Surveillance Rover: The Future of Defense

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Abstract **- Surveillance robots prove to be advantageous in defensive environment.This project providesreal-time surveillance at hazardous terrain and borderlineby means of versatile robot based on Lab VIEW software,for safeguarding the frontier. It works in real-world environment and no conditioned scenario is required by it. Variousperipherals like vision camera for live system tracking, inductive proximity formetal detection and radar for obstacledetection are implemented.**

Keywords - LabVIEW; NI-myRIO;Inductive proximity sensor; DopplerRADAR;

I. INTRODUCTION

Surveillance is the monitoring of behavior, activities, or information for the purpose of influencing, managing or directing. This can be done by observing conditions prevailing on ground from a distance via CCTV, by intercepting the information that was transmitted electronically or through post. It can also be done manually by humans who gather the intelligence information. Surveillance is used by governments for intelligence gathering, prevention of crime, the protection of a process, person, group or object, or the investigation of crime.

MyRIO is a real time embedded evaluation board developed by National Instruments. It provides real time response needed to control the actions of surveillance vehicle.Its processing speed is almost ten times more than that of generalmicro-controllers and microprocessor, which decreases the response time.Program can be circuited with LabVIEW, fused with MyRIO, and can be operated in wireless mode.

Radar (Radio Detection and Ranging) is a detection system that uses radio waves to determine the range, angle, or velocity of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. A radar system consists of transmitter section which produces radio waves or microwaves that are capable of travelling without getting damped or affected by atmospheric conditions to very long distances. Microwaves or radio waves are transmitted via transmitting antenna and they revert back after getting bounced off by object/target. The altered signal is received by receiving antenna (usually same antenna is used for implementing both the actions) and is processed in receiver section of radar system. The change in frequency and phase of received signal reveals the object's location, its speed and its relative movement from radar.

This project proposes to develop an autonomous navigation vehicle by using machine vision techniques available in LabVIEW platform.Computer vision techniques are used for sensing the environment through a web camera. Live video & audio can be procured through webcam and can be processed in computer by taking advantage of image processing toolkit offered by LabVIEW i.e. IMAQ (Image Acquisition). ARM Cortex-A9 dual core processor present in NI-myRIO enables programmer to incorporate embedded logic control techniques required for vehicle navigation. This vehicle also acts as obstacle detector due to the presence of radar hence it automatically alerts the user if any object/target is present in its range of operation and proceeds to next step.

Our approach in building thissurveillance vehicle and its controlling differs from existing ones in a number of ways. This projectoperatesin real-time environment and not just as any prototype. Using LabVIEW platform to implement this project, alone has its advantages. LabVIEW enhances the efficiency of the system to the next level due to its excellent computational performance and analysis capability. Thus, making this approach much more reliable than others. Also, this vehicle can be wi-fi controlled and monitored using data dashboard (android application of National Instruments).

II. LITERATURE REVIEW

Previous works in this domain were explored and reviewed thoroughly to understand the pros and cons of existing systems.

Karthikeyan et al[1] proposed a system that could control surveillance vehicle wirelessly using GPS navigation and wireless LAN. Anto Clintonet al [2] developed a robot to perform the act of surveillance in domestic areas by means of Arduino and ESP8266. Ravikumar et al[3] devised amethodology for tracking the surveillance rover in real-time and monitor potential threatsusing LabVIEW softwareand tracking camera. Thirumurugan et al [4] proposed a low-cost, light weight, small size unmanned ground vehicle(UGV), controlled by NI-myRIO. Along with this gas sensor was used to detect the presence of harmful gases. Kanagavel et al [5] designed a surveillance robot that could detect obstacles via IR sensors mounted upon it.

After reviewing the existing systems following observations were made:

1. Previous proposed systems range of obstacle detection was less (in order of few meters)
2. Usage of open-source embedded system such as Arduinoand raspberry-pi are not desirable as they are not much reliable in their operation.
3. For wireless connectivity most of the earlier systems used either Bluetooth or Zigbee which had lesser range of connectivity.
4. There waslack of real- time response as the processing speed was very less. This hindered the reliability of surveillance vehicle.

Themethodology proposed inthispapermakes effort to overcome the above drawbacks.This paper aims to meet the following objectives.

1. Tobuilda surveillance vehicle for military applications using LabVIEW and NI-myRIO, which provides real-time response.
2. Live system tracking of terrains and geographical areas using camera.
3. To design a robotic vehicle that could detect obstacles within its range along with metal detection ability, so that it could automatically alert to the user.
4. Incorporate Wi-Fi technology for wireless connectivity and make this rover a stand – alone device.

