ANATOLIAN ROVER CHALLENGE

2022

Design Report

TEAM INFO

ANATOLIAN ROVER CHALLENGE

Team Name:

- Name of the team and if applies, name of the rover.

MIST Mongol Barota

Rover Name: Phoenix 2.0

Contact:

- Contact information and social media links of the team.

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Contact No:
Team Lead(Shafayetul Islam) : +8801303909705
Academic Consultant(Lt Col Muhammad Nazrul Islam,PhD): +8801725560099
Facebook Page: https://www.facebook.com/mongolbarota.mist
LinkedIn: https://www.linkedin.com/company/mist-mongol-barota

TEAM INFO

ANATOLIAN ROVER CHALLENGE

Academic Institution:

- Name and address of the affiliated academic institution.

Military Institute of Science and Technology(MIST)
Mirpur Cantonment, Dhaka, Bangladesh

Academic Consultant:

- Name, affiliated academic institution and contact information of academic consultant.

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Head of the Department, Department of CSE,Military Institute of Science and Technology(MIST)
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2. Lt Col Muhammad Nazrul Islam, PhD
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TEAM INFO

ANATOLIAN ROVER CHALLENGE

History of the Team:

- A paragraph of teams history including foundation date, attended competitions and experience.

Team Mongol Barota is the dedicated robotics team formed in 2013 at the Military Institute of Science and Technology (MIST) in Bangladesh comprising the students of the Department of Computer Science & Engineering and the Department of Mechanical Engineering. Since its inception, this ambitious little team had only one objective: to present our institute, as well as our country on a global platform with pride. As part of its contributions to the world of technology, Mongol Barota has been working on several projects over the years.

- Having worked on its first rover for a full year, the team participated in the University Rover Challenge (URC) of 2014, marking the first-ever time any team from Bangladesh entered this prestigious global challenge. Although the team started with limited resources and a small workforce, it earned a respectable 12th position (among 31 countries) globally, making history and paving the way for the journey that lay ahead.

- The team, after its unexpected success in 2014, continued with its journey in URC 2015, with a more organized team and better design. The performance of the team had greatly improved which reflected in the achievement of the global 9th place (among 44 countries).

TEAM INFO

ANATOLIAN ROVER CHALLENGE

History of the Team:

A paragraph of teams history including foundation date, attended competitions and experience.

- Team Mongol Barota's first attempt at the European Rover Challenge was in 2016. Despite their high ambition and will to reach the top, the team was unsuccessful in that attempt, resulting in a period of hiatus for the next few years.
- After a long break, Team Mongol Barota rose from the ashes, with a new rover, aptly named "PHOENIX". The team, now stronger than ever, participated in the University Rover Challenge of 2021, and scored highest among all teams globally. This was a first in the history of our team, the institute, as well as our country, Bangladesh.
- The team has participated in the University Rover Challenge of 2022, with “PHOENIX 2.0” - a game-changing development, and scored highest in SAR (System Acceptance Review) among all other teams in our country. Now the team is all set to attend the finals in June.
- The team, originally formed in 2013 and reformed together last year, has multiplied since, and now is a blend of members with varying levels of experience and expertise. Furthermore, with a view to encouraging and training the newer members of the team, the project leaders have formulated a thorough recruitment process.

TEAM INFO

ANATOLIAN ROVER CHALLENGE

Active Members List:

- A table of active members including following information: Name (or initial letters), University Major, and duty in the team.

Name	University major	Role
Shafayetul Islam	CSE	Team Lead
Shah Md Ahasan Siddique	ME	Team Co-lead
Riasat Haque	CSE	Electrical Lead
K M Jamiul Haque (Zayed)	ME	Electrical
Naim Ibna Khadem Al Bhuiyan	CSE	Electrical
Md Rashid Ul Islam	CSE	Electrical
Abrar Faiyaz khan	CSE	Electrical
Mehedi Hasan	CSE	Electrical
Arr Rafi	CSE	Electrical
Muntasir Hasan Porag	CSE	Electrical
Shoeb Ahmed Tanjim	CSE	Communication & Software Lead
Tahsin Ahmed Refat	CSE	Communication & Software
Tariqul Islam Tamim	CSE	Communication & Software
Rayhan Ferdous Faisal	CSE	Communication & Software
Tariq Hasan Rizu	CSE	Communication & Software
Fardeen Ashraf Rotno	CSE	Science Lead
Subah Tasnim Shiary	CSE	Science
Chowdhury Farzana Santona	CSE	Science

TEAM INFO

ANATOLIAN ROVER CHALLENGE

Active Members List:

- A table of active members including following information: Name (or initial letters), University Major, and duty in the team.

