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An Intelligent AGV with Lane Detection and Obstacle Avoidance Using ARM

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Abstract

Road accident is 'a global tragedy' with ever-rising trend. This Project aims at the development of an AGV (Automatic Guided Vehicle) using ARM Cortex M3 based microcontroller which will prevent the accidents in road ways. The AGV will be guided by the controller by gathering the information provided by the sensors. The lane detection is done by the color sensor input and other vehicles are detected by the ultra sound sensor. If the system detects that a vehicle is going before it and the other lane is free then it will switch over to the next lane. Also if the other lane is not free then it will slow down to avoid accident. The vehicle speed and direction will be controlled by the ARM controller using 4 stepper motors.

Keywords: Automatic Guided Vehicle, lane detection, Advanced Driver Assistance Systems, Intelligent Transportation Systems, ultrasonic sensors.

Introduction

The objective of the project is to improve the internal and external security to the human in roadways. Ninety-one percent of the world's fatalities on the roads occur in low-income and middle-income countries, even though these countries have approximately half of the world's vehicles. If no action is taken, road traffic crashes are predicted to result in the deaths of around 1.9 million People annually by 2020.Hence the goal of the United Nations' Decade of Action for Road Safety 2011-2020 is to save five million lives. In this paper an automated guided vehicle is proposed to prevent the accidents in roadways. An AGV is a kind of robot. A Robot is a virtual or a mechanical artificial agent. In practice, it is usually a mechatronics device consisting of mechanical model and electronic circuit which is guided by computer or electronic programming, and is thus able to do tasks on its own. The guiding force behind the robot is an Embedded System. At the core of every Embedded System there is either a microprocessor or a microcontroller or any other programmable intelligent unit. Basically a robot consists of a mechanical device, such as a wheeled platform, arm, or other construction, capable of interacting with its environment Sensors on or around the device that are able to sense the environment and give useful feedback to the device Systems that process sensory input in the context of the device's current situation and instruct the device to perform actions in response to the situation.

Automatic Guided Vehicles (AGVs)

Automatic guided vehicle systems are fully automatic transport systems using unmanned vehicles. AGVs safely transport all kinds of products without human intervention within production, logistic, warehouse and distribution environments. The clear way to reduce costs and to increase efficiency and profitability.AGVs has to make decisions on path selection. This is done through different methods: frequency select mode (wired navigation only), and path select mode (wireless navigation only) or via a magnetic tape on the floor not only to guide the AGV but also to issue steering commands and speed commands.

B.Lane Detection and Tracking

Lane-tracking is a fundamental function of current intelligent vehicle system with different realization methods, mainly of different lane-detection sensors. An intelligent racing vehicle is designed for the real driving environment with road marks, cars and even walking people. In order to recognize them all, a camera sensor is required for

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sufficient information. In some cases, more sensors such as lidar and sonar are also required for obstacle avoidance and improving safety. However, as to an intelligent vehicle designed for material handling in factory, the infrared sensor is usually used for lane detection because the environment is often structured by guidance lines. Sometimes the magnetic sensor and underground metal wires are also used for lane are preferred for lower cost and higher flexibility.

Objective and methodology

Objective

- To avoid the accidents in Road ways
- To maintain a safe and reliable travel
- To provide road security by using Automatic Guiding Vehicle with a standalone ARM controller capable of avoiding collisions and switching lanes
- To perform lane and object detection using IR light and sensor.
- To control the speed and direction of Automatic Guided Vehicle (AGV) by the ARM controller.

Existing System

Today's the Existing System in the Road ways Travel is manual Driving and the AGVs are under research. This system results in many accidents since it was driven by humans, the nature of driving is unpredictable. Also if there is an accident occurred the cause for the accident can't be determined. Some of the driving experience will be like uncontrolled rash driving. The lane-tracking accuracy is affected by the response time of the selected servo motor. In the existing system, the spline-based lane model was used in lane marking detection and tracking area. But its potentials and advantages against other models have never been fully explore and lane detection based on hough transform was less accurate during detection in bad conditions.

Proposed System

Our proposed system is an Autonomous Guided Vehicle which will be controlled by a standalone ARM controller. This is a high performance processor so the response to take an action will be very fast. Our AGV will take the necessary actions when it detects a collision like lane switching, slowing down, or stopping the vehicle. The proposed system presented an integrated approach to detect and follow the road lanes line and /or detect and avoid obstacles while a small ground vehicle is driven autonomously. A design of DC motor driver, based on the H Bridge using complementary MOSFET type, is implemented in the proposed system. Differing from the conventional DC motor driver requiring dead time generation, the proposed driver does not has a dead time generator by using gate bias. Therefore, this proposed H-bridge driver without dead time generation can not only reduce its hardware complexity, but also increase the driving efficiency. In the proposed system the speed of operation increased than the existing system.

