ARORA: Autonomous Rover for Rapid Assistance

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Abstract: *Robotic cars are applicable in the industrial area for the detection of gas leakages and as fire extinguishers. The problems associated with the implementation of these type of robotic cars are less coverage area, less memory capacity and inability to support multiple instruction processing. To overcome these problems, an Android application which helps to maintain, monitor and control the movement of the robotic car is developed, where a WIFI-module and Raspberry Pi microcontroller is introduced. The commands generated from the Android application are sent as signals to Raspberry Pi and in turn the application is responded by Raspberry Pi with the video streaming signals.*

***IndexTerms* – Autonomous, rover, Raspberry pi, wi-fi, camera, video streaming, android, python, ultrasonic sensor.**

I. INTRODUCTION

Autonomous vehicles are the mechanical improvement in the field of automobile. Also, the portable stage has turned into an appendage in which all mankind from youth to old could not surrender. In this way, an application made on this stage will be more fascinating, agreeable and more valuable for them. Although, the robotized vehicles are for simplicity of mankind yet, the advancement of smart phones offers a preparatory open door for easing the use of robots. Robots are being utilized progressively in our regular day to day existence and furthermore in the engineering and medical fields.

As equipment, the robot body is constructed mechanically and electrical parts were additionally used to manufacture it. In most parts of the country, the robots are controlled by wire. The problems associated with the implementation of these type of robotic cars are having some space restrictions, less memory capacity for computation and inability to support multiple instruction processing. To overcome these problems, an Android application which is able to monitor, maintain and control the manual movement of the robotic car is developed and to maintain a strategic distance from the impediment the mechanical control is made remote. That is, it controlled by Wi-Fi[1]. The rover also consists of various sensors, which influences it to detect the presence of obstructions in order to take after the course and move easily. While the ultrasonic sensors, which have been utilized for model outline, maintains a strategic distance from impediments to runtime.

The Android supported smartphone is used as the backup plan for the autonomous rover[2]. The primary point is to have the capacity to control the rover utilizing Wi-Fi[1] when the rover is unable to move forward autonomously. Second one is to have the capacity to get a live video stream[3] from the camera by utilizing Raspberry Pi UDP port address. Under the procedure of car, it is conceivable to specify two sections as equipment and software. In the equipment part, the necessities are for building the robots and the building process. The software part contains the main correspondence process like the Android and python and the communication between them.

II. IMPLEMENTATION METHODOLOGY

This model demonstrates some work on both the application that have been examined in this paper. Figure 1 demonstrates the block diagram of the current model.

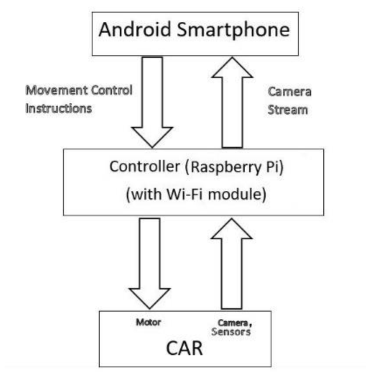

Figure 1: Block diagram

A rover comprised of mechanical outline with electronically controlled wheels has been built. The principle center of the project was around moving the rover autonomously, which recognizes and maintain a strategic distance from hindrances, capture and stream live to the ARORA android application and take over the manual control over the rover when necessary. If the overall project can be divided into two as hardware and software modules, then the necessary hardware modules for implementation are:

2.1 Raspberry Pi 3 Model B

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore, computing, and to learn how to program in languages like Scratch and Python.

The Raspberry Pi 3 Model B is the latest version of the Raspberry Pi. Add a keyboard, mouse, display, power supply, micro SD card with installed Linux Distribution for a fully-fledged computer that can run applications from word processors and spreadsheets to games. It runs on 1GB LPDDR2 (900 MHz) RAM and 4× ARM Cortex-A53,a 1.2GHz processor with 10/100 Ethernet, 2.4GHz 802.11n wireless networking capabilities[5].