Name	University major	Role
Ellora Yasi	CSE	Science
Hafsah Mahzabin Chowdhury	CSE	Science
Sadia Nur Nazifa	CSE	Science
Tasfia Akter Sara	CSE	Management Lead
Fabiha Mukarrama	CSE	Management
Alisha Kabir	CSE	Management
Tasnim Ullah Shakib	CSE	Management
Shadmanee Tasneem	CSE	Management
Nuraia Nahrin Fahmida	CSE	Management
Naheen Ibn Akbar	ME	Mechanical Lead(Arm)
Abdul Hasib Hasan Zayed	ME	Mechanical Lead(Body)
Sakib Ahmed	ME	Mechanical
Syed Tanjib Mahmud	ME	Mechanical
Ragib Tahshin Rinath	ME	Mechanical
Md. Fahim Faisal	ME	Mechanical
Nafiul Islam	ME	Mechanical
Mahatab Bin Rashid	ME	Mechanical

TEAM INFO

ANATOLIAN ROVER CHALLENGE

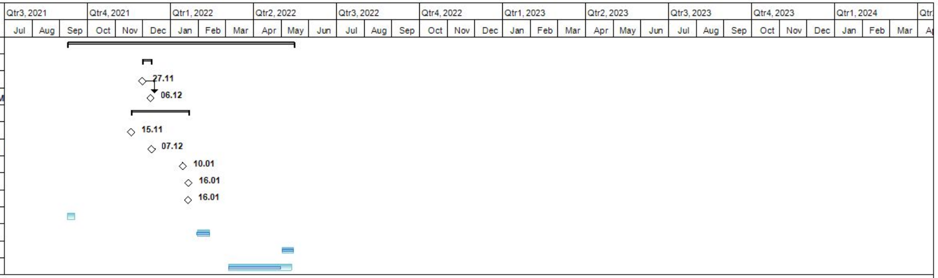
Team Photo

- A photo/screenshot of the whole or part of the team.

MANAGEMENT

Work Calendar:

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**ARC-2022**	**246 days**	**Tue 9/07/21**	**Tue 5/10/22**		
2	**DESIGN/PLAN**	**9 days**	**Sat 11/27/21**	**Mon 12/06/21**		
3	Final selection of tests for achieving Science mission	0 days	Sat 11/27/21	Sat 11/27/21		Science
4	Final Science Payload Design	0 days	Mon 12/06/21	Mon 12/06/21	3	Science,Mechanical (Science Payload M
5	**DEVELOPMENT**	**62 days**	**Mon 11/15/21**	**Sun 1/16/22**		
6	Prototype test using Controller	0 days	Mon 11/15/21	Mon 11/15/21		Software(Dashboard Module)
7	Prototype Communication test with Vision	0 days	Tue 12/07/21	Tue 12/07/21		Communication,Software(Dashboard M
8	Final PCB Design	0 days	Mon 1/10/22	Mon 1/10/22		Electrical(Circuit Design Module)
9	Final Power Distribution unit	0 days	Sun 1/16/22	Sun 1/16/22		Electrical(Power Module)
10	Fetching Data & Visualisation using Dashboard	0 days	Sun 1/16/22	Sun 1/16/22		
11	INTEGRATION	9 days	Tue 9/07/21	Wed 9/15/21		
12	EVALUATION	14 days	Wed 1/26/22	Tue 2/08/22		
13	DOCUMENTATION	13 days	Thu 4/28/22	Tue 5/10/22		
14	MISC (Educational Outreach & Media Plan)	69 days	Tue 3/01/22	Sun 5/08/22		



Project: Mongol_Barota_2021_draft_01
Date: 5/9/2022 7:52 AM

Task	Project Summary	Inactive Milestone	Summary Rollup	Progress
Split	External Tasks	Inactive Summary	Manual Summary	Deadline
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

