Autonomous Visual Navigation System ,

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Abstract : The objective of this paper was to develop a robot that can autonomously navigate and to send live information to the destination. The proposed system had a camera, a robotic rover, GPS and GSM module and a base station. The camera acts like eyes of the system. It takes/sends live video/image of the frontal view of the rover to the base station. The base station had any system with a browser is needed to view the real-time feed from the robotic rover. This system can capable of using Bluetooth/XBee/Wi-Fi/GSM/GPS as the communication medium to connect the rover to the base station. The entire system was consists of a robot, camera and an application that was used for monitoring. This system was a standalone autonomous navigation system, done by an on board computer. This system was implemented with the help of Internet of Things (IoT), Micro Electro Mechanical System (MEMS), Machine Learning Algorithm / Deep Learning Algorithm and Image processing. With the help of IoT, we can control this robotic rover from anywhere and anytime with proper security credentials. By adding different types of sensors, these rover was very useful in unmanned vehicle to navigate. It also had support to Android and iOS application.

Keywords : AI, ML, DL, Robot, Autonomous Navigation

I. INTRODUCTION

In this era, autonomous vehicle plays a major role in every field for monitoring surveillance and automation processes. These autonomous vehicles can be controlled by multiple ways using RF, Bluetooth and XBee etc. Autonomous vehicles can be used to access areas were human can't get through and helps to monitor in real time. In this Research work, we proposed IoT based RC Robotic Rover as autonomous rover for all types of surveillance and monitoring purposes.[1-3]

In this proposed system, the Raspberry pi is used as a master computer because of its high machine speed, inbuilt Wi-Fi capabilities. The other advantage of pi is the camera control through web servers. Pi gives low latency in video streaming across internet but at the same time there is no compromise in video quality which is rare in any other processors or controllers.

In older systems a huge size of camera mounting is used and it occupies more space and consumption of power also more so it cannot be used in small areas and needs more battery backups those were overcome in this research. IoT based robotic rover can be controlled by a single person. It does not require more number of computers to activate it. Both the control of rover and pan and tilt module is controlled from the same web browser and the video streaming is in place above to see the front view of the rover.[4][5]

II. BLOCK DIAGRAM OF THE SYSTEM

The proposed systems block diagram is given in Figure : 1.

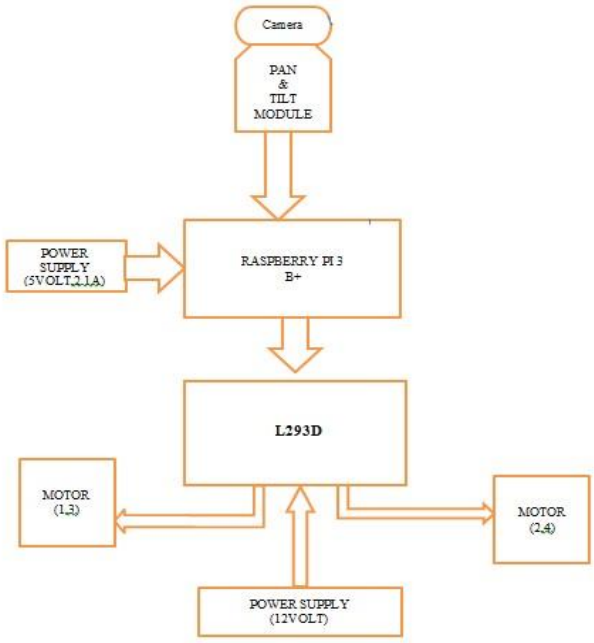

Figure : 1 Block Diagram of the System

The Components of the proposed system are:

- Raspberry pi camera
- Pan and Tilt Module
- Raspberry pi 3 b+
- L293D - DC Motors
- Web Server

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- MPEG Streamer
- XBee Module
- GPS Module
- GSM Module
- Sensor Modules
- Bluetooth Interface
- Digital Compass
- Data Logger
- Solar Panels
- Recharge Module

Raspberry Pi Camera

The Raspberry Pi Camera Board is a custom designed add-on module for Raspberry Pi hardware. It is attaches to Raspberry Pi hardware through a custom CSI interface. The sensor has 5 megapixel native resolutions in still capture mode and in video mode it supports capture resolutions up to 1080p at 30 frames per second. The camera module is light weight and small making it an ideal choice for this research.

Pan and Tilt Module

Pan-Tilt module was mount in the rovers front and the control is done with Raspberry Pi. The pan and tilt module has its on-board microcontroller and it independently drive the two servos (pan and tilt), as well as driving up to 24 regular LED (with PWM control). There's also a handy slot through which we can route the servo, LED, and camera cables. The module pans and tilts through 180 degrees in each axis.

