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Internet Controlled Mobile Robot

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Abstract

Nowadays, most of the robots has gained mobility feature along with the developing technology. The measurement process in different environments can be performed in many various ways. Studies on mobile robots has been increased in the area of dangerous working conditions to human health. Reaching a target, performing measurements, transferring the data obtained with mobile robot are important issues. For this purpose, the algorithm of robot which will reach the target has great importance. Soil and stone samples, humidity and temperature information is preferred as the desired image data. Thus, measurements can be carried out and data can be transferred to the desired point by knowing only the coordinates of place without going destination. In this study, mobile robot and robot arm controlling has performed successfully by the Internet protocol.

Keywords: Robot arm, internet control, ip camera, mobile robot

INTRODUCTION

Internet-controlled vehicles are one of the product of developing IOT technology. The devices made by land, sea and air tool. For usage purposes in vehicle, sensors and mechanisms may be added [1]. There are advantages of internet-controlled vehicles. It allows you to work in the environment without affecting human health adversely. They can operate in very narrow and small spaces. It is possible to control robot without having the work area. Sonar, thermal vision systems can be used in areas which have not visibility (fog, smoke, etc.). Internet controlled vehicles have disadvantages.

The state of disconnected connection of one by the server or the client can not be connected and the robot can not function. The result of the slowdown of the server and the client can not be contacted by one of the necessary command and go to the instability of the system. There are many uses of Internet systems are used. Field research, measurement, search and rescue, military, transportation, there are areas to be a hobby. In our project, the robot arm, there are additional features to measure temperature and humidity.

Recently, image processing algorithm is used in variety application [2, 3]. Researched the literature, it is seen by many studies on this subject. Overall image transmission is made in real time [4]. If we look at another study designed communication card, RF transmitters and RS232 converter is used [5]. Java as a programming language is used in a similar project. There is also an ultrasonic distance measuring device [6].

In this study, kinematic equations are calculated for the robot arm by using a mathematical model as seen in Eq. (1-4). The robot arm has been designed in SolidWorks environment. IP Camera is also used to transfer images. It can receive images from IP cameras on the vehicle where the robots reach. Arduino development board with the transfer of information reaching the robot to remotely control and accessing to the Internet protocol is provided.

METHODOLOGY

Mechanical Design

The mobile robot has three degrees of freedom robot arm. It is seen in the Fig. 1. Moving of the robot arm is controlled by servo motors that is mounted on. Some processes are shown in the Fig. 2. Although the view of the robot arm on the car looks like a complex form, it has a simple rotary joint and two prismatic joints. Robot arm has three degrees of freedom. The motors are placed bottom of the arm to prevent the extra weight on the arm. Forward-back and up-down movements are provided via transfer components. One of the motors returns the robot arm in Z-axis and the others move robot arm forward-back and up-down.

$$T1 = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & h1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1)$$

$$T2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -d2 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2)$$

$$T3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & -d3 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (3)$$

$$T = \begin{bmatrix} \cos(\theta) & 0 & -\sin(\theta) & d2 * \sin(\theta) - d3 * \sin(\theta) \\ \sin(\theta) & 0 & \cos(\theta) & d3 * \cos(\theta) - d2 * \cos(\theta) \\ 0 & 0 & 1 & h1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (4)$$

Interface Design

Interface program are written by using HTML codes. User interface is given up with figure 3. Top arrows help to control of car, bottom arrows help to control of robot arm. There is camera image in the below [7]. A step of robot arm is 5 degrees.

Port Connection

The control is performed only through the network. Because of this reason robot and interface have to be on the same network with control computer to control the robot. The Fig. 4 illustrates this situation. IP address of the robot can be connected by using the interface and send commands to it. It can be sent commands to robot by connecting to port of the robot on the network and IP address of the internet [8]. The robot can be controlled in this way. This way is shown as in the Fig. 5.

"Local Network 1" and "Local Network 2" are the internet networks in the different locations. IP address of the mobile robot to internet network is connected using user interface and the commands are send to robot over the corresponding port.