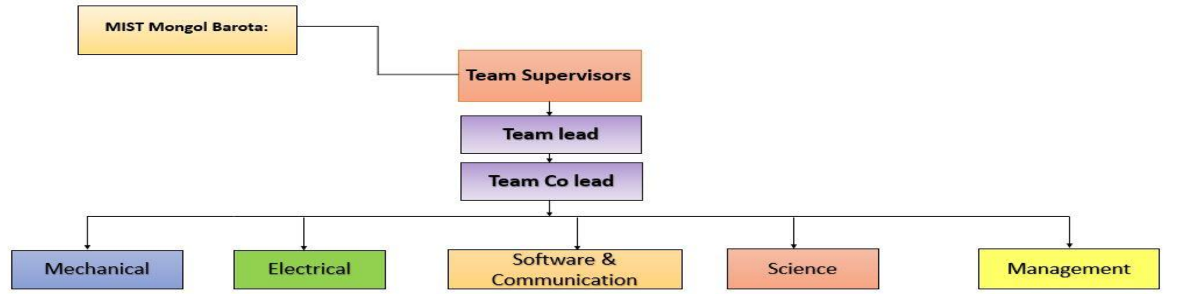
Page 1

MANAGEMENT

Team Formation:

- How is the team workforce structured? (2-3 sentences) Include a graphic to explain the structure as well.

We are an assorted team of over 50 members from all levels and under the guidance of Project Leader and co-Leader, the student members have been divided into 5 sub-teams: Mechanical, Electrical, Software & Communication, Science and Management. The team, originally put together last year, has multiplied since, and now is a blend of members with varying levels of experience and expertise. A detailed organogram of MIST Mongol Barota has been given in Figure, highlighting the fields of expertise and backgrounds of the essential team members.



Team Workforce Structure

MANAGEMENT

Workplace:

- How the team design, build and test the rover physically? Explain the workplace. (2-4 sentences) Include a photo/screenshot of the workplace.

We have 2 dedicated labs only for the MIST MONGOL BAROTA team. We use our campus field for different kinds of field tests too. Moreover, there are some spacious construction places near our campus where we perform our field tests sometimes.

MANAGEMENT

ANATOLIAN ROVER CHALLENGE

Funding :

- How are the funds of the project at the time of submission of this document?

Initially we had a fund of 48,000USD and we have already spent 16,000 USD for the development costs. The rest of the amount is kept for further tests and practice and for the competition.

- How much spending is expected for the development costs? How much spending is expected for the travel costs?

We are expecting 18,000 USD for the development costs which includes Rover Body (Including Arm & Science Payload), processing & Control Modules, Communication, Navigation modules, Science modules, Rover vision and Power Resources.
Our team has enough funds to visit Turkey physically for participating in ARC 2022. We expect 15000 USD for travelling costs for 10 members.

- What is the team's plan in an insufficient funding situation by the competition date?

Our rover is completely functional and we are all set to participate in the upcoming ARC. Even after that, if an insufficient funding situation occurs, then we have a dedicated budget for this type of Research & Development Project. However traditionally Industries, Banks etc. always respond to sponsorship proposals from our university. We have already sent the sponsorship proposal forms and got good responses, so we can take help from them if needed.

MANAGEMENT

Logistics:

- What is the team's plan to package and bring the rover to competition site by July? (4-6 sentences)

We will divide the rover part by part and take it in our personal luggages. As every part of the rover can be divided into several modules so it is easy to assemble and disassemble, also other shipping services take more time than needed, that's why we're finding it more reliable to take the parts of the rover in this way.

ROVER DESIGN

Mobility System:

- What is used? Describe the system (3-5 sentences)
- Why the system is chosen? What are the considerations? What are weaknesses and strenghts? (3-5 sentences)

For the suspension system, we used a Rocker bogie mechanism with a bevel gear differential system to absorb both frontal and rear impacts. Steerable wheel subsystem is equipped with a stepper motor and thrust bearing. Apart from this, our wheel is made of 3D printed honeycomb structure tires using thermoplastic polyurethane material.

Instead of Ball joints, this year we used bevel gear which keeps the whole system compact thus preventing wastage of space. Besides rocker bogie suspension was used for better stability. Steerable wheel subsystem ensured better maneuvering and precise movements of the rover. Thrust bearing has been implemented to carry the axial load to the wheel. Moreover, the rocker arm is made of stainless steel for better strength.

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Mobility System:

- Unique points and inspirations (3-5 sentences)