Raspberry Pi 3 B+

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, and PoE. The dual-band WLAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the previous versions.[4]

L293D

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

The operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. The logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively. In the IC Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.[7]

DC Motors

It has a permanent magnet and brushed electric motor is the workhorse of small, powered mechanical systems. These are the small motor and the gear motor in the robotic rover as shown in Figure-2.

Figure : 2 DC Motors used in this System

The small motors like to spin fast with low torque. The gearing reduces the shaft speed and increases the torque. When the motor leads are connected to a source of DC power, the shaft spins. Small motors run best at a preferred voltage, which is listed on the data sheet. Common preferred voltages are 3, 6, 12 and 24 Volts.

LXTerminal

LXTerminal is the standard terminal emulator of LXDE. The terminal is a desktop-independent VTE-based terminal emulator for LXDE without any unnecessary dependency. LXTerminal supports multiple tabs. All instances of program share the same process to reduce memory usage. LXTerminal can be configured to hide the menu bar and the scrolling bar. The tab bar does appear only if a second tab is opened. A right click opens a menu and allows reaching for the options or any elements from the hidden menu bar.

Web Server

A Web Server is a program that uses Hypertext Transfer Protocol (HTTP) to connect web pages to users base station. All that host web sites must have a web server. Leading web servers are Apache, Internet Information Server (IIS). Other Web servers include Novell's NetWare server, Google Web Server (GWS) and IBM's family of Domino servers. Our system uses Apache web server.

MPEG Streamer

It is a command line application that copies JPEG frames from one or more input plugins to multiple output plugins. It can be used to stream JPEG/MPEG files over an IP-based network from a webcam to various types of viewers such as Chrome, Firefox, VLC, and other software capable of receiving JPEG/MPEG streams. MPEG transport stream is a standard digital container format for transmission and

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storage of audio, video. It is used in broadcast systems such as DVB, ATSC and IPTV. The Figure-3 shows the MPEG Streamer page.

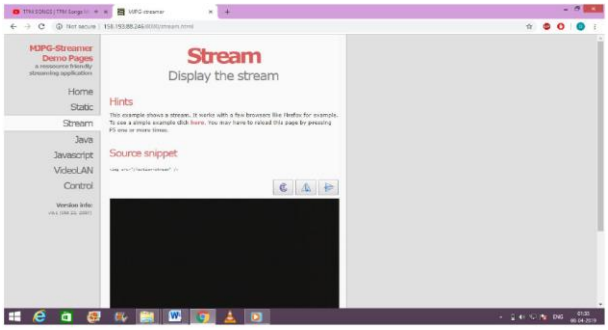

Figure : 3 MPEG Streamer Page

III. CIRCUIT DIAGRAM OF THE SYSTEM

The circuit consists of Raspberry PI 3 B+ model, camera, pan and tilt module, GPS/GSM Modules, Sensors, 293D driver IC, 4 DC motors, two 9V batteries and chassis. Figure-4 shows the circuit diagram of the system.

First stage of circuit is assemble of the pan and tilt module with two servo motor. One servo is for panning to left to right and the next assembly of the tilt part with another servo motor. The full assembly of the module is fitted in front of the rover. And the camera is mounted on pan and tilt module. And then Raspberry pi is used to interface the camera using ribbon cable. The power supply for the two servos is taken from the Raspberry pi board itself. Pin number 2 and 4 is the 5V, and the ground pin 9 and 14 are ground for servo motors. Controls pin for the pan servo is pin 16 and the tilt servo is on number 12 is connected to the raspberry pi directly.