Flowchart

In the Fig. 6, circuit can be explained as follows; Servo motors are connected to 2,3,4,5 pins of Arduino Mega which has PWM features.

Communication pins of ESP8226 Wireless Module are connected to second UART unit of Arduino Mega card.

DHT11 temperature and humidity sensor which has digital output is connected to D37 pin of Arduino Mega. Here D37 pin is used a digital input.

Input signals of L298N motor driver are send from 22, 23, 24 and 25 pins of Arduino Mega. Active channel pins of motor driver are logic-1 because of the fact that the car has not speed control. Here there is no control algorithm for speed of the car.

A 5V 10000 mAh lithium battery is used to power up the electronic module cards and servo motors, a 5V 2600mAh lithium battery is used to power IP camera and four batteries, each one has 3.7V 4800mAh, are used to power up motors which drive the car. The flowchart of the program is shown in the Fig. 7. The link flowchart of project is given as in the Fig. 8. Sensor flowchart in project is shown in the Fig. 9.

Controller Card

Arduino card is used to control ESP8226-01 wireless internet module in this application. The access to ESP8226-01 module is provided with its hayes (AT) commands. At the beginning of the program, variables must be defined. After this, accessing to ESP8226-01module is started by connectNetwork command. AT commands in below are send to ESP8226-01 module with Arduino in this subprogram [9].

AT+CWMODE = 1: Module will be used in the station mode.

AT+CWJAP = "Network name", "Network password" : This command provides connection.

AT+CIFSR : Learning the IP address

AT+CIPMUX = 1: This command activates the multiple access of the module.

AT+CIPSERVER = 1, "Port No": It initiates TCP/IP connection over "Port No"ESP8226-01 sends an "OK" feedback if operation is successful for each command. After the last command, the led in thirteenth pin of Arduino is logic-1 if it sends "OK". Therefore, it reports the system is ready to user. Thus, the program has two tasks.

1. Checking whether the user interface sends commands to Arduino over the ESP8226-01 or not.

2. Ordering the sensor information, which is measured via Arduino to user interface through ESP8226-01.

In the first section, the serial communication pins are checked. If a command is sent from the interface program, value of the "data" variable changes. Robot arm and car are controlled according to the value of the "data". For example, if "data" is 'A', the car moves forward. If "data" is 'J', the degree of the first servo motor increase or decrease.

In the second part, the time is recorded from the beginning of the program using Arduino command "millis". Temperature, humidity and raw information can be learned which come from DHT11 sensor when time record is 60 seconds. This information are arranged according to ESP8226 command set and send to ThingSpeak.com servers.

CONCLUSIONS

In this study, internet controlled mobile robot was designed. Mathematical calculations and algorithms have been developed for the robot control. Materials are preferred appropriately for manufacturing. Some parts have been designed by using 3D printer. The system is controlled by network. If system control is desired to be provided via the internet, it is necessary to open the port that ESP8266 module uses. Therefore, the system can be controlled by network. Note that the interface program should now send data to the IP address of the connected network rather than the IP address of the local ESP8266-01 module. The prototype is designed and produced by using 3D printer. As a result of this study, this prototype robot is used to perform remote control. The robot is controlled successfully.