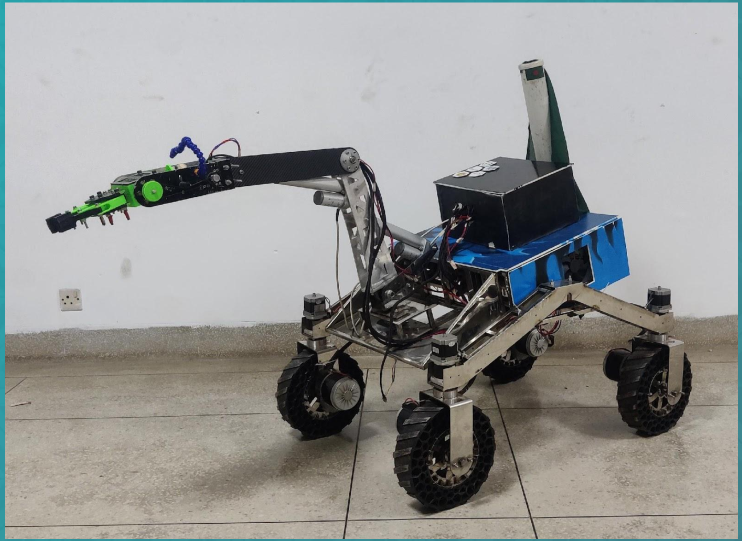
The Customized Wheel System ensured better traction and compliance while traversing challenging desert terrain. The honeycomb structured non pneumatic tires ensured better shock absorption. In addition to this, the rover is capable of climbing stairs. The bevel gear mechanism and steerable wheel system have been inspired from the Mars 2020 Perseverance rover.

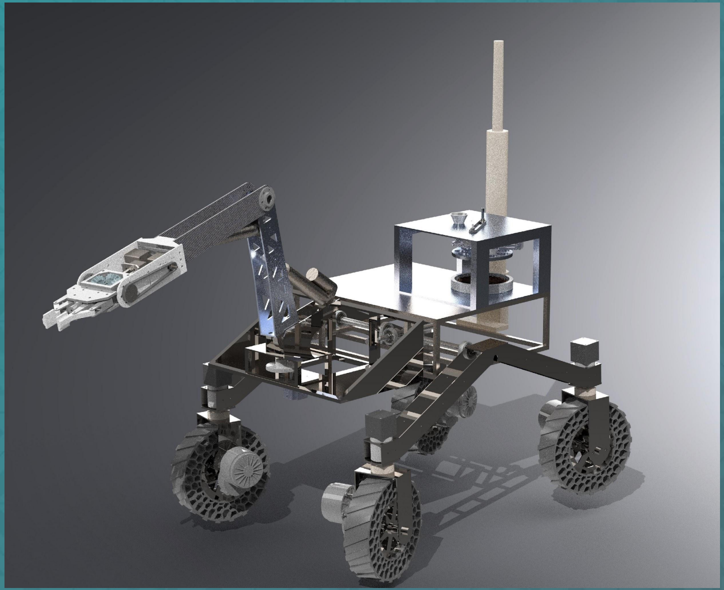
ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Mobility System:

- Visuals of the system (2 photos/screenshots)





ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Mobility System:

- Technical Specifications including mass and size (3-5 sentences)
- Discuss system's adequency for it's role in competition missions. (3-5 sentences)

Phoenix 2.0 weighs 50 kg in total.
The full rover size is 87 cm x 86 cm.
The chassis is 55 cm x 45 cm x 15 cm in dimension.
The diameter of the wheel is 23 cm.

The rover is well equipped with better suspension and shock absorption. It can swiftly move through rough terrain and climb through elevations without any complication. It is also capable enough to move through narrow spaces without crashing or causing any kind of damage. Additionally, The rover can precisely move along a line of path.

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Electronics and power system:

- What is used? Describe the system (3-5 sentences)
- Why the system is chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentences)

The main focus of the electrical sub system is the control of the rover and the integration of the core electronics and embedded systems. The modular architecture of the electronics subsystem is implemented by simulating the real time electrical circuits of the rover using custom-designed PCBs and Solidworks Electrical 3D. Lithium-polymer batteries primarily power the integral systems of the rover .

The electronic subsystem is isolated into different modules to support quick and easy plug and play. Thus a particular module only needs to be connected to the rover in order to be configured and to function perfectly, without affecting the remaining modules during the changing of electrical components in the mission. Basically, the modular architecture ensures portability, reduced maintenance time and easier fault detection.

ROVER DESIGN

Electronics and power system:

- Unique points and inspirations (3-5 sentences)

1. A voltage stabilizer system is used in the power supply which shuts down the excess voltage from being applied to the components. A temperature sensor and a cooling fan is used in the circuit for heat protection so whenever the temperature rises to a certain level (a level which is marked as dangerous) the system will shut down automatically.

2. If there is any sub-system that is consuming power while not functioning it will be shown in the dashboard which will be switched off from the control panel.