III. SYSTEM REQUIREMENTS

- Hardware Components:

1. NI-myRIO:

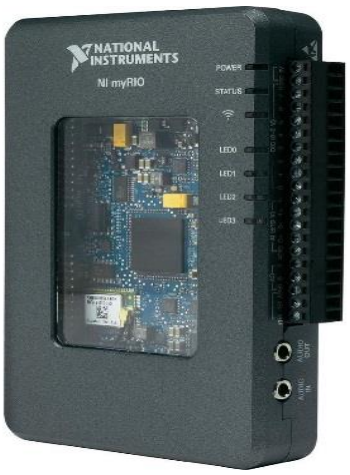

Fig.1 NI-myRIO

MyRIO is a real-time embedded evaluation board made by National Instruments. It is used to develop applications that utilize its onboard FPGA and microprocessor. MyRIO student embedded device has various features in it. It has I/O on both sides of the device in the form of MXP and MSP connectors. It includes analog I/O, 2 ports of 16 digital I/O lines, LEDs, an onboard 3 axis accelerometer, a Xilinx FPGA, and a dual-core ARM Cortex-A9 processor. Some models also include Wi-Fi support.

2. Doppler RADAR:

A Doppler radar is a specialized radar that uses the Doppler effect to produce velocity data about objects at a distance.A microwave signal is bounced off towards desiredtarget and the returned signal's altered frequency is analyzed. This alteration of signal occurs due to movement of desired target.

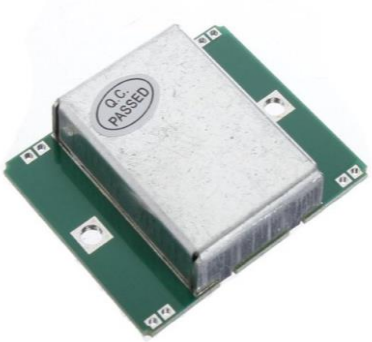

Fig.2 HB100 RADAR sensor module

This variation gives direct and highly accurate measurements of the radial component of a target's velocity relative to the radar. Ideally, its detection range is up to 20m.

3. Web Camera:

Fig.3 USB Type Web Camera

A webcam is a video camera that feeds or streams an image or video in real time to or through a computer to a computer network, such as the Internet. Webcams are mostly used during video chat sessions involving two or more people. Also, they are used in security surveillance, video broadcasting, and for recording social videos.Web camera used in this system has an image resolution up to 16M pixel and typically its focus range is 4cm to infinity.

4. Inductive Proximity Sensor:

An inductive proximity sensor is a non-contact electronic proximity sensor which is used for positioning and detection of metallic objects.Inductive proximity sensor is sometimes

referred to as an inductive proximity switch. The sensing range of an inductive proximity sensor
depends upon the type of metal being detected. For ferrous metals such as iron and steel, it exhibits a longer sensing range whereas for non-ferrous metals such as aluminum and copper, the sensing range may reduce up to 60 percent.
The sensor comprises of 4 main components such as coil,

Fig.4 Inductive Proximity Sensor

oscillator, Schmitt trigger and output switching circuit.This system uses NPN type proximity sensor.

5. L298NMotor Driver Module:

L298N is a multi-watt integrated circuit package whichis capable of providing high voltage required to drive a motor. It is a high current dual full-bridge driver. L298N can drive inductive loads e.g. relays, solenoids, motors (DC and stepping motor), etc.

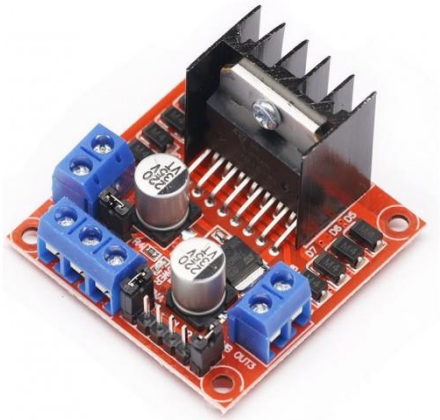

Fig.5 Motor Driver Module(L298N)

In contrast to microcontrollers and microprocessors which operate on very low voltages(5V), the motors require high voltage and current for their operation. The motor driver is nothing but a current amplifier which amplifies the low current given at the input and presents it as high current at the output end, which drives a motor.L298N motor driver IC has many applications in the embedded field, especially on the robotics side.Typically, its maximum supply voltage is 46V, and maximum output DC current is 4A.

