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Research Article

Remotely operated terrestrial vehicle

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Abstract

In recent years, with the increase usage of machines in industrial applications, the demand for a system that could reduce the human interruption in industrial processing's, providing safety to humans in surrounding environment, handles payloads and hazardous wastes in a perfect manner. This paper presents the development of a remotely operated electrical vehicle prototype. An electrical vehicle that is equipped with a robotic arm that functional to do pick, place and store objects. It is having environmental sensors that observe the data about the remote environment. It can move forward, reverse, turn right and left for a specific distance without colliding with the surrounding objects according to the controller specification. It can be navigated by the use of navigation unit. The development of remotely operated electrical vehicle prototype is based on the Arduino Mega platform that will be interfaced with transceiver module to the robotic arm, navigation unit, environmental sensors and motion control drives. Finally, this prototype is expected to overcome the problems such as pick and place hazardous wastes, transfer pay loads, accessing hazardous environments and monitoring of a specified area fastest and easiest way.

Keywords: Terrestrial vehicle; Prototype; Robotic arm; Environmental sensors.

Introduction

All the areas cannot be monitored by humans alone. Some areas may be unsuitable for human environment to live such as hot deserts or volcano prone areas. Some areas also have human threats. These environments may have hazardous effluents which would cause serious health issues to mankind. Hence a device is needed to monitor the various aspects in that unmanned areas [1]. This can be done by only by unmanned vehicles. Remotely Operated Terrestrial Vehicle is an unmanned vehicle mainly used to operate in plane surfaces. The vehicle can be proposed to move on any terrains by providing suitable wheels. The main purpose of the vehicle is to sense the data's collected from the environment and to handle the hazardous wastes [2]. The data's include pressure, temperature, humidity and gas sensor. In this proposed paper climatic changes of an unknown environment is monitored and can be thoroughly analyzed further for finding the effects of drastic climatic changes [3].

The various sensors required and other components required are explained further. This paper mainly uses obstacle avoidance mechanism. The mechanism involves avoiding the obstacles sensed by the rover. The prototype is primarily designed to stop and alarm a buzzer if the vehicle encounters an obstacle. The prototype also consists of additional features such as the detection of the heading the vehicle is resting with respect to earth's magnetic field [4]. The voltage level of the power supply given to the controller is wirelessly transmitted and monitored over the computer. The waste handling mechanism is done using a robotic arm. The robotic arm is capable of picking up the hazardous particles and places them in a safe area or can be examined for study [5].

Hardware description

The block diagram shown below gives the basic working flow of the prototype setup as shown in the Fig. 1. The block diagram represents the basic flow of the working done by the hardware. The commands to the microcontroller can be given via personal computer and the outputs of the sensors are seen in the monitor of the computer [6]. The transmitter/receiver module is used for the two way wireless transmission of data. Microcontroller decides whatever action to be performed according to the program specification. On-board sensors send the output

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continuously for every 2 minutes. The robotic arm operation is controlled by geared dc motors [7]. The power supply is given by two Li-Po batteries each 12V 2.2A connected in parallel. Motor driver IC gives enough power to drive the motors as the controller supplies very small amount of current.

