Gsoc'16 Proposal for Web-based ROS-Industrial Robot Pendant

ABSTRACT :-

The objective of this project is to develop a web-based ROS industrial Pendant for users to use ros from a light weight web user interface . A variety of libraries have been proposed to access ros topics and visualization from web browser. I am trying to add some features to the libraries and design some python libraries which meets the requirments of more generalized web platform .My plan includes the design of a complete Integrated development enviroment(IDE) for ros which is web-based .The unique feature of the ide is that user unaware of all ros commands and packages can easily create workspace/ package, design nodes by generate python codes, run visualization and make bridging with the ros nodes running on the server side .This leads to easy accessibility of many ros packages . The proposed web based ide will make the ros platform independent and can extensively use for industrial application.

1. INTRODUCTION :-

The problem statement is describe briefly in the abstract. The rest of the proposal is organised as follows. Section 2 describes briefly some of existing libraries for the web tools and how i approch to this project before the proposal submission..The prominent deliverables at the completion of the internship are listed in Section 3,while the timeline of achieving milestone is listed in Section 4 . A detailed description and funtionality of my web ide is detailed in Section 3. Section6 is about the software tools and libraries used by me .In Section 7 the total software architecture of the ide and some common scenarios encountered when using ide and how it allow for creation of a wide variety of tools .General information about me , my previous work amd my my statement of intent is given in Section 8 .

2. BACKGROUND RESEARCH :-

2.1 Django(python) + ROS :-

Last december my idea to design the complete web site with django frame work . I also took some initiative in this work. Currently the libraries , i designed ,can recieve a json packet from website when user enter the package/workspace name , then store names into one sqllite database and execute ros system commands to generate workspace and package on server side and send back the file structure of workspace to the website in a jason format .Working on how to add some dependencies to cmake and package.xml from ui and build the total workspace with diffrent nodes .

2.2 Robotwebtools :-

After release of idea page i just go through funtionality and source code of libraries roslibjs, ros2djs, ros3djs ,visualization rwt .These libraries are provids many funtionality to design tool which allows web applications to interface with a variety of robots running middleware

lie Robot Operating System(ROS).Using this javascript and html one can design a website to access the topics , visualization and other system dependent featurs of ros from web browser.

2.3 Ros-web :-

For the first approch user interface for the MTConnect project is replecat on a website ,which is limited to LINUX before .Currently the light-weight material design from Google to make the website light with good aesthetics and using roslibjs libraries to establish a bridge connection between the web site with my running nodes on local computer . To show the visualization part on web currently using Three.js .No specific server need to run the website , it will directly run on web browser and it need internet to download the jquery part .U can find the updated work on this in my git account(https://github.com/oblivione/ros-web)

3. DELIVERABLES :-

The key deliverables at the end of thr GSOC 2016 internship are as follows :

- Design django(python) and javascript libraries to generate skeleton python codes for several ros applications .
- Implement the node.js funtionality in web site so it can acess the external connected hardware .
- Provide diffrent robot modules for visuallization using ros2djs ,ros3djs
- Provied a ui which can assign and update topics and data types to each button , table and card on the web site ,so the web ui can be generalized for every package (no need to change the source code every time).
- Finally Using my backgroung research and current knowledge i want to deliver a complete a web based IDE for ros .