- Software requirements:

1. NI-LabVIEW:

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming environment which is widespread throughoutacademia, industry and research labs.It is used by professional scientists, engineers as well as students to prototype their systems.It is aversatile analysis tooland instrumentation software which can be used in measurement and automation. Its graphical programming language is known as G programming and itis executed using a graphical block diagram that compiles it into machine code. While the programming end is done at block diagram, the results and measurements are displayed at the front panel for user convenience. The programmer need not worry about the syntactical details and procedures. It is this unique feature of the software which makes it easy to learn and implement. LabVIEW programs are known as virtual instruments (VIs), because their appearance and operation mimic actual physical instruments. LabVIEW can acquire data using the devices like GPIB, Serial, Ethernet, VXI, PXI Instruments, Data Acquisition (DAQ), PCI extensions for Instrumentation (PXI), Image Acquisition (IMAQ), Motion Control, Real-Time (RT) PXI, PLC (through OPC Server), PDA, and Modular Instruments.

2. LabVIEW myRIO toolkit:

The LabVIEW myRIO Toolkit is a software add-on for LabVIEW that provides the necessary driver and tools to quickly develop and deploy applications to the myRIO.

3. LabVIEW IMAQ vision toolkit:

Image processing can be implemented using LabVIEW Image Acquisition (IMAQ) toolkit package that has all necessary functions required to implement image processing. Using these inbuilt functions, we can crop, merge, rotate, combine, and compress images. Image analysis combines techniques that compute statistics and measurements based on the gray-level intensities of the image pixels. Image analysis functions also providemeasurements to perform basic inspection tasks such as presence or absence verification.

IV. METHODOLOGY

- In the below figure, a power source, preferably rechargeable Li-Ion batteries are used to power up all the blocks i.e. NI-myRIO, motor driver module(L298N), geared DC motors, Radar, Inductive proximity sensor.
- DC motors are mounted on robot chassis for movement of vehicle. The Ground and VCC pins of geared DC motors are connected to L298N motor driver along with power supply. Driver module provides the control over rotation of DC motors, thereby controlling direction of vehicle.
- Here, myRIO being an embedded system controls all the operations of the robotic vehicle. Therefore, motor driver is connected to myRIO. Also, myRIO has inbuilt

wi-fi module which can be used to make it astandalone device.

- Due to this feature the vehicle can be operated in wireless mode.
- Inductive proximity sensors(NPN) is used to impart metal detecting capabilities for the robotic vehicle. It is just placed below the chassis such that it faces the ground or terrain when travelling.
- Inductive proximity sensors are provided with power supply via myRIO. When there is no metallic object present, the output of sensor remains same. But under the presence of metallic object, the output voltage of sensor reduces due to generation of eddy currents.Thereby we can sense the environment for land mines that are spread across the field.

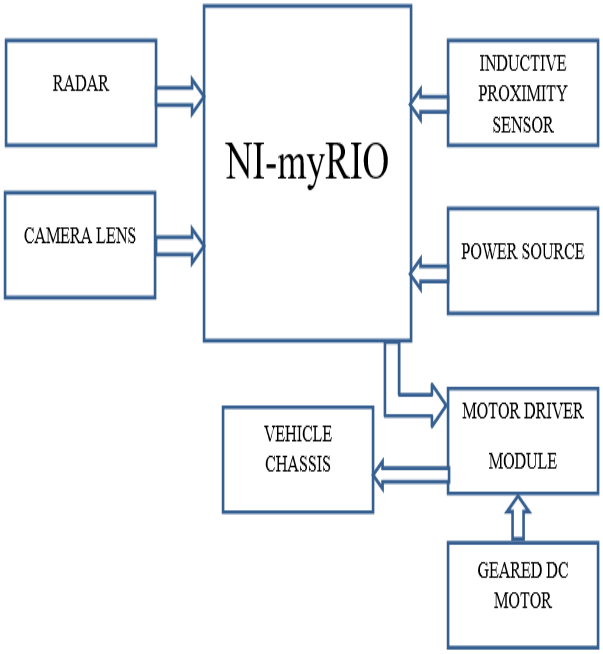

Figure.6 Block diagram of proposed system

- For object/obstacle detection radar is used. Radar generates electromagnetic waves that travel in free space. If any obstacle/object is detected the waves reflect back and reach the receiver section of the antenna. Based on the time taken for waves to reflect back the object/obstacle speed, location can be determined.
- For live system tracking, a web camera is mounted upon the vehicle. This proves to advantageous when the vehicle is used for rescue operations or exploring unknown landmass.
- LabVIEW being a graphical programming language has wide range of toolkits to implement real time applications. Among them is IMAQ toolkit which has wide range of functionalities for image processing and image acquisition. Using these in-built functionalities of LabVIEW, we can capture live images.
- While the design of proposed system is done at the block diagram section, user interface, pop-up or alerts, live streaming of video is available at front panel. Hence the data available is presented in an organized and more convenient manner.

V. RESULTS

The results of proposed system can be depicted in figure.7, figure.8 and figure.9.