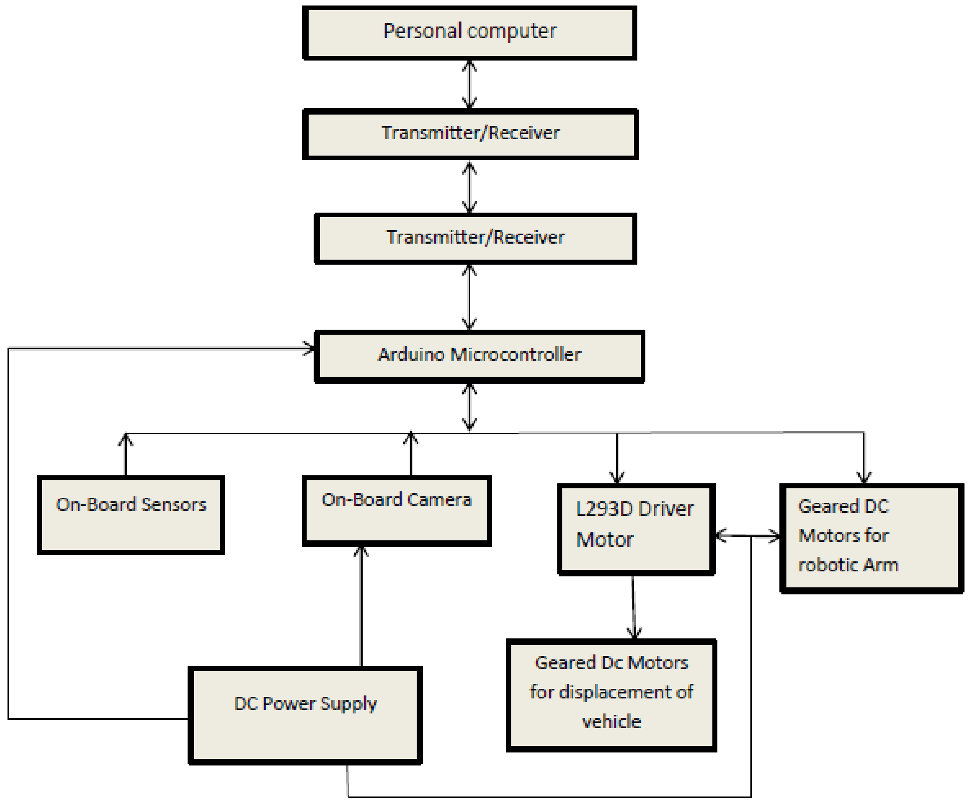

Fig. 1. Block diagram of remotely operated terrestrial vehicle

The main components of the vehicle are Arduino microcontroller, Chassis and wheels, Environmental Sensors, Ultrasonic proximity sensor, Magnetometer, Robotic Arm, Motor Driver IC, Wireless Transmitter/Receiver module, Wireless Video Camera, Power Supply.

Working of hardware setup

The vehicle moves in the forward, backward, left and right direction. The vehicle moves according to the command received by the user from the personal computer through the controller. When all the motors move in the forward direction then the terrestrial vehicle moves in the forward direction. The supply is given to every motor in the positive directions with the help of the L293D Driver IC. When all the motors move in the reverse direction then the terrestrial vehicle moves in the reverse direction. The supply is given to every motor in the negative directions with the help of the L293D Driver IC. When the right side motors are given supply and the left side motors are not given any supply then the vehicle slowly makes a left turn. When the right side motors are given positive supply and the left side motors are given negative supply then the vehicle takes a sharp left turn. When the left side motors are given supply and the right side motors are not provided with any supply then the vehicle slowly takes a right turn. When the left side motors are given positive supply and the right side motors are given negative supply then the vehicle takes a sharp right turn [8].

Ultrasonic proximity sensors are used for object avoidance mechanism. In the hardware the proximity sensor is fixed in all the four sides to detect the obstacles surrounding the vehicle. These sensors always maintain a particular distance between the obstacle and the prototype according to the controller specification. In every control command to the vehicle these sensors detect if any obstacle within the specified distance then executes the command. If there is an obstacle it over controls the command and stop the vehicle. The robotic arm works with the help of the dc motors. It has four degrees of freedom. It moves in two co-ordinate axis both in positive and negative direction [9]. For the load that the robot arm can pick depends on the strength of dc motor. If the load exceeds the strength of the dc motor, it will cause the dc motor not working and can cause more usage of current in the dc motor [10]. Because this is a prototype paper, the load that can be lifted by the robot arm is quite small.

Results and discussion

The program coding implemented in the hardware is compiled and executed using Arduino software. The output is checked with individual components and then later integrated to a whole code and also verified. The sensors connected in this prototype are temperature, pressure, humidity and CO gas sensor. The outputs of each sensor are illustrated in Fig. 2 to 8.

The proposed prototype has many advantages over the existing model. The proposed model will reduce the human deaths during any accidents and would be highly efficient compared to previous models. The performance of the prototype was good and thoroughly checked practically. The need for this type of vehicle is high in all the industries and hence this prototype when developed further will be highly useful. Remotely Operated Terrestrial Vehicle can also be used in the surveillance purpose for finding any intruders or detection of bombs. In the proposed paper a multifunction robotic vehicle is proposed. The proposed methodology has functions such as to avoid the objects without hitting them, determining the heading values, determination of the battery level, robotic arm operation and the sensor outputs.