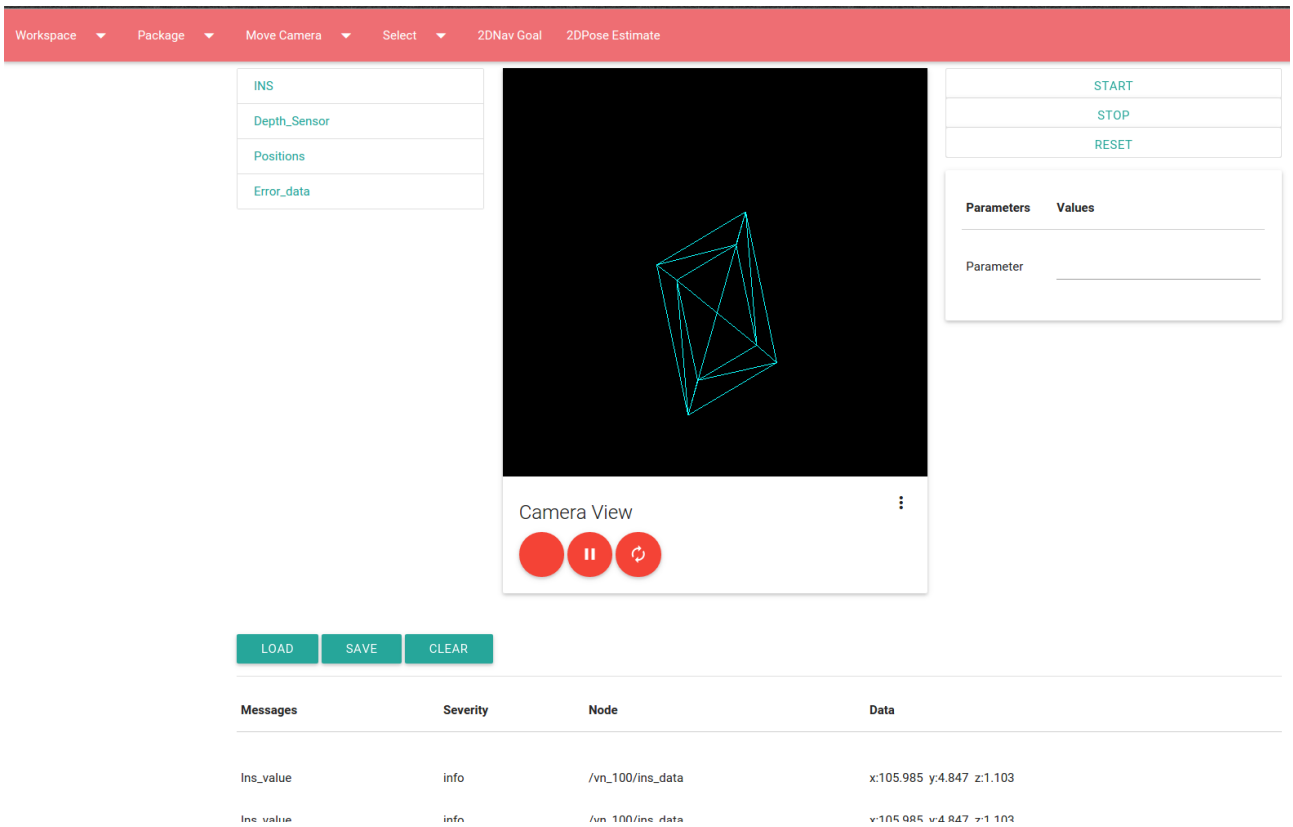
4. TIMELINE :-

- **April 22 - May 10** : Gain Expertise django and start the work on auto generate python code
- **May 10 - June 10** : Finish the work and design some example packages of drons and auv for server side
- **June 10 - June 27** : Tesing current work with my packages and Document how to use this package , Mid Term Evaluation
- **June 28 – July 28** : Design some example robot modals and try to link the sdf libraries for users to design their own modules or import it.also finish the node.js libraries to access the external hardware .
- **July 28 – August 10** : Design the ui and action_server for the buttons and cards in the web site

- **August 11 – August 23** : Complete all the testing and finalize the total web ide .
- **August 24 – August 26** : Design the Documents and submit it for review to any modification before final evalution .

5. DESIGN GOALS AND FUNTIONALITY:-

Here i am adding a screen shot of my currently devloped interface .so i can make u under stand the current features and and what extra feature i want to develop .



Previously in section2 , i already expalined the design tools of ros-web and how it is working .Some features points are noted which are there in the ui currently and i am going to add some new featurs to it and improve this features during my internship program.

a . Workspace and package creation and search

b. Status of Dynamic reconfiguartion

c. Selection of modals and show the visualization part with diffrent camera views

d.Dialog box for currently subscribe or publish

a . Workspace and package creation and search:

