IDEA-2016-IC-01-Smart Surveillance System

Idea Lab Project

Submitted By

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Under the mentorship of

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Declaration

We do hereby declare that the technical project report submitted is original, and is the outcome of the independent investigations/research carried out by us and contains no plagiarism. The research is leading to the discovery of new facts/techniques/correlation of scientific facts already known. This work has not been submitted to or supported by any other University or funding agency.

We do hereby further declare that the text, diagrams or any other material taken from other sources (including but not limited to books, journals and web) have been acknowledged, referred and cited to the best of our knowledge and understanding.

Date : 19/05/17

Place: Ahmedabad

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NIRMA UNIVERSITY

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IDEA LAB

DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING

Annual/Final Report of the work done on the Idea Lab Project.

- Idea Lab Project ID: IDEA-2016-IC-01

- Project Title: Smart Surveillance System

- Period of Project: 18/08/16 to 27/03/17

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  (b) Shivam Mishra(13BIC024)
  (c) Shubham Sharma(13BIC054)
  Name of Mentor:Prof. Sandip Mehta

Department: Instrumentation and Control Engineering

- Project Start Date: 18/08/16

- (a) Total Amount Approved: INR 25,000/-
- (b) Total Expenditure: INR 20,158/-

    - Brief objective of the project: This project aims to provide an internet facility to control a remote bot/vehicle/hardware anywhere in the world through a website interface.

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Contents

- Introduction

In this Project we have designed the web page with url access through which we can control the things/any hardware across the world through internet.
For the prototype we have tested a manual robot by our developed web page.
In this project we have categorized two modes i) manual and ii) auto mode.
In manual mode we have controlled the bot through the buttons on web page and while in auto mode we have designed the tracking part through which we have to select an object and the bot automatically track that entity.
The live video feed for the surveillance is available directly on our web page.

On the website, we implemented Websocket connection between server and client using pywebsocket module which provides Websocket standalone server(and Websocket extension for Apache as well). We used the standalone server to serve our website file and a separate python file to handle the socket communication.

- Literature Survey

In the future generation of internet revolution it is assumed that 50 billion things will be connected through internet. So our scope of the project is dynamically vast.

By interfacing the physical/real world with the internet we can expect many things that are to be done very easily and efficiently and that is the privilege advantage of our project.

In almost every field it will be now mandatory to have internet access and if control is possible through internet it will lead to huge era of innovation in every field like agriculture, medical, sports, industries etc.

- Objectives Achieved

This project aims to provide an internet facility to control a remote bot/vehicle/hardware anywhere in the world through a website interface.

- Monitoring and indication of any measurable variable on webpage
- Control of devices remotely through webpage
- Live video surveillance and snapshot uploaded to the server.
- Automatic tracking and manual control over devices

- Experimental Setup and Results

The necessary instructions are displayed on a simple template. There is a connect button which establishes the socket connection to the server by getting the client's hostname and protocol via location.protocol and location.host functions in the window BOM in javascript.

After pressing the connect button, the user is now able to control the bot. He/she can already see a live feed on the website through which he/she can guide the robot. The buttons are fully dynamic, as in continously pressing the button will result in the continuous motion of the bot. And additional link is provided to redirect to a keyboard controlled page where everything is same except the user can control the bot by typing 'W','A','S','D' commands in a separate text box provided.

Webserver-
modpywebsocket built in light python based web server is used. Running the standalone.py file runs a server which serves out website file to the client.
We created a socket extension to our website by editing its socket handler file-echo_wsh.py. We programmed it to give logic 1 to the motor pins whenenver a "move" command is received(i.e. either Forward, Left or Right) connected to the corresponding motors, and logic 0 when Stop command is received.

The "move" and "stop" commands are synchronized with this on the client side via onmousedown and onmouseup events available in javascript. The pseudocode is like-

```
 button "forward" onmousedown=function1() onmouseup=function2();
function1()
{
socket.send("1");
}

fucntion2()
{
socket.send("9");
}
```

Then the socket handler at the server side is programmed as said earlier to move the bot accordingly where "1" is for forward, "2" is for left,"3" is for right and "4" is for backward and "9" is to stop the bot. The commands are sent using the socket

communication, also mentioned earlier.