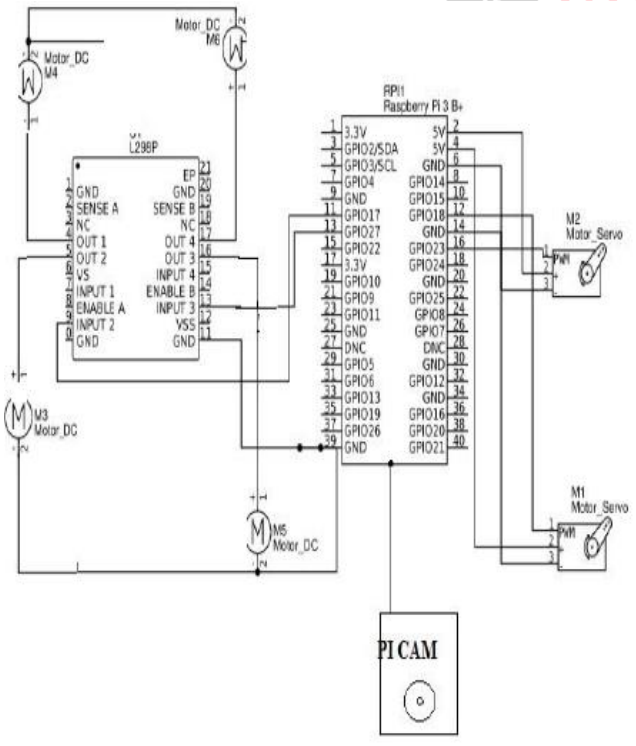

Figure : 4 Circuit Diagram of the System

L293D is the driver IC used for driving 4 DC motors, which gives equal power to run the motors and gives the direction to run the Robotic Rover according to the direction keys. The four input pin are used for forward, reverse, left, right. They are driven by the voltage, according to selected direction keys. And next final part is web server and MPEG streamer which is controlled by the user using Internet. Whenever raspberry pi connects to the internet through Wi-Fi all other device must be connected to the same network with same IP addresses.

Once the IP addresses of the network is known and that was typed in the browser, as a http address. The system will be display the image/video in the browser from the remote area where the autonomous visual navigation system was placed. The navigation system can be controlled via direction keys which is shown in the browser itself for pan and tilt and direction.[12]

IV. WORKING PRINCIPLE

The control section is done in the way to turn the servos. The chassis of the rover is made up of light weight material to carry the weight of the electronics in it and to balance the whole weight and to move easily in any weather and in any terrain condition.

Every time Raspberry pi boots it will search for internet connection and get connected with paired network. Once the internet is connected user must open the LX terminal type the host name. The next process is to connect with MPEG Streamer using the same IP address. The system connects to the web server's webpage with small screen and direction keys for rover controls will be displayed. And the user can control the rover and view live video streaming. By having Image Processing Techniques and using Machine Learning Algorithms' and Deep Learning Algorithms' this system acts as an Autonomous Visual Navigation System.

Figure : 5 use of OpenCV, AI, ML and DL

The gradients in a specific direction, with respect to the center of the object image, will give us the object shape. Here, it was implemented by Histogram of Oriented Gradients (HOG) method. The figure-5 shows the OpenCV provides a trainer as well as detector to desired objects/persons. The designed autonomous visual

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navigation system's prototype model is shown in the Figure : 6.

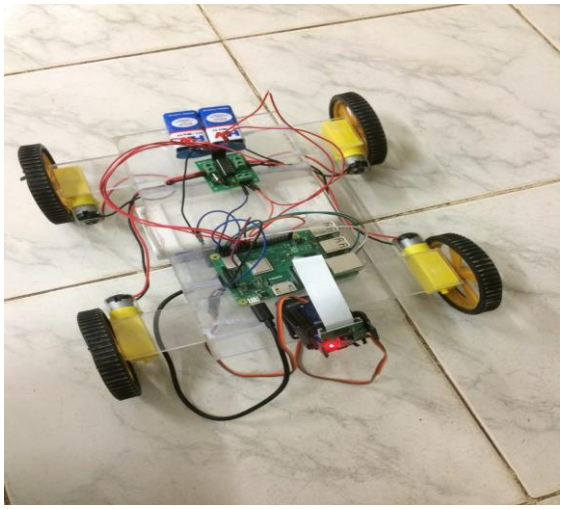

Figure : 6 Autonomous Visual Navigation System

There may be cases in which the current level of robot technology cannot ensure adequate functions, depending on conditions, this research almost overcomes those huddles and can be expected to achieve progress through their self learning and AI, ML, DL algorithms gives this autonomous visual navigation system as a versatile system. The actual use of this system is being used as a real time rescue robot, Live Monitoring, Image Comparison of the person in remote areas. Mostly this system can be used in nuclear power plants, in the space for research and as surveillance robot in disasters area or in battle field, further it can be used in non-human (autonomous) vehicles.[8-11]

V. CONCULSION

In this study has examined the application of the advanced autonomous visual navigation system. This study also set out to contribute new data to the literature of this particular area of study as well as to identify areas that require further research. Autonomous visual navigation is considered as one of the main application areas, which have gathered numerous attentions due to its wide potential application. Moreover, ML and DL algorithms were observed to meet development obstacle in this field, which include complex computing and high dependence on high-precision sensors.

The competency to navigate in any surrounding is vital in visual navigation application to avoid any hazardous situations such as collisions and serious conditions. Therefore, it is required to keep the stability of the trajectory and formation in order to reach the target in a short time. Basically, the navigation can be achieved with three combination algorithms, namely self-localization, path planning, and map building. Hence, the intelligent algorithm is proposed to improve the performance as well as to overcome the disadvantages related to visual navigation. On top of that, the ML and DL intelligent algorithms, which includes soft computing and artificial intelligent are considered as powerful approaches that can provide the solution. Finally, if the algorithms are combined, a good performance autonomous visual navigation system is achieved.

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