Methodology

In the proposed system, Automatic Guided Vehicle (AGV) using ARM cortex M3 based microcontroller is used for the lane detection. The AGV will be guided by the controller by gathering the information provided by the sensors. The lane detection is done by the color sensor input and other vehicles are detected by the ultra sound sensor. The guiding force behind the robot is an Embedded System. At the core of every Embedded System there is programmable intelligent unit. This proposed system discusses a protocol which avoids vehicle accidents. The vehicle state information is being obtained using ultrasonic sensors, to predict potential accident and accordingly reduces the vehicle speed. This protocol provides warning message when the safety distance is reduces than the safety limit. Here, the car will be equipped with an ultrasonic sensor which will continuously track for any obstacles from the front side.

The AGV is capable of interacting with its environment Sensors on or around the device that are able to sense the environment and give feedback information to the device systems that process sensory input in the context of the device's current situation and instruct the device to perform actions in response to the situation. Motors can be used to drive the AGV using differential turning mechanism. The term 'differential' means that AGV turning speed is determined by the speed difference between both wheels, each on either side of the AGV.

The AGV read the lane status and object detection is done by using IR light. The basic idea is to send infra red light through IR-LEDs, which is then reflected by any object in front of the sensor. The IR emitter LED is used which emits infrared radiations. The radiations are reflected by any object or obstacle in its path. IR has a property that it is reflected by the white line and absorbed by the black surface. Using this principle we construct an AGV robot. A white line is drawn on a black surface. The emitted IR is thus reflected back when sensor comes over a white surface. However no IR is reflected back in case of black surface. The reflected IR is detected

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by an IR receiver photodiode. This is an electrical property of receiver photodiode which is the fact that a photodiode produce a voltage difference across its leads when it is subjected to light. When the IR is reflected by white surface the voltage drop across the cathode of the receiver LED decreases.

The AGV checks for lane detection. When it detects lane, it produces high electric pulse and further checks for collision. If it doesn't detect any lane, it produces lower electric pulse and switches to left or right direction for the detection of lane. The AGV need something to make it run. An actuator activated the AGV and is basically anything that causes movement on your robot. A direct current motor is used to translate electrical pulses into mechanical movement. In DC motor we have + and – leads. Connecting them to a DC voltage source moves the motor in one direction (i.e. clockwise rotation). By reversing the polarity, the DC motor will move in the opposite direction.

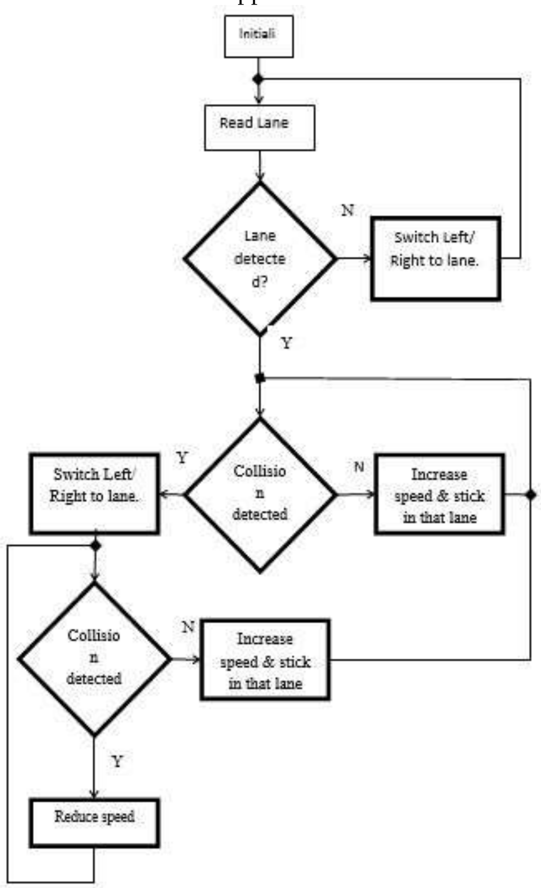

Fig.1 System Flow diagram

The microcontroller sends a signal to the H-bridge that acts as a switch. If the signal received by the H-bridge is high, it will rotate the motor or else it will reduce the speed of AGV. The microcontroller sends a signal to a switch which gives the voltage required by the motor to rotate. When the AGV detects collision it reduces the speed of AGV and it switches to either left or right direct for further lane and collision detection. The process is iterating when the lane or collision is detected. If the AGV doesn't detect any collision, then it increases the speed of AGV and sticks on that lane and again start the process of reading and detecting the lane. In the proposed methodology, an integrated driving safety system, which combines lane detection, collision detection is presented. Lane detection and vehicle detection are work together for providing accurate recognition result. The overall AGV circuit diagram is shown in fig.2.