By only using ros javascript libraries we can able to connect to the nodes or packages which are already running on the server side , but cant able to create a workspace or package on the server side . Using this ui user just need to enter the workspce name and it will create and initi a workspace on the server side with same name . User can also create packages with dependencies inside the same workspace and can make the whole workspace .

```
$('#workspace_create_modal > .modal-footer > .modal-close').click(event,function(){
  console.log($('#workspace_name').val())
  var workspace_name = $('#workspace_name').val()
  $.ajax({
    method: "GET",
    url: "http://192.168.50.243:8080/execute_command/",
    data: { command_name : "workspace_create", workspace_name : workspace_name+""},
    dataType: "json"
    })
  .done(function( msg ) {
    console.log( "Data Saved: ");
    console.log(msg);
  });
});
```

This code screen shot shows how django server receive the jason packet with name. Then decode it and using python code and execute the system commands to create a workspace or package . It send the file stucture back in jason format for conformation .

Future work :-

With extension of this feature i am planning to add a IDE to it , where users can generate their skeleton of ros python codes for packages they created before .The IDE will contain many options like publisher , suscriber , dynamic_reconfiguration, action_lib.User just need to drag that menu to the ide and give own topic name and fill some other option and click generate button for the skeleton code .Planning to apply same thing with .cfg, , srv, . action files also.

Technical approch for the future work:-

1. Planning to design the entire ide with html and java script .
2. For drag and drop options and drop down options javascript will be helpfull.
3 . Ajax methods are there to send any data to django server .
4. Initially the code will generate on the ide it self , after all edit done by user .it will send to the desired packages .
5. There will be a continues change in cmake file for each addition of new file .For this reason planning to convert the entair cmake .txt into one html file , so addition of new things will be easy . Final Cmake.txt will send to the package at the time of catkin_make and run .

6. Some specific packages for various robots should be there in server . So user can write t heir own algo or change any code and test them using that visualizer presnt in the web site .

b. <u>Status of Dynamic reconfiguartion</u> :

dynamic_reconfiguration mainly use while tuing of control algorithms and image processing algorithms . In current ui by subscribing and publishing the dynamic reconfiguration topic i can change and reset their values and can look their current status

<u>Future work:</u>

Only want to add a box to know status all service and action files .

c. <u>Selection of modals and show the visualization with running node</u> :

For the first approch i design a cube using Three.js and simulation made by reciving the live data from INS connecting to the computer . By accessing the quat_data from the ins the visualization is running , you can also stop and replay it by using the buttons .The visualization only start when press the play button on the ui.By moveing camera option we can access top view , side view of the visualization .

<u>Future work :</u>

1. provide standart robot modules for users .
2. User can design or import their robot .
3. Run the simulation on web directly by receive the data from serial port .

<u>Technical approch for the future work:-</u>

1. To design some standard modules i am planning to use ros2djs ,ros3djs and Three.js
2. Need to include sdf modules to the web ide .which allows the users to design and import their own modules to the visualization .Imported or written xml file shoud be compile on the server side .
3. To directly access the comport or any other hardware device form web browser node.js funtions will be helpfull .

With all the above features and their future work , i would like to add some extra feature to it also

d. **<u>Complete ui to set topics and data types</u>**:-

The idea is user can use this web ui to test any kind of his own written package . For this we need to assign topics and data types to the present buttons , tables , cards to show their values in the web site and publish/subscribe .The importance of this kind of interface is no need to change the source code .The user interface will directly update the topics and data types in the source code . This idea is little bit complex , to over come that we have to put a constrains on the topic names and data types for users .

