Europian Rover Challenge 2019

Proposal

Team Name: **IUT AVIJATRIK**

Rover Name: **AVIJATRIK 3.0**

Affiliation: **IUT IEEE RAS**

Version: **1.0**

SUBMISSION DATE : 31-03-2019

Introducing Team Avijatrik

Team Leader

Name: Zaheen E Muktadi Syed

Department: Electrical and Electronic Engineering

Familiar with Proteus,MATLAB,IP camera, networking etc.

Thesis on 5G networking.

Participation: University Rover Challenge 2017
Indian Rover Challenge 2018

Supervisor:

Name: Dr. Golam Sarowar

Assistant Professor, Islamic University of technology

Mechanical Section

Name: Abdul Aziz Bhuiyan

Department: Mechanical and Chemical Engineering

Familiar with Solidworks, GAZEBO simulation. And primary research area is on vibro-acoustic optimization of cutter blade.

Participation: Indian Rover Challenge 2018
European Rover Challenge 2018

Electrical section

Name: Abdullah Al Mamun

Department: Electrical and Electronic Engineering

Familiar with Proteus, Eagle, Raspberry Pi, ESP8266, MATLAB, Arduino etc.

Research area is Optimizing and Control of Power Electronics.

Participation: Indian Rover Challenge 2018
European Rover Challenge 2018

Coding Section

Name: Mashur Shalehin Sakib

Department: Computer Science and Engineering

Familiar with Raspberry Pi, ROS, STM32, MATLAB, Python etc. And primary research area is image processing and graphics design.

Thesis on Biomedical image processing.

Designing Section

Name: Nadim Ahmed

Department: Electrical and Electronic Engineering

Familiar with Proteus, Raspberry Pi, ESP8266, MATLAB, Arduino, Python etc. And primary research area is on CNC and already built one.

Thesis on FPGA implementation of neural network.

Participation: Indian Rover Challenge 2018
European Rover Challenge 2018

Communication Section

Name: Tahmid Bakhtiar

Department: Electrical and Electronic Engineering

Familiar with Mikrotik routers, IP camera, networking etc.

Primary research area is on Ultra dense Network.

Participation: Indian Rover Challenge 2018
European Rover Challenge 2018

Software Section

Name: Mainul Bin Ibrahim
Department: Electrical and Electronic Engineering
Familiar with web app development, IoT, data mining etc. And primary research area is on data mining.

Thesis on Cyber security and Networking.

Participation: Indian Rover Challenge 2018
European Rover Challenge 2018

Marketing and Logistic Section

Name: Md. Beheshti Kabir
Department: Electrical and Electronic Engineering

Secretary of IUT IEEE Robotics and Automation Society

Familiar with Facebook marketing Logistic and have a startup (https://www.facebook.com/WeddingEdgeBD/)

Team Achievements:

1. Avijatrik 1.0 placed 5th in IRC 2018 (Indian Rover Challenge).
2. Avijatrik 2.0 placed 14th in ERC 2018 (European Rover Challenge).

Rules Analysis:

1. Initial project assumption:

1.1. The rover has to be standalone, mobile platform and commercial off the shelf components can be used.

1.2. The rover weight limit is 50kg. A lighter rover than the weight limit will be rewarded and heavier one will be penalized.

1.3. The rover maximum speed limit is 0.5 m/s. Every task area will be within 100 m radius and starting point will be 50 m from the base.

1.4. For rover safety there must be an emergency stop & indicator light. The indicator light should be active for 5 seconds and during this time the rover should be completely safe. The light indicators must clearly indicate the state of the rover.

1.5. The rover has to be controlled wirelessly at a maximum radius of 100 meters. Radio communication of the rover has to use legally available frequencies. All the accepted Radio, Wifi & ISM bands given in the rule book should be followed.

1.6. Automation needs to be applied for certain processes. The rover should be able to respond to certain commands and act accordingly. For example "start" command to initiate a process. We can automatize only certain parts of a process if not the the whole process.

2. Technical requirements and Proposed Solutions.

2.1. Mechanical Body

The rover should be able to traverse a rocky uneven terrain. However it also has to be lightweight and portable, and able to sustain the harsh condition of Mars.
Last year in mechanical sector a customized rocker bogie mechanism and 6 degree of freedom (DOF) robotic arm was built. This year we are going to optimize the body design for maximum

stiffness with reduced weight and incorporate corner wheel steering. We are planning to implement a full aluminium body which will decrease the weight but increase the cost.

2.2. Robotic Arm

A functional robotic arm is required for assisting in different aeronautical operations as well as assisting an astronaut in outer space missions.
Previously there was not any feedback from the robotic arm. This year we will implement the feedback system using closed-loop actuators. We are also going to implement inverse kinematics in the hand for the autonomous tasks.

2.3. Electrical System

In the electrical system we are bringing about major changes by devising the entire system to be completely modular assisting in quick and efficient change of damaged modules and altering for specified tasks. We will be using Arduino for the hardware feedback and controlling and a high end laptop for all the images processing and autonomous computing.

2.4. Safety and Light Indicators

A large visible emergency safety button will be implemented which will cut out the internal power and bring the rover to abrupt halt as soon as the button is pressed,
An array of light is needed to indicate three states of the rover: normal state, processing state, autonomous state.

2.5. Communication

We need to control the rover wirelessly for at least 50 meter but no more than 100 meter.
In the communication sector, we will be enhancing the range by using two MikroTik Rb metal routers with high gain antennas for reliable radiolink that will provide link between the rover and the base station for processing data. The Router will utilize 2.4 GHz frequency band for data transmission and reception. However for remote controlling of the rover we will be using 864 mHz (EU LBT) frequency and all the telemetry data will be sent over 433 mHz frequency bands. However all this band has to be recheck for compliance with the rulebook and the entire communication setup needs to be tested before implementation.