While the programming part of the system is done at block diagram panel in LabVIEW software, the results are displayed at front panel for user's convenience. Direction controls make sure that the vehicle travels according to user commands. The live video captured by webcam occurs at the window in front panel where we can view and analyze the area/surroundings, where vehicle is travelling. Radar is mounted at front end of the chassis which detects the speed of object travelling towards/away from vehicle and displays at front panel. Inductive proximity sensor is mounted downwards such as it faces the land. Whenever there is detection of any metal object it alerts the user. The whole operation is conducted wirelessly by dumping the programmed code into myRIO and controlling all the operations from PC via Wi-Fi, making it a stand-alone device. Inbuilt Wi-Fi capability of NI-myRIO enables this feature of the system.

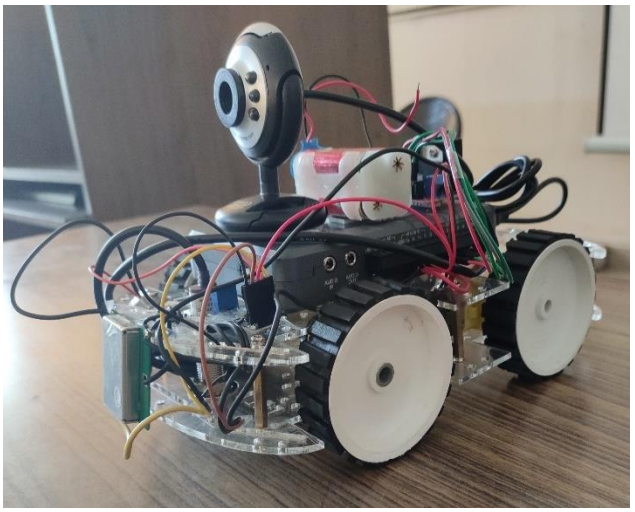

Figure.7 Hardware implementation

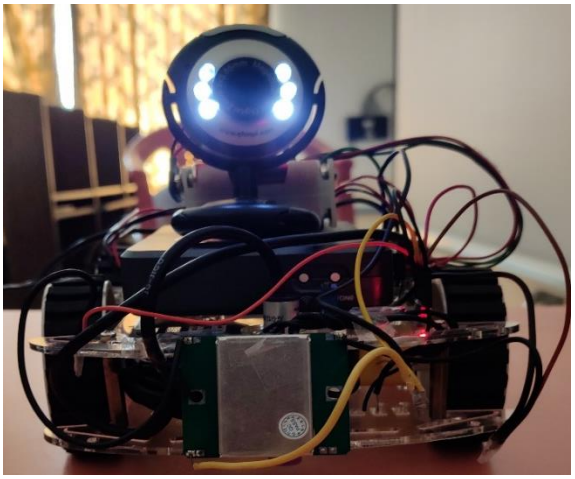

Figure.8 Live system tracking from USB Webcam with night vision feature

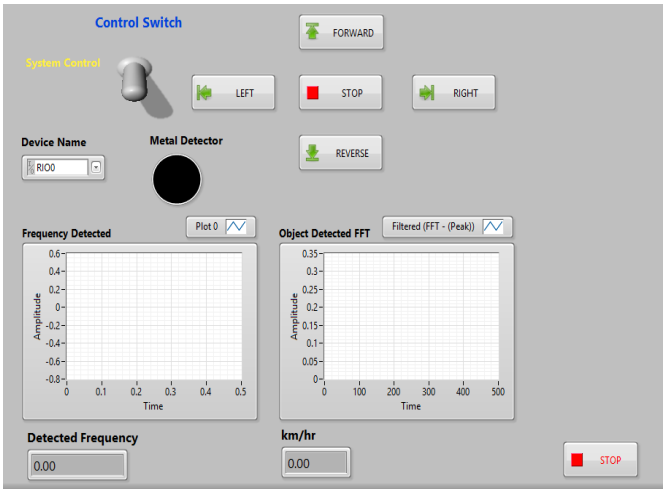

Figure.9 Front panel

VI. CONCLUSION

Autonomous vehicle navigation is achieved and all controlling actions are implemented wirelessly. The surveillance conducted by vehicle is safe, reliable and real-time response is obtained. Obstacles/Objects detection is successfully implemented with increase in its range of operation, than previously existing ones. Human life can be endangered while exploring inaccessible terrains, hazardous mines etc. Such system acts as a reliant substitute in place of humans and serves the purpose efficiently.

ACKNOWLEDGMENT

The work described in this paper was supported by GSSS Institute of Engineering and Technology for Women, Mysuru. The authors would also like to express their gratitude towards Department Electronics and Communication Engineering and our project guide Padma R for their valuable insights and guidance.

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