<u>Technical approch</u> :-

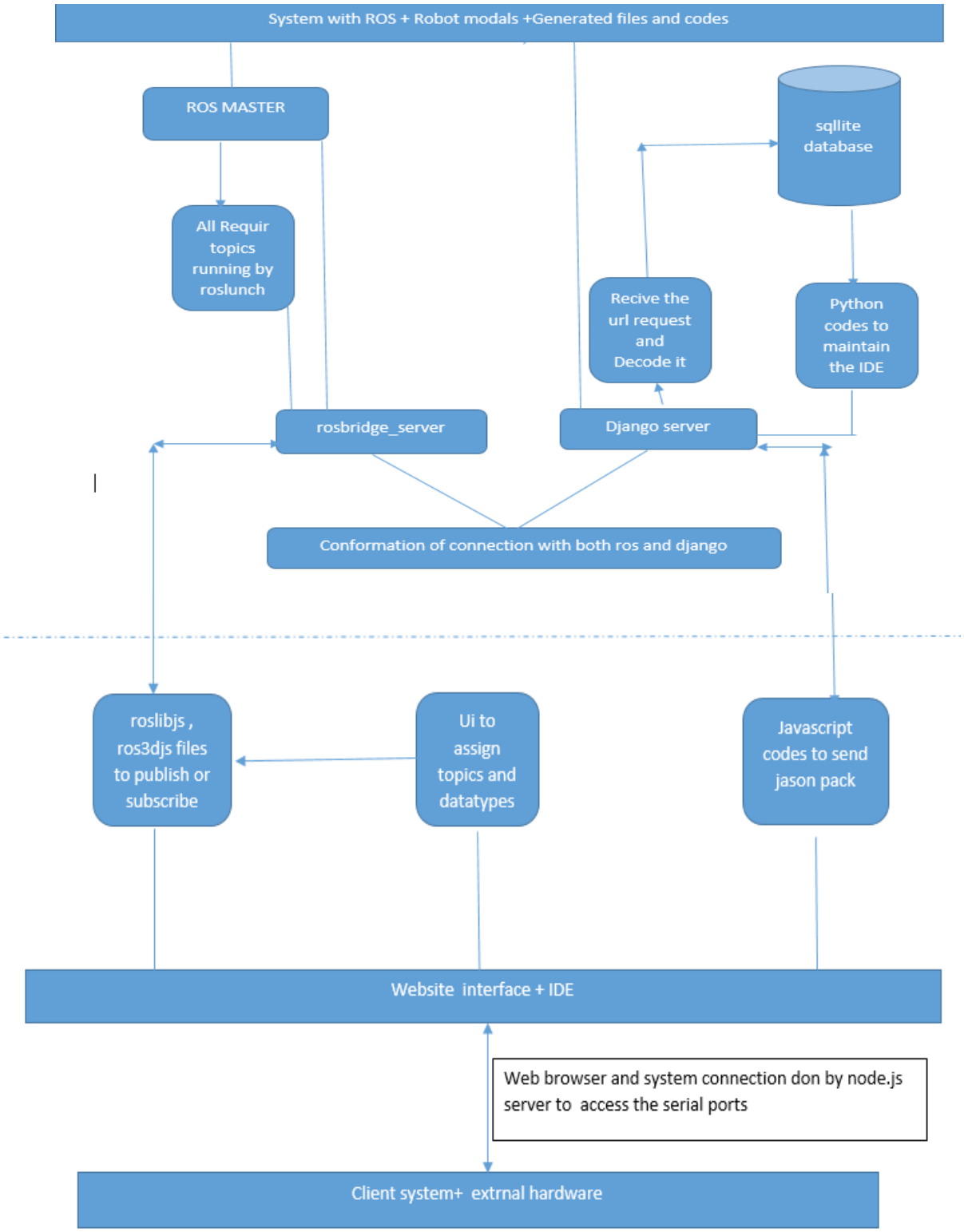
1. The ui design will be on java script and html . It will link with the source code directly .

2 .And a action_server should be there to connect the packages with the user interface .

6. <u>SOFTWARE TOOLS :-</u>

- For front end design of web-based ui javascript , HTML .
- Server side rosmaster , django server,node.js , continuesly running to provide all funtionality
- For Bridging between Ros and web page ros java script libraries like roslibjs are used .
- For Design of robot models of bots three.js , ros3djs , sdf libraries are used.

7. SOFTWARE ARCHITECTURE :-



8. **ABOUT ME :-**

Contact Information

Name : Omprakash Patra

University : National Institute of Technology,Rourkela,India

Course/Major : Computer Science and Engineering

Email : omprakashpatro@gmail.com

Git link : https://github.com/oblivione

Ph no : 09439156469

Coursework

I am currently a student of Computer Science and Engineering at National Institute of Technology, Rourkela, India. Here is a list of relevant courses that I have taken.