Figure 2: Raspberry Pi Model B

Figure 2 shows a Raspberry Pi Model B. The instructions from the Android application are received through Wi-Fi communication and are processed.

2.2 Stepper Motor Hat for Raspberry Pi

Since the Raspberry Pi does not have a lot of PWM pins, we use a fully-dedicated PWM driver chip onboard to both control motor direction and speed. This chip handles all the motor and speed controls over I2C. Only two GPIO pins (SDA & SCL) are required to drive the multiple motors, and since it's I2C you can also connect any other I2C devices or HATs to the same pins[6].

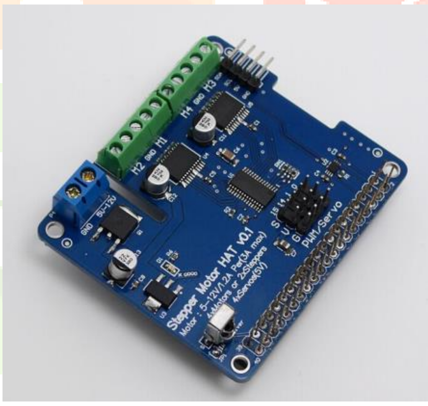

Figure 3: Stepper motor hat for Raspberry Pi

Motors are controlled by TB6612 MOSFET drivers with 1.2A per channel current capacity (you can attract up to 3A crest for approximately 20ms at any given moment), a major change over L293D drivers and there is built-in flyback diodes too. Figure 3 shows a model of the motor hat. The role of stepper motor hat is to covert the output signals from Raspberry Pi to electrical form and produce it to the dc motor.

2.3 HC-SR04 Ultrasonic sensor

HC-SR04 Ultrasonic (US) sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that is

$$\text{Distance} = \text{Speed} \times \text{Time}$$

Figure 4 shows an HC-sr04 ultrasonic sensor. The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in the air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module. This part of the work is very important for the autonomous movement of the rover.

Figure 4: HC-SR04 Ultrasonic sensor

2.4 DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. The output current from the stepper motor hat is used to rotate the wheels of the rover.

2.5 USB Camera

It will be conceivable to exchange live video to the smartphone with the USB Camera attached to the Raspberry Pi 3. The live video transmission ends when the application is terminated on the smartphone.

The hardware part is implemented with the help of a framework of a rover and the dc motor is attached to its wheels. The stepper motor hat is mounted on the Raspberry Pi. The Raspberry Pi and USB camera are then to the framework. The motor hat is connected to dc motors, the USB camera to the Raspberry Pi, sensors to rasp. Figure 5 shows the hardware implementation.

Figure 5: Hardware implementation

The software module consists of an Android application implemented on the smartphone and a python program that runs on the Raspberry Pi which receives signals and helps to control the movement of the rover. The Android application [7] ARORA, is made such that is acts as a user interface for controlling the movement of the rover and for live streaming. A connection between the Android smartphone and the Raspberry pi via UDP protocol is established initially and then the screen controls on the application. The autonomous mode of the rover is enabled when the control_mode is set to the value 1 or else by default, the manual control can be taken over the rover.

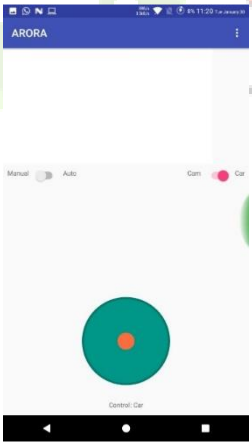

Figure 6: Screenshot of ARORA

Figure 7 below shows the flow chart of the algorithm of autonomous movement of the rover.