ACKNOWLEDGEMENT

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Figure 1. Robot arm

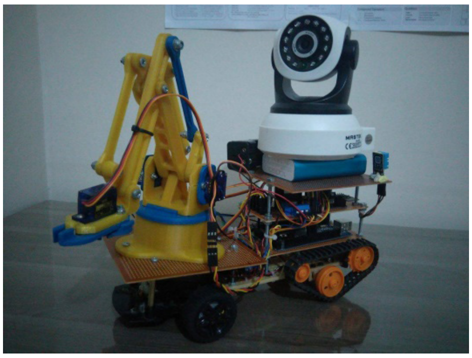

Figure 2. Mobile robot

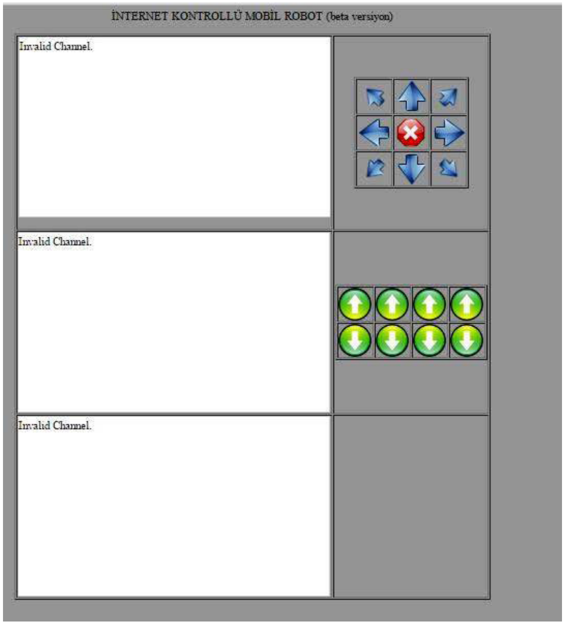

Figure 3. The user interface of the project

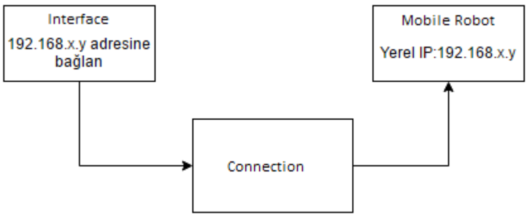

Figure 4. Network diagram

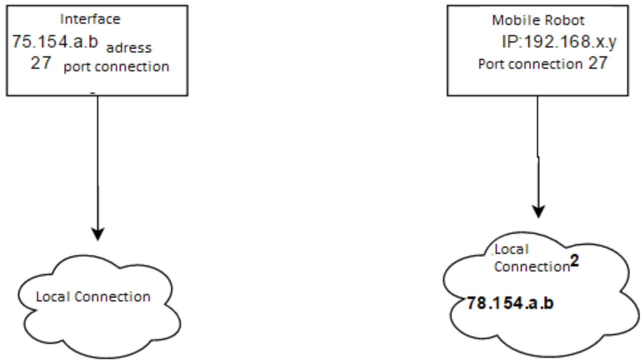