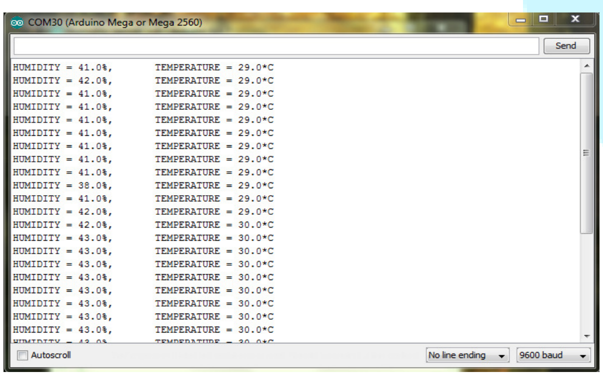

Fig. 2. Humidity sensor readings

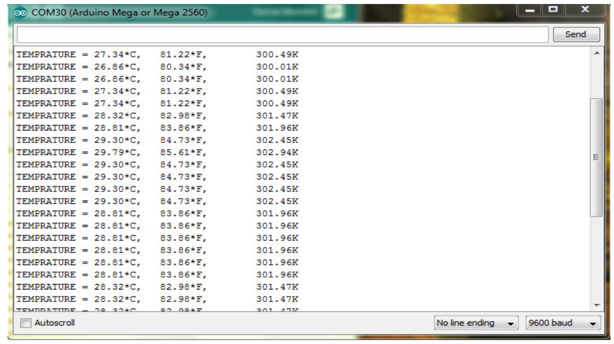

Fig. 3. Temperature sensor readings

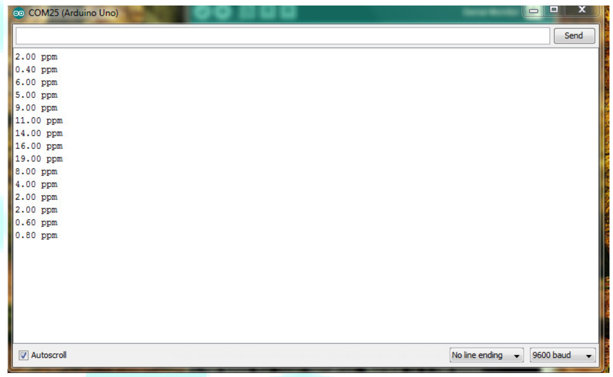

Fig. 4. Carbon-mono-oxide gas sensor readings

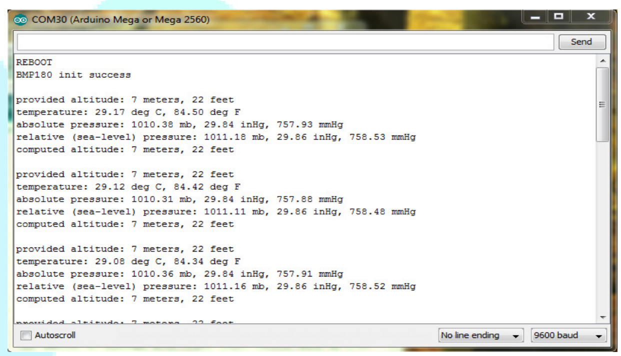

Fig. 5. Pressure sensor readings

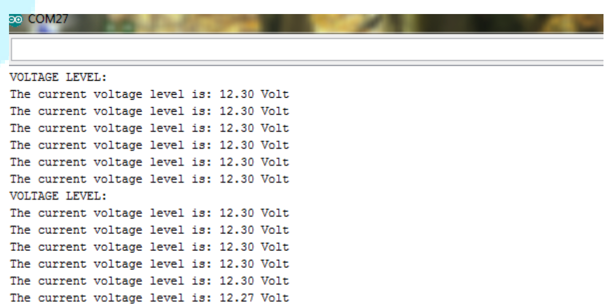

Fig. 6. Voltage level detector readings

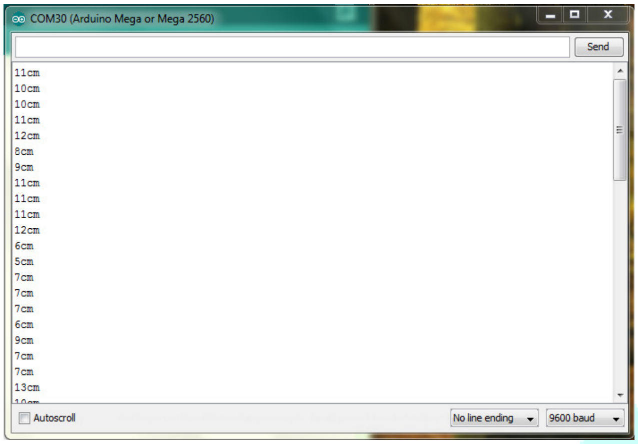

Fig. 7. Proximity sensor outputs

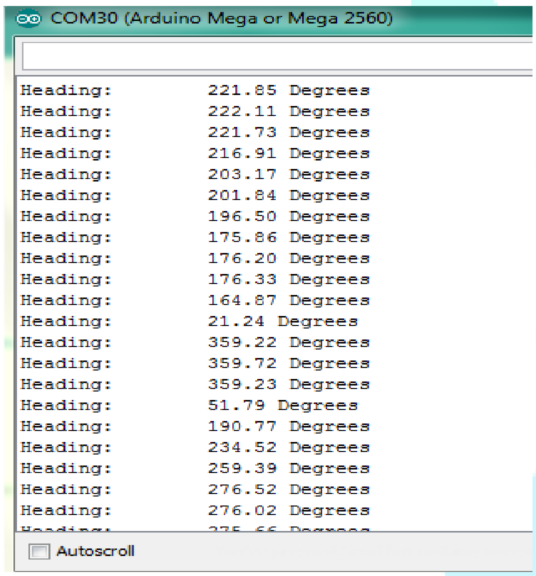

Fig. 8. Magnetometer heading readings

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