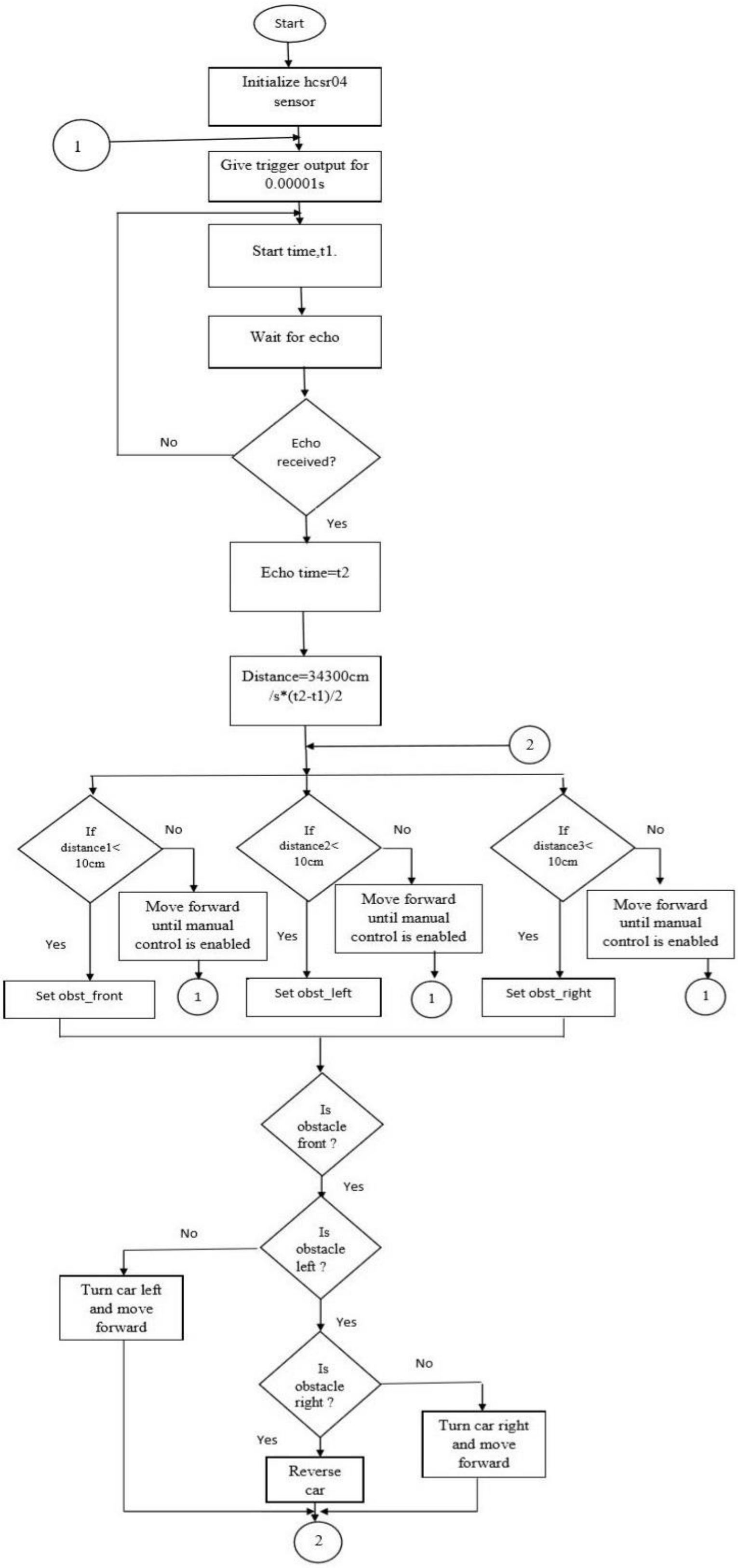

Figure 7: Flowchart of the algorithm of autonomous movement

The HC-sr04 sensor is initialized first. A trigger output for 0.00001s from the sensor is given at time t1 and waits for receiving the echo. When the echo is received, then echo time is set as t2and then the distance d is calculated as d=34300cm/s*(t2-t1)/2. If distance1 is less than 10cm, then the obstacle is in the front it checks for distance2 or the rover moves forward. When the distance2 is less than 10cm, then the obstacle is on the left side of the rover or else the rover turns left and moves forward. When the distance3 is less than 10cm, then the obstacle is on the right side of the rover or else the rover turns right and moves forward. When it seems to have obstacles on the three sides, the rover moves in the backward direction to a little distance and then again check for the distance between the rover and the obstacles. The autonomous movement of the rover continues until the manual mode is enabled. Figure 8 shows the schematic diagram of the joystick button used in ARORA for manual movement of the rover.

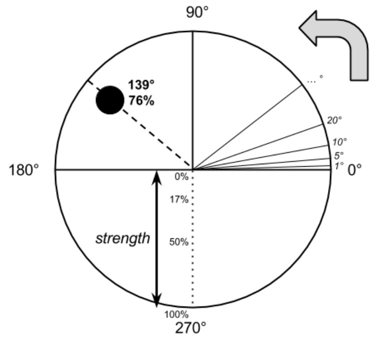

Figure 8: Schematic diagram of joystick button

The angle follows the rules of a simple counter-clock protractor. It decides the turning angle of the front wheels of the rover. The strength is the percentage of how far the button is from the center to the border. The degree of the strength decides the speed of the rover. By default, the refresh rate to get the data is 20/sec, i.e., every 50ms. Figure 6 shows a screenshot of the application, ARORA. The orange button in the green circle acts as the joystick.

At the Raspberry Pi part, the python programming is done. The Wi-Fi hotspot of the Raspberry Pi is turned on and the smartphone is connected to it, such that it works in a personal area network(PAN). The UDP connection is established at Raspberry Pi IP address through the UDP port. Servos and motors are then reset. Then the Raspberry Pi waits for a UDP message from the ARORA application that is running on the smartphone. The incoming messages are split into flags in order to decide the mode of control and other inputs given by the user[5]. The live video streaming is established in the space provided on ARORA application. Live streaming is also possible in a web browser if the device or the personal computer is connected to the same network by inputting the address