Figure 5. Representation of control by the internet protocol

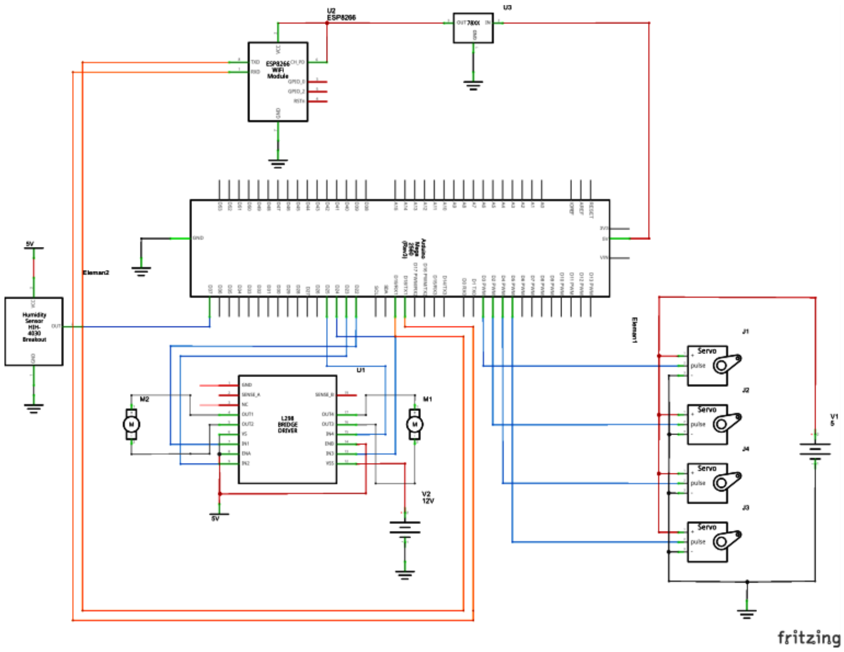

Figure 6. Electronic circuit scheme

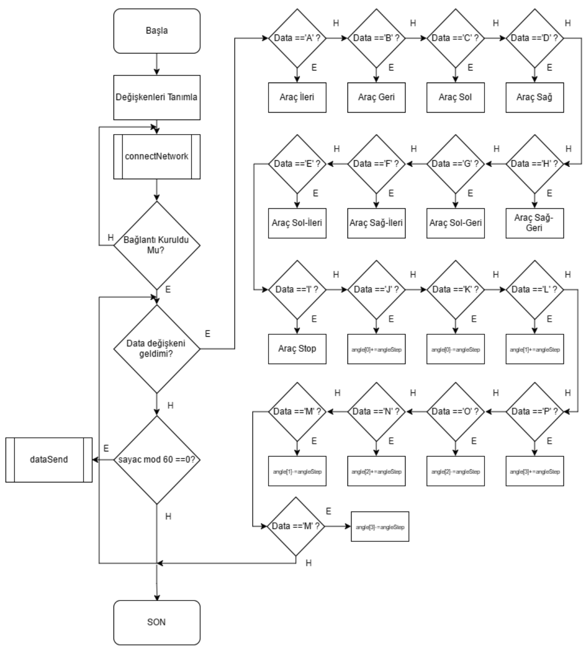

Figure 7. Flowchart of program

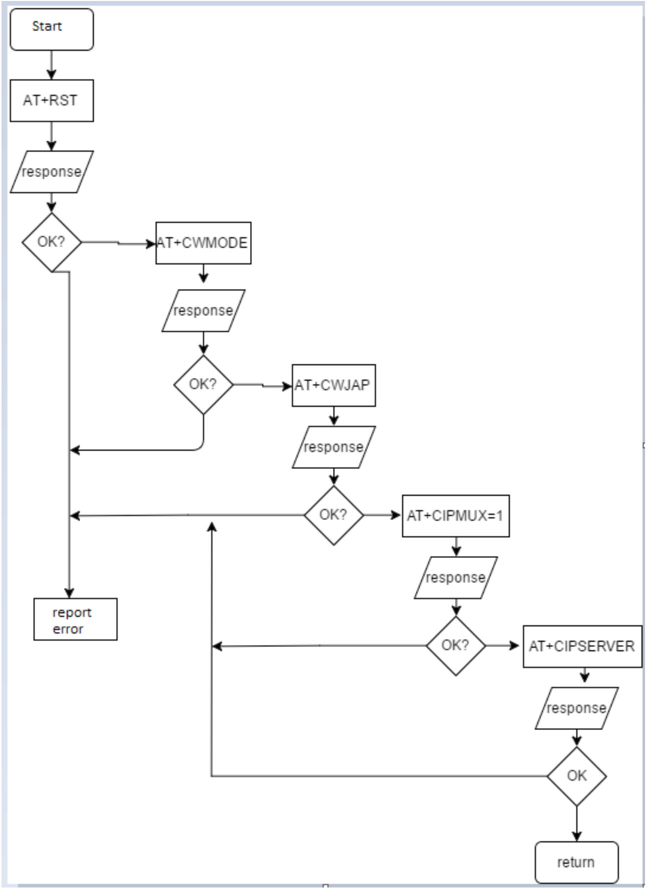

Figure 8. Flowchart of link

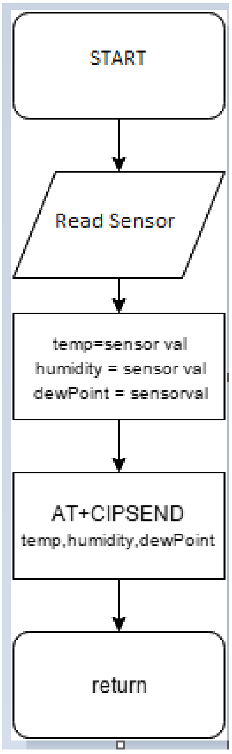

Figure 9. Sensor usage flowchart