides deviation from the geographical north in degrees
I2C soldering ports	3
Prototyping areas	4
Radius	185 mm
Heigth	85 mm

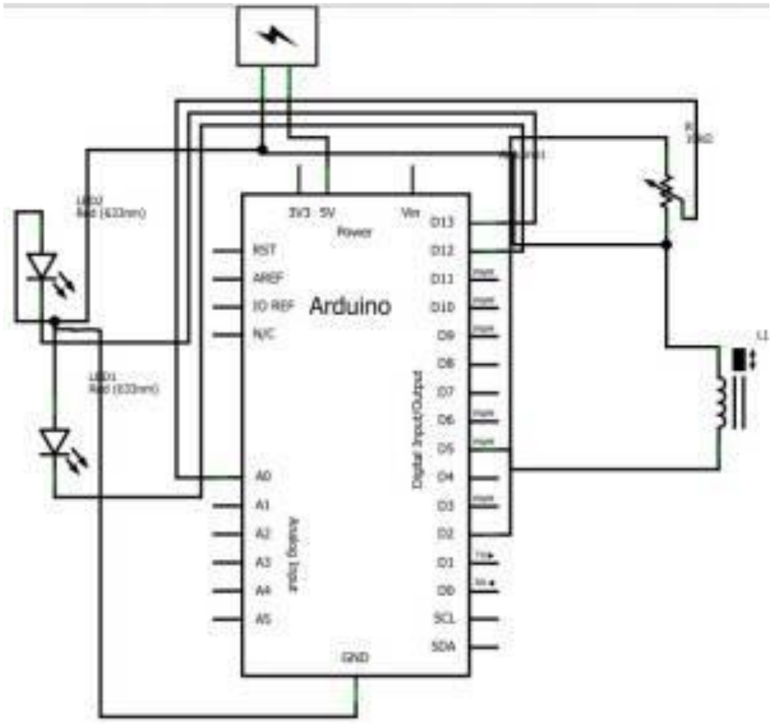

Fig. 3: Arduino Uno with Digital Input/output

3.4. Remote Control

An encoder decoder pairs (HT12E and HT12D) with a transmitter-receiver pair is used to monitor the robot from afar. The 433MHz transmitter-receiver pair with the encoder-receiver pair is proposed here. The encoder decoders are CMOS ICs with a working voltage range between 2.4V and 12V. The encoder has 12 lines (8-address lines & 4-address / data lines) that are transmitted serially when the activate pin is transmitted low. On OUT pin the output data appears serially.

The transmitted data consists of differing lengths of pulses for ‘1’ and ‘0’ which is of positive going. The ‘0’ pulse width is of twice that of ‘1’ pulse width. The address part of the data received on A0 through A7 pins four times in succession is done, only then valid transmission pin is taken high. The internal oscillation frequency of decoder HT12D is 50 times more than the encoder HT12E. The data on address pins AD8-AD11 of HT12E appears on pins D8-D11 (data lines) of HT12D, the device acts as receiver of 4-bit data with 8-bit addressing.

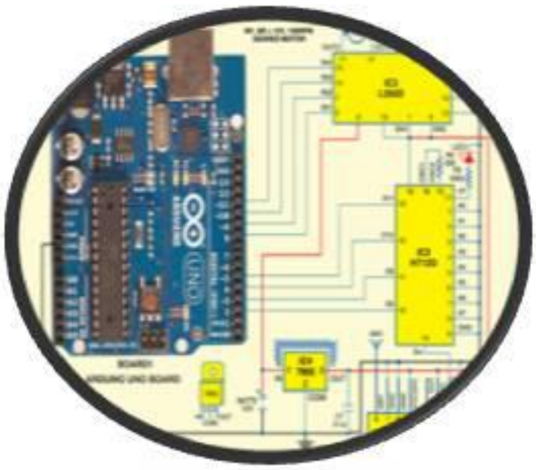

Fig. 4: Receiver and Motor driver Circuit

Transmitter: To set the transmitter frequency, the resistor R1 is connected between the oscillator pins 15 and 16. The S1, S2, S3 and S4 switches are interfaced with the HT12E encoder for forward, reverse, left and right motions respectively.

3.5. GPS

GPS satellites circle the Earth twice a day in a precise orbit. Each satellite transmits a unique signal and orbital parameters that allow GPS devices to decode and compute the precise location of the satellite. GPS receivers use this information and trilateration to calculate a user's exact location. Essentially, the GPS receiver measures the distance to each satellite by the amount of time it takes to receive a transmitted signal. With distance measurements from a few more satellites, the receiver can determine a user's position and display it electronically to measure your running route, map a golf course, find a way home or adventure anywhere. To calculate your 2-D position (latitude and longitude) and track movement, a GPS receiver must be locked on to the signal of at least 3 satellites. With 4 or more satellites in view, the receiver can determine your 3-D position (latitude, longitude and altitude). Generally, a GPS receiver will track 8 or more satellites, but that depends on the time of day and where you are on the earth.