Using this approach, the bot is fully dynamically controlled.

The bot control is visually controlled. The live feed is available from TP-link NC220 camera on the website itself. This is achieved using "img" tag in html and linking its source to the ip camera videofeed.

A tracking functionality is also provided. The project aims to run the bot in two modes-manual and automatic. The manual mode is breiefly discussed above. In the automatic mode, the user can select an object using the cursor on the live feed. This is done using the jcrop API in jquery.

Object selection--
It is achieved with the help of jcrop api in jquery. The sample demos are available on their website - http://jcrop.org/. We used the "thumbnail" demo which gives us the coordinates of the highlighted portion of the image presumably containing the object which we send to the server using the socket communication.

The coordinates when received by the server, it immediately takes a snapshot from the ip camera feed and then crop out the object using the coordinates received. The snapshot is grabbed by the server using the urllib library in python. OpenCV library is further used for cropping and image processing purposes.

When the cropped image is stored, it is used as comparison subject in subsequent snaphsots from the feed. The server continuously grabs the screenshot and then tries to find the object in it. This is achieved by cv2.templatematching function available in OpenCV. Examples are given in the documentation.

Upon finding the object, a green rectangle is drawn around it using cv2.rect function and saved in the image. The image is then continuously saved on the server. A separate page is opened which continuously refreshes the image so that the moving object is recognised with the green rectangle drawn around it. This is achieved by "canvas" tag in HTML. The image is refreshed every 1s.

After being done with selecting the object, the user can press the button and then

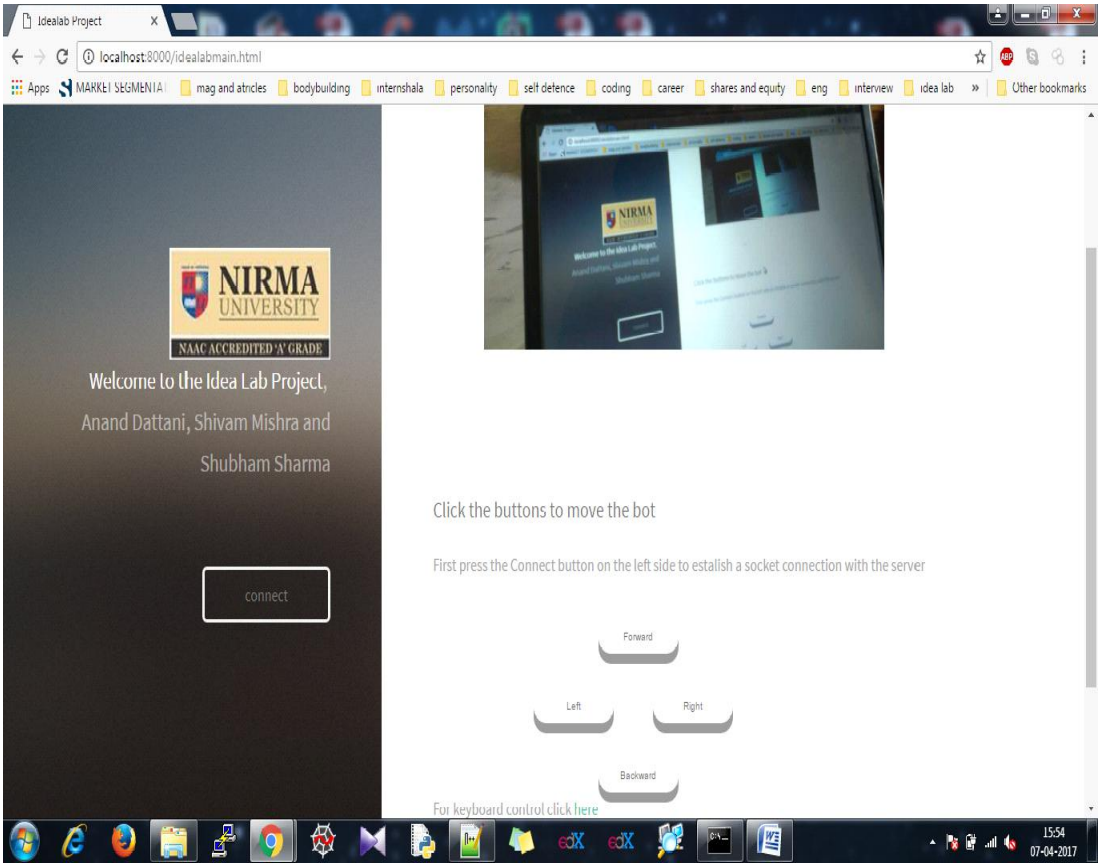
“Track” button to open a new page showing simultaneous feed of the camera with a rectangle drawn around the custom object the user chose. This is implemented using two methods-