2.6. Automation

In the previous version of the rover our main drawback was the automation framework. This time with the feedback from the robotic arm, all the science tasks will be done autonomously. Implementation of Inverse Kinematics (IK) was not pulled off last time owing to lack of previous experience and knowledge in that particular sector, but this time we are confident to be able to implement this. Due to lack of enough knowledge and resources last time we were unable to implement Simultaneous localisation and Mapping (SLAM). This time along with OCR and Aruco markers SLAM will also be implemented for traverse task. We will be using depth cameras along with Lidar systems for accurate sensing of the environment.

2.7 Management

This year all the subteam heads are to work cooperatively while strictly maintaining the deadlines. We have assumed all the deadline a week earlier than stated. This allows us back up time in case of unwanted circumstances. We have decided to use Trello Board for better organising of the entire operation. A separate creative team will take charge of branding and marketing the project.

3. Analysis of Challenge Tasks:

No	Challenge Task	Description	Compliance / assumptions
1.	**Science task**	Obtain samples of surface and subsurface layers of the soil each taken from different locations specified by judge.	Acquisition of 3 surface samples of at least 25g from designated spots. A science box is to be designed for preserving the samples on board with 3 different containers with automated rotation to store different samples.

No	Challenge Task	Description	Compliance / assumptions
2.	**Maintenance task**	Demonstrate rovers and teams ability and performance in operating electrical panels on which several switches and other electrical components are mounted.	Focuses on task automation, tele operator interface, end effector performance and manipulator performance. Tasks automation should be presented in one or more cases. Depth sensors and video feedbacks required for operating the switchboard using the arm. Identify and rotate the knob to at least 5-degree precision in the switch panel. Grasp the high-power plug from the ground and insert it into the socket The rover shall be equipped with manipulation device which is able to pick up cache and place it into container on-board.
3.	**Collection task**	Reach locations marked on map, search and pick up the cache and place it into container on-board in a required orientation, then deliver container with caches to final destination	Focuses on automated elements detection, approach and collection, operation robustness, container and chance design, delivering the container to designated place. The container is kept caches in vertical position to prevent movements during traversal There are least 4 slots for cache in the container to hold the cache of 200mm height and 30mm diameter at one end and 20mm diameter at another, in correct orientation.
4.	**Traverse task**	To demonstrate system ability of semi to fully autonomous traverse.	Sending rover position and way position to the system, reaching 4 way-points, reaching additional point located in more challenging terrain etc. Odometer, IMU used for automated traversing. Localization and mapping using image processing and SLAM algorithm and create a probability stick map. Use of LIDAR to select an automatic route with less obstruction.
5.	**Presentation task**	The overview of the project and how the team worked on the project, all the kind of technical issues and solu-tions.	

Preliminary Risk Assessment:

Risks	Probability of occurrence	Severity of occurrence	Mitigation Methods
Short circuit in the power	Low	Electrical system failure	Backup modular PCB boards for different sections are prepared to tackle such unlikely scenario.
Motor driver failure	High	Control of that particular motor will be lost	Backup motor drivers should be bought. These components are very much likely to suddenly stop working. Again modular system means these can be changed promptly.

Risks	Probability of occurrence	Severity of occurrence	Mitigation Methods
Communi-cation signal lost	Medium	Controlling of the rover from the base sta-tion fails	A system should be able to auto reconnect after a connection timeout. We have to monitor the connec-tivity status at all time.
Feedback reception failure from the motors	Medium	Inverse kinematics controlling of the rover hand fails	Manual controlling methods using the controller will have to be used in such circumstances.
Deadline Failure	Medium	Risk the entire project	We must try to finish all the work a week before the deadline and constantly remind the team of the due dates.
Sponsors	Medium	Failure to gather sponsor may lead to budget cuts and deviation from the proposed plan	The team members will have to donate a significant amount of money which will enable us to carry out the initial costing.

Mainly this project is done by us, the group of undergraduate students. Since we are not industrially affiliated, the parts we are making for this rover may not be as precise as we are expecting. Again due to lack of resource and funds sometime we are unable to make prototype and do trial and error. As both precision and error both are important, lack of resource in these sectors are generating some percentage of risk in this project.
However to make the rover precise and compact we are setting up our very own lab and CNC workbench. Also we are trying to arrange some sponsors for making prototypes and trial and error for making the rover effective to the fullest sense.

Project Potential Evolution:

The rover itself is a mega project housing various research topics that are not only interesting but also in high demand in the current status quo. These topics are mentioned below:

- **Implementing machine learning and artificial Intelligence:** Although we are only thinking about the competition but this technologies can be easily modified and used for self driven cars etc which is an ongoing hot topic.
- **Rocker bogie mechanism:** Current industrial robots are looking forward to evolve and replace the manual labour done by human. A versatile mechanical design is much appreciated in this field where we can use robot to carry around goods and sensitive materials.
- **Robotics arm design:** A functional robotics arm can be used a different fields and gives us the opportunity to carry out many different project starting from biomedical application to car assembly.
- **Communication system:** We can use the rover communication set up to explore various other networking topics like ultra dense networks, communication security etc.
- **Embedded systems:** The rover electrical circuitry can be converted to implement different embedded system projects.

We could use our mega project to provide a platform for smaller projects and we plan to document each part of the rover carefully so that we can yield academic research papers. Furthermore for marketing purpose we can use our project learning and expertise to assist different companies in home automation and setting up security cameras.
We can showcase our project in different robotics competitions held in our country