Once your position has been determined, the GPS unit can calculate other information, such as speed, bearing, direction, distance to the destination, time to sunrise and sunset and more.

GPS receivers are extremely accurate, thanks to their parallel multi-channel design. Our receivers are quick to lock onto satellites when first turned on. They maintain a tracking lock in dense tree-cover or in urban settings with tall buildings. Certain atmospheric factors and other error sources can affect the accuracy of GPS receivers. Garmin GPS receivers are typically accurate to within 10 meters. Accuracy is even better on the water.

Some Garmin GPS receiver accuracy is improved with WAAS (Wide Area Augmentation System). This capability can improve accuracy to better than 3 meters, by providing corrections to the atmosphere. No additional equipment or fees are required to take advantage of WAAS satellites. Users can also get better accuracy with Differential GPS (DGPS), which corrects GPS distances to within an average of 1 to 3 meters. The U.S. Coast Guard operates the most common DGPS correction service, consisting of a network of towers that receive GPS signals and transmit a corrected signal by beacon transmitters. In order to get the corrected signal, users must have a differential beacon receiver and beacon antenna in addition to their GPS.

Fig. 5: Working Principle of GPS

We got the current position using the GPS of our smartphone and then we used the Google Earth coordinates to run the car according to the desired route.

4. Working Principle

4.1. Video acquisition

Various camera mounted on the car offer RGB frames in real time. The Compiled program collects the frames (RGB) from the camera at regular trigger intervals that are set at a given frame rate. Performance and precision depend on the fps and refresh rate.

4.2. Pre-processing

To apply thresholding algorithms, the obtained images are converted to GRAY scaled images, and then to binary images. After that specific noise reduction algorithms are implemented including median and Gausian filtration techniques. Morphological functions are eventually applied to binary frames so that no noise can present in them.

4.3. Detection of Objects

Red layered matrix is transferred to circle finding functions that identify the road symbols that appear on the way. Such objects are positioned and are circled and compared to the path matrices which are prestored. The path images are then transformed to grayscale and divided into nine parts. White pixels in these segments are saved and 1D array of different directions is created. If an object's co-ordinates shift for different frames, it means a moving object is identified. The detection method is iterated by looking for unique coordinates in different frames. In this way, from the video source input each frame produces two mathematically determined arrays for the right and left direction respectively. The input list from the frame is appended, and the minimum difference algorithm is implemented by simultaneously searching for total number of discrepancies between the two sets. The array generating the minimum value gives us a precise estimate of the path that the video source must have taken into account.[6, 7]

4.4. Speed Change

The changing of moving object coordinates is measured at different time intervals and stored in an array. For objects around the vehicle, the rate of velocity change is determined using the array. When

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the processed path is detected, the program starts the microcontroller with signals and regulates the velocity of the actuators (motors). Histogram represents tabulated frequencies such as rectangles / triangles erected over discrete intervals with an area proportional to the frequency of observations. This aids in and tracks speed variations.

4.5. Data processing

The Processor measures everything from the upcoming inputs, and sends successful commands back. The retour controller transmits the decoded logic for the actuators as a binary electrical value. It is then forwarded to the receiver that is mounted on the car. Different signs are stored as blocks of data and matched using best matching algorithm.

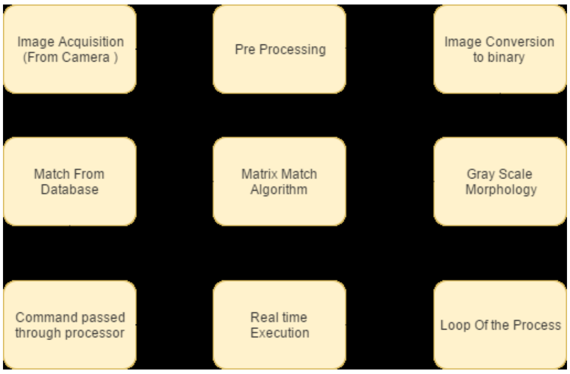

Fig. 6: Block Diagram

5. Result

Due to compression and continuous image capture., the processor take decision and directs the car. It follows lane driving and changes lanes if heavy density is found on the lane and its speed also varies. This reads various road symbols on the road and acts accordingly.