- BRIEF features:

  In javascript, we used tracking.js module to identify the BRIEF features in the selected object and then match them in the subsequent images from the feed. This method is not much reliable.

- Template matching:

  This method is implemented in the python server itself. When the user selects the object, its coordinates are sent to the server using the socket connection. A snapshot is taken at that instant and the object is extracted out using the coordinates received. This is stored as “template.jpg” on the server and is subsequently used to determine the object in the subsequent feed using the templateMatching() fucntion in python.
  The final page executes a javascript which continuously refreshes the image on the page thus showing the feed from the camera. This is done using HTML canvas.



Hardware-

Raspberry Pi-3

The Raspberry Pi 3 Model B builds upon the features of its predecessors with a new, faster processor on board to increase its speed. It also features WiFi and Bluetooth Low Energy capabilities to enhance the functionality and the ability to power more powerful devices over the USB ports.

- Quad Core 1.2GHz Broadcom BCM2837 64bit CPU
- 1GB RAM
- BCM43438 WiFi and Bluetooth Low Energy (BLE) on board
- 40-pin Extended GPIO
- 4x USB 2 ports
- 4 Pole stereo output and composite video port
- Full size HDMI
- CSI camera port for connecting a Raspberry Pi camera

- DSI display port for connecting a Raspberry Pi touchscreen display
- Micro SD port for loading your operating system and storing data
- Upgraded switched Micro USB power source up to 2.5A

Chassis-

The R-Bot robotic chassis is a light weight, low cost, compact, medium capacity multipurpose robotic chassis which provides a great opportunity for rookies as well as pros to quench at least a bit of their limitless robotic passion carvings.

R-Bot is cut out of a 3mm acrylic sheet with 15 cm diameter which provides a strong and rigid platform to build a robotic chassis. Apart from bottom and top layer, an intermediate layer provides space for accessories like battery pack and more. Design is simple making it easy to assemble even for a school going kid and the circular design makes sure that the chassis doesn't get stuck at corners.

Two plastic geared DC motors with two premium quality rubber gripped plastic wheels powers the chassis along with a ball caster wheel for support. Top plate holds a micro servo motor with its pan head can hold proximity sensor like SHARP IR or RhydoLabz® ECHO Ultrasonic. The pan head can also be attached to the uppermost plate without using servo motor depending upon the application. An array holder is also provided with R-Bot capable of holding IR sensor arrays of various dimensions like Pololu QTR Reflectance sensor arrays.

Bottom and middle layer have just enough space to accommodate 2 4xAAA battery holders. But if the user wishes to add the top plate, there will be plenty of space to hold these battery holders. It simply means that the entire chassis is customizable as per the user's choice; i.e. except the bottom layer, top and middle could be interchanged.

R-Bot always welcomes add-ons enhancing its features like providing multiple pan heads, array holds, and extra plate to increase payload capabilities and also an extra caster ball wheel can be provided to increase to stability of the chassis. Once fully assembled, it could be easily interfaced with a quick start board or an Arduino™ development platform.