1. Mathematics - I (ODEs and Laplace) during Autumn 2013
2. Mathematics - II (Linear Algebra and Vector Calculus) during Spring 2014
3. Data Structures and Algorithms during Spring 2014
4. Mathematics - III (Numerical Analysis) during Autumn 2014
5. Digital Image Processing during Autumn 2014
6. Softcomputing Technique during Spring 2014
7. Principle of Programming Languages during Spring 2015
8. Algorithm Analysis and Design during Spring 2015
9. Computer Graphics during Spring 2016
10. Software Analysis and Design during Spring 2016
11. Computer Aided Design during Spring 2016

Some Privet Training Undertaken on

1. Linux Kernel And Device Driver

2. Advance C

Experience

1.

PROJECT :- BALLOON SATELLITE -1 (June 2014 – August 2014)
POSITION :-MEMBER OF COMMUNICATION DESIGN AND SENSOR INTEGRATION TEAM
GIT LINK :- https://github.com/oblivione/Balloonsat-Sensor-integration-codes-

DETAILS :-

• A helium balloon is used to send the payload to the desired height, which in this case is the stratosphere (40 km). At the point of highest reach, when the balloon has expanded to its maximum due to the dropping pressure, it explodes and the payload drops, being guided by the attached parachutes. As it drops through the atmosphere, the various sensors attached to the payload make observations and this data is then available for further analysis. The payload being designed by NIT Rourkela students will be containing sensors for temperature, pressure, altitude, atmospheric quality & composition, imaging and tracking. The various sensors available on-board will serve the purpose of a complete moving weather observatory. The tracking data will be continuously transmitted via GPRS to allow the students on the ground to track, chase and pinpoint the final landing location. The entire aerial journey will be tracked on Google Maps and Google Earth.
•My responsibility was to integratetion of all sensor with arduino and GSM based communication system to send all sensor data to a python server for balloon satellite-1 and take the GPS data to locate in google map.

2.

PROJECT :- ONLINE VEHICLE TRACKING SYSTEM (Dec 2014 – Jan 2015)
POSITION :- INDIVIDUAL PROJECT

DETAILS:-

• Integration of sensors in the eco-kart(electric vehicle): GPS, GSM, IMU ,TEMP etc. with the Arduino development board. The data that was collected from the sensors, was displayed in the IoT site (www.ubidots.com).For this i wrote a arduino library to establish hhtp connection between GSM module and php server .The php server work as a intermidiate between the iot and sensor modules , which decodes the jason packet and add a variable id to it .

3.

PROJECT :- BALLOON SATELLITE -2 (June 2015 – August 2015)
POSITION :- HEAD OF ONBOARD SOFTWARE TEAM

DETAILS :-

• The balloon satellite is being developed to measure the air quality measurement. This project emphasizes on measuring the components of air. This project will give an insight into the air pollution levels in the industrial areas, and the help the industries to maintain a particular level.
• Designed a python server integrated with MongoDB to store all sensor data and to write C++ library to convert all gas sensors data to a JSON packet on a UDOO devlopment board.
• Lead a Team to complete othe parts like sensor intigration, website design, GUI development .

4.

PROJECT :- KALAM SATELLITE PROJECT (March 2015 - Present)
POSITION :- HEAD OF ONBOARD SOFTWARE TEAM

DETAILS:-

• The objective of the project is to develop and deploy nano-satellite and to use it for monitoring the ecology of Chhotanagpur plateau. The nanosatellite is chosen due to its light weight and mass for which launching of this kind of satellite incurs very low investemnt and operational costs. The possible orbits for launching nano-satellite are LEO (Low Earth Orbit). The choice of orbit depends on application and type of satellite.
The primary objective is to study the following features of Chhotanagpur plateau and to share the information with other users.

- Estimation of agricultural land used in different seasons
- Deforestation and afforestation
- Agricultural and forest land area damage due to open cast mining
- Estimation of restoration of mining area
- Estimation of Biodiversity in mining area

• This project is going to funded by ISRO (India Space Research Organisation) . The proposal and CDR(Concepttual Design Report) completed and it is under review . So my software team decided to design the complete software stack on ROS platform . Now i am working on the total simulation part and train other team members to code ROS .

5.