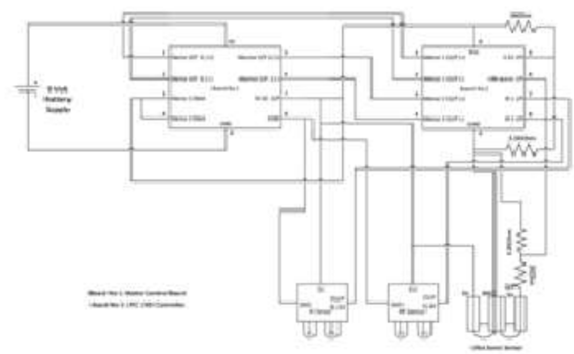

Fig.2.Over all AGV Circuit diagram

System description

Embedded systems technologies are usually fairly expensive due to the necessary development time and built in efficiencies, but they are also highly valued in specific industries. Smaller businesses may wish to hire a consultant to determine what sort of embedded systems will add value to their organization

Basic Components Required

1. Chassis
2. Wheels
3. Battery
4. Power supply
5. Electronic circuitry
6. Motor

Dc Motor

A direct current motor is used to translate electrical pulses into mechanical movement. In DC motor we have + and – leads. Connecting them to a DC voltage source moves the motor in one direction (i.e. clockwise rotation). By reversing the polarity, the DC motor will move in the opposite direction (i.e. counter clockwise rotation). The maximum speed of DC motor is indicated in rpm. The DC motor has two rpms: no load and loaded. The rpm is reduced when moving a load and decreases as the load is increased.

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DC motors also have voltage and current ratings.

Fig.3. 60 RPM 12V DC Motor & L298 Motor driver

The nominal voltage is the voltage for that motor under normal conditions, can vary from 1 to 150V, depending on the motor .As we increase the voltage, the rpm goes up. The current rating varies from 25mA to a few amps. As the load increases, the rpm is decreased, unless the current or voltage.

H-Bridge (L293B)

The microcontroller sends a signal to the H-bridge that acts as a switch. If the signal received by the H-bridge is high it will rotate the motor or else it won't do so. Note that microcontroller only sends a signal to a switch which gives the voltage required by the motor to rotate. Here we are using L293B which can be used to control two motors. Pin connections for

H-bridge: En1 & En2 are given logic 1 from microcontroller or give 5V from outside and are used to activate/deactivate one „half" of the H-bridge. V is the voltage that you want to supply to the motor(s) 9 or 12V Vcc is the logic 1 or 5V

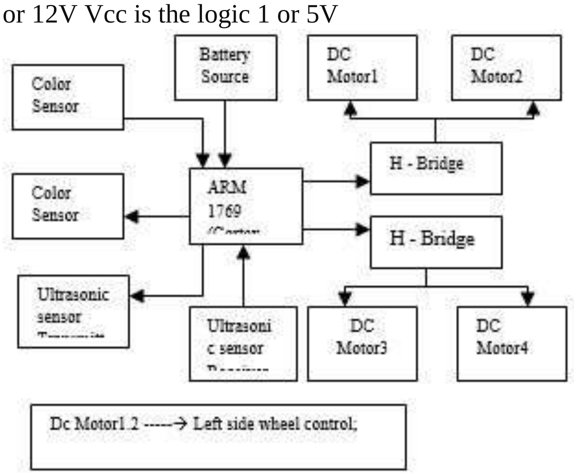

Fig.3. System's over all block diagram

Sensors

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer and by an instrument. A transducer is a device that converts one type of energy to other. The conversion can be from electrical, electromechanical, electromagnetic, photonic or any other form of energy.

Robots react according to a basic temporal measurement, requiring different kinds of sensors. The term transducer is often used interchangeably with sensors. A Transducer is the mechanism of the sensor that transforms the energy associated with what is being measured into another form of energy. A sensor receives energy and transmits a signal to display or computer. Sensors use transducers to change the input signal (sound, light, pressure, temperature etc,) into an analog or digital form capable of being used by a robot.