Features:

- Strong 3mm acrylic body parts

- Kit include all necessary robotic parts
- 4 X AA battery holder available
- Do not struck at corners because of Round shape
- Enormous space between middle & bottom chassis
- Six Pan head slots are provided around the top chassis
- R-Bot can be use with and without middle chassis
- Options for different types of sensors like Echo ultrasonic, pololu QTR Reflectance sensor arrays

Basic applications of this robotic kit are:

- Line tracking
- Wireless/wired controlling
- Wall hugging
- Autonomous obstacle avoidance
- Maze solving mouse

Specifications:

- DC motor (100RPM BO1 Plastic Gear Motor)
    - Operating Voltage 3V-12V DC
    - RPM 100rpm
    - No load Current 40-80 mA
    - Output Torque : 4 Kg-cm
- Wheel (BO Motor Tyre with Grip -3mm Shaft (70mm X 8 mm))
    - 70MM Diameter
    - 8MM Width

    - Wrapped with Rubber Track for maximum Grip
- Servo Motor(FS90 Micro 1.3kg Torque Analog Plastic geared Servo)
    - Operating voltage 4.8-6V DC
    - Operating Angle 120°
    - Operating Speed:
        - 0.12sec/60° (4.8V)
        - 0.10sec/60° (6V)
    - Small Torque:
        - 1.3kg.cm/18.09oz.in(4.8V)
        - 1.5kg.cm/20.86oz.in(6V)
- Toggle Switch
    - Double Pole Double Through
    - Rated Current 3A
    - Rated Voltage 50V

Dimensions:

- Length 150mm(excluding array hold)
- Width 150mm
- Height 80mm (excluding servo & pan head)

Parts included are:

- 1 x top chassis
- 1 x middle chassis
- 1 x bottom chassis
- 4 x DC motor hold

- 1 x array hold
- 1 x pan hold
- 1 x servo head
- 2 x Battery Holder 4xAA (2X2)
- 1 x Toggle Switch
- 1 x Caster Ball Wheel
- 2 x 100RPM BO1 plastic geared motor
- 2 x BO Motor Tire with Grip
- 1 x FS90 Analog Plastic Geared Micro Servo Kit
- Stand offs
    - 4 x M3 6mm HEX
    - 4 x M3 25mm HEX
    - 4 x M3 25mm HEX(male to female)
- Screws
    - 4 x M3 35mm STAR HEAD
    - 16 x M3 6mm STAR HEAD
    - 6 x M3 12mm STAR HEAD
    - 2 x M2 12mm STAR HEAD
    - 3 x 7mm x 3mm Mushroom Head
- Nuts
    - 14 x M3 2mm HEX

2 x M2 2mm HEX

1.8 Budget Analysis

- Budget Sanctioned: INR 25,000/-

- Budget Utilized: INR 20,158/-

Serial No.	Name of Product	Amount	Bill No.	Date	Consumable/ Nonconsumable	Dead Stock Number (if any)
1	Raspberry Pi-3	3675/-	RKI/16/03026	21/09/2016	NA	NO
2	RPi-Camera Module with SD card	2730/-	RKI/16/03027	21/09/2016	NA	NO
3	Servo-Pan-Tilt and IMAX Battery Charger	3077/-	RKI/16/04982	28/02/2017	NA	NO
4	Rbot chassis	1569/	RL-1603266	03/03/2017	NA	NO
5	Motor Driver and PIR sensor	420/-	RKI/16/07196	15/03/2017	NA	NO
6	Lipo Battery-3 300mAh	3097/-	RKI/16/07195	15/03/2017	NA	NO
7	Motion Detector HB00	1732/-	RKI/16/07195	15/03/2017	NA	YES

8	TP-Lin Camera NC220	3858/-	MH-SPNA-14295 4331-365 29	11/03 /2017	NA	NO

- Budget Unutilized: INR 4842/-

1.9 Conclusion and Future Work

The project can be used in-

- Industry :
  Remote control access of equipment through web page
  Efficient diagnostics and time saving
  Monitoring and surveillance

- Medical, agriculture and others :
  Remote monitoring and telepathy
  Efficient immediate action and communication.

Bibliography

https://www.raspberrypi.org

element14

Electronics4u

Electronics garage

IOTmap

pyimagesearch

OpenCV docs

Python docs