PROJECT :- AUTONOMOUS UNDERWATER VEHICLE) (May 2015 -Present)
POSITION :- TEAM CAPTAINAND SOFTWARE TEAM HEAD
GIT LINK :- https://github.com/oblivione/auv_packages

DETAILS:-

• Our AUV vehicle was designed keeping in mind the key factors of mobility, modularity, and maximum functionality with minimalistic design.Extensive design optimization and mathematical modelling was carried out to produce our final result
which is bound to provide an edge to our AUV in the competition in the light of the following factors:

1: High localization capability in unknown environments autonomously
2: Easily manoeuvrable and energy efficient
3: Low cost and modular design
4: Easy debugging

• The complete Software stack Developed on ROS platform .Currently I am working on INS(vn-100),GUI node,control algorithm nodes and Image processing algorithms for AUV. Above github link contains the complete package which is written by me . In near future ,I am going to implement Machine learning nodes .

6.

PROJECT :-UAV(UNMANNED ARIAL VEHICLE) (February 2016 – Present)
POSITION :-INDIVIDUAL PROJECT / ACADEMICS THESIS

DETAILS:-

•Although years of res earch of GPS pos ition and data tracking have improved outdoor navigation and localization, in environments such as indoors or dens e urban areas where maps are unavailable and the GPS s ignal is weak, an UAV will operate in high hazardous regions ,

running the ris k of becoming los t and colliding with obs tacles . Since the s cope of this project cons is ts of enabling an UAV to autonomous ly navigate in an unknown environment without res orting to GPS localization, the main challenge is using vis ual odometry and on-board IMU to develop navigation and pos ition es timation algorithms to achieve an autonomous and robus t navigation.

For sample codes you can check my git hub link https://github.com/oblivione . Previously i worked on many website and database projects. One complete project on website and database present in my git .i have working knowledge of php, mongo db data base,socket programming , thread programming .so i have experience in both website designing , operating system theory and ROS platform which can help me to complete this web based ros project .

REFERENCES :-

Prof. Ajit Kumar Sahoo
Assistant Professor,
Dept of Electronics & Communication Engineering(EC),
ajitsahoo@nitrkl.ac.in
Ph: 91-661-2462461

Prof. Samit Ari
Assistant Professor,
Dept of Electronics & Communication Engineering(EC),
samit@nitrkl.ac.in
Ph: 91-661-2462464

Prof. Haraprasad Roy
Assistant Professor,
Dept of Mechanical Engineering(ME) ,
royh@nitrkl.ac.in
Ph: 0661-2462526

Statement of Intent

I have always been fascinated by technology. It holds my awe, and has been pushing me towards working in this field form four years. I guess we are all dwarfed by that behemoth called science, which is progressing at an unprecedented speed. Today's technology is tomorrow's obsoleted tool. I got introduced to LINUX and Embedded Systems for Robotics in my first year at National Institute of Technology, Rourkela. I got exposed to and appreciated the work of open source developers and therefore, now I aspire to become one. It is my way of leaving behind a legacy that can benefit and inspire many others to follow. One of my best learning experience has been LINUX Kernel device drivers. I started looking for projects going on in our institute, and am now the captain of the Autonomous Underwater Vehicle development team and will take part in the national edition of the competition scheduled in November 2016. Previously, the software package was based on Windows, but our team decided to do away with it. Now, the complete stack is developed on ROS Platform. I find issues in the package rosserial and make my own tweaks. I want to work in the ROS Platform based industry.

Apart from the Autonomous Underwater Vehicle project, I have been involved in several other projects and participated in many competitions in the technical fests of IITs. I am regular face at IIT Bombay Techfest and IIT Kharagpur Khsitij and have always won prizes in the robotics events. Our institute launched its first Balloon Satellite for the atmospheric data collection in the year 2014. I was a member of the communication and sensor integration team. Currently, I am the team leader of the on-board software not only for the second leg of the Balloon satellite project but also for the KalamSat, the institute nano-satellite project. My interests have been diverse. I and some of my friends developed an unmanned aerial vehicle that can be used for remote surveillance.

Our team, while working on the Autonomous Underwater Vehicle, faced several of these problems while implementing ROS. Therefore, I decided to take on this problem, which can help several aspiring Robotics enthusiasts to adopt ROS which was previously thought to be a very tough domain. It is my way of simplifying the problem, which is the main reason why the field is progressing exponentially. We all want an automated world, and this is just a baby step.