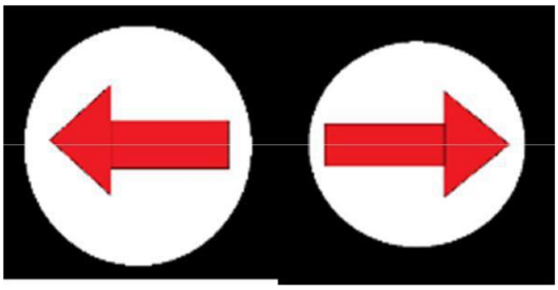

Fig. 7: Left Right Database

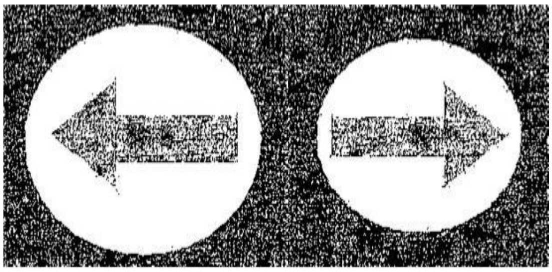

Fig. 8: Left Right Gray Scaled Images

Fig. 9: Lane Detection

Fig. 10: Road Symbols in different formats

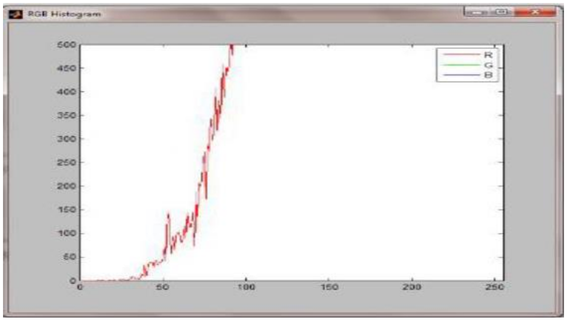

Fig. 11: Histogram of dense traffic

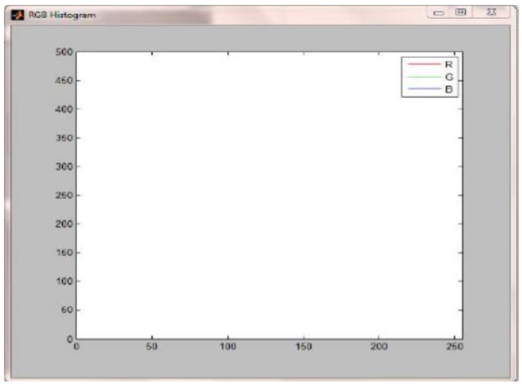

Fig. 12: Histogram of Empty Roads

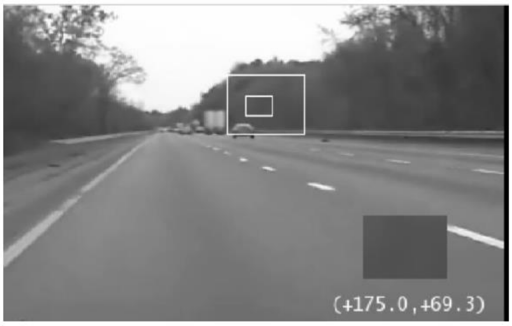

Fig. 13: Vehicle Detection on the road

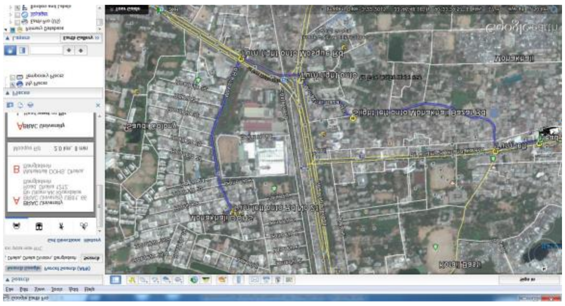

Fig. 14: Working Path via GPS

Fig. 15: Real Time Image Identification

6. Discussion & Conclusion

Autonomous driving is now a very exciting aspect of the motor vehicle industry. This kind of autonomous research has not been established much especially in Bangladesh. Autonomous vehicles will represent a major step in our country's technological advancement. This project shows significant promise as a forum to improve autonomous driving technologies and it is expected that future work will concentrate on refining and developing the approaches outlined here with the implementation of the underlying systems completed. It would be a very propitious sector if our government and private investors are willing to grant this research field to finance.

Even so, implementing this project with a limited budget is difficult. LASER sensors are necessary to get precise and accurate results. Such kinds of sensors are pretty expensive, which is a downside. If the laser sensor called "LIDAR" is used in future works, the tests will certainly have very fewer errors. Further changes in the hardware platform would give better results in accurately collecting and synchronizing GPS data with the Arduino simultaneously.

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