HC-SR04 Ultrasonic Sensor Distance Measuring Module

Ultrasonic ranging module HC-SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit.

The basic principle of work is to use IO trigger for at least 10us high level signal,The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning. Test distance = (high level time×velocity of sound (340M/S) /2.

Fig.4. Ultrasonic sensor

Infrared (IR) Obstacle Avoidance Sensor Module (Adjust-Distance)

This sensor module have great adaptive capability of the ambient light, having a pair of infrared transmitter and the receiver tube, the infrared emitting tube to emit a certain frequency, encounters an obstacle detection direction (reflecting surface), infrared reflected back to the receiver tube receiving, after a comparator circuit processing, the green LED lights up, while the signal output will output digital signal (a low-level signal), through the potentiometer knob to adjust the detection distance, the effective distance range 2 ~ 80cm working voltage of 3.3V-5V. The detection range of the sensor can be adjusted by the potentiometer, with little interference, easy to assemble, easy to use features, can be widely used robot obstacle avoidance, obstacle avoidance car assembly line count and black-and-white line tracking and many other occasions.

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Fig.5. IR obstacle avoidance sensor & object detection using IR sensor.

ARM Controller Board

ARM development boards are the ideal platform for accelerating the development and reducing the risk of new SOC deigns. The combination of ASIC and FPGA technology in ARM boards delivers an optimal solution in terms of speed, accuracy, flexibility and cost.ARM development board are often used to evaluate benchmark and software development on the latest ARM processors.Prototype, validate and develop software drivers for new Soc IP blocks – for example, a modem or video engine.Test custom logic block or system IP in an FPGA, connected to an ARM core running at ASIC speed.

Results and discussion

The Screenshots for software and Hardware Implementation is shown below.

Fig.4.Development board connected to Laptop via Debugger for programming

Fig.5. Erasing the target device

Fig.6. Flashing the device.

Fig.no.7. Main Screen

Fig.no.8. New project added in Library

Fig.9. New Project wizard

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Fig.10. Project Build successfully

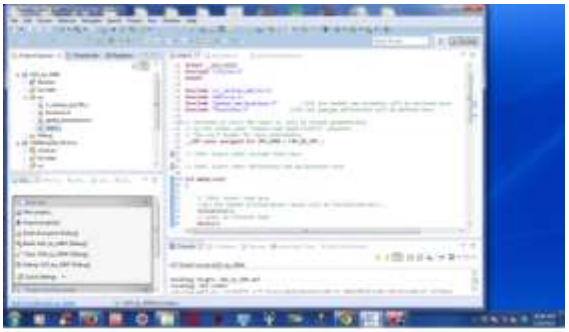

Fig.11. Project with code

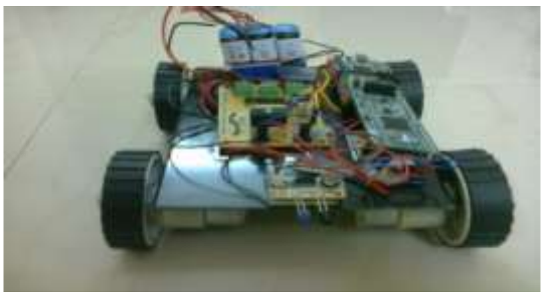

Fig.no.12. The target LPC1769 controller board connected to the Base development board

Fig.no.13. Target LPC1769 controller board connected with Ultrasonic sensors for obstacle avoidance with battery power source

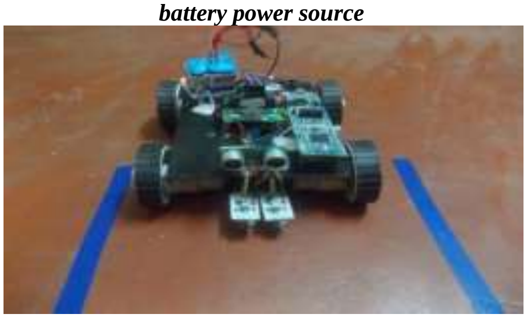

Fig.no.14 The AGV following the lane

Fig.no.15. showing the AGV shifting lane

Conclusion

From the simulation and operation condition, the system has performed as expected. This system is especially useful in extreme situations, namely when the speed is very high or the steering angle is quite sharp .Instead of Using the Computer and a web camera interface ARM and Ultrasonic sensors will be of great advantage since the Computer was controlled by a human anyway. The Outcome of this project will result in a safe travelling in roadways.

Future work

Further study could be done on improving the lane tracking algorithm, so more accurate position of the lane could be obtained and shorter response time could be achieved.

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