of the camera. The speed of the motor is controlled by the strength of the joystick button and is set as set_speed. The rover moves forward when the joystick button is moved in positive y-direction, backward when it is moved in the negative y-direction and halts at 0. The rover is able to turn right when the joystick button is moved in the positive x-direction and turn towards left when it is moved towards in the negative x-direction.

III. Evaluation And Results

The people of the current era are using smartphones widely, regardless of the age. The knowledge about using a smartphone is really unlimited. This project also has some better qualities and shortcomings as there might occur in each and every one. The live streaming of the video through USB camera has made very helpful for maintaining and controlling the movement of the rover. The use of joystick button made the project work more interactive than for manually controlling the rover through separate buttons. Use of the Wi-Fi technology has helped to achieve a secure communication and cover the communication area up to more distance than using the existing systems. Ultrasonic sensors helped to calculate the distance to the obstacle in the front, left and right sides of the rover and then the movement of the rover is made according to the algorithm used above.

IV. Conclusion And Future Scope

It is a known fact that after a few years, men are going to be lazy and machines are going to rule the world with their own computational capability and learning. So, the future scope of the work is endless. Some of them are as follows.

Border security at a low profile so that the enemies will not be easily able to spot the rover. Live license plate recognition on road using the camera & alert to authority through sending messages, people/face detection, track and follow system, surveillance with camera etc., in the crime management sector. The damages that occur in factories could be analyzed and immediate response can be provided as remote fire engine using location awareness and GPS tracking. It will also be very useful in medical fields such as accident scene survey that could be implemented with existing electric vehicles, can be used a remote ambulance. It is also very useful in areas such as room/location mapping, lane driving through obstacle detection and avoidance, object tracking, voice-controlled robotics etc.

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