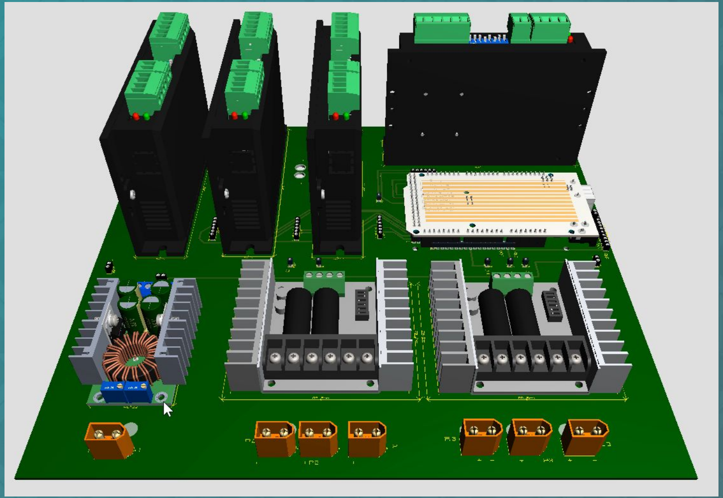
3. Rover safety is ensured by implementing a fail-safe in the code allowing remote shutdown of all rover operations.

4. The electrical subsystem's payload has been customized to cater to the rover's requirements assisting it to complete the missions.

ROVER DESIGN

Electronics and power system:

- Visuals of the system (2 photos/screenshots)



ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Electronics and power system:

- Technical Specifications including mass and battery duration (3-5 sentences)
- Discuss system's adequency for it's role in competition missions. (3-5 sentences)

1.Ovonic 3s 50C 5000mAh 11.1V Lipo Battery which powers the integral systems of the rover and allows for 120 minutes of uninterrupted operation.
2. 24V DC Motor
3. NEMA 17 planetary gear reducer hybrid stepper motor
4. STEPPERONLINE CNC Stepper Motor Driver
5. Sabertooth Motor Controller

Our System is designed such that the electronic components would not be harmed during rough terrain traversal. For emergency stop of the rover, we also have a kill switch. The circuit connections are tightly attached to ensure that the wirings do not become loose. All power connections are properly wired so that no short circuit occurs.

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Manupulation system:

- What is used? Describe the system (3-5 sentences)
- Why the system is chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentences)

For gripping, the optimum claw was designed by testing various geometrical shapes. A worm gear is used to dispatch a tight grip to the claws.

Carbon Fiber has been used in an arm link as it has a high strength-to-weight ratio that reduces the overall weight of the arm. The precise length of the arm link is connected with an actuator to increase the pulling capability of the arm.

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Manupulation system:

- Unique points and inspirations (3-5 sentences)

1. Carbon fibre material has been used to link the building materials. Inspired from F1 racing cars chassis material
2. Spur Gear is used in the arm base for precise waist motion
3. Bevel gear mechanism has been used in end effector to get two different motions from a single mechanism. Inspired from car’s differential housing
4. A wide range of work envelopes to complete tasks easily
5. Custom made bearing housing and 3d printed spacer for link joints

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Manupulation system:

- Visuals of the system (2 photos/screenshots)

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Manupulation system:

- Technical Specifications including mass, max payload and size (3-5 sentences)
- Discuss system's adequency for it's role in competition missions. (3-5 sentences)

Mass: 8.5 kg
Max payload: 6 kg
Max reachable height: 1340 mm
Operating Radius: 830 mm

Various gear ratios were tested to verify the prescribed waist motion for precision. For science missions, an arm with 5 degrees of freedom is used to collect samples.

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Science Payload:

- What is used? Describe the system (3-5 sentences)

The science payload of our rover tests two different kinds of samples- soil and rock, by collecting data and images, which are then processed to classify the presence of extant or extinct life or absence of life. A specialised gripper at the end of the manipulator collects and deposits soil from the sampling sites to the beakers onboard the rover, while different kinds of sensors present in the mechanism measure the physical characteristics of the soil. Rock samples are closely inspected via the USB microscope and the sensors present, and images are captured using a high-resolution camera, which are sent to the dashboard after processing, for further analysis.

ROVER DESIGN

Science Payload:

- Why the system is chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentences)

The system was chosen for its ability to collect multiple soil samples while ensuring minimal cross-contamination, and process data and images collected from rock samples in order to determine the presence of life in the rock and soil samples, including extinct, extant, and no presence of life. In soil sample analysis, the system can collect multiple samples from different sampling sites, using methods that are cost-effective, less complicated, less time-consuming, and equipment that is basic, lightweight, and compatible with the rover systems. The analysis of rock samples is based heavily on a machine learning approach, as opposed to the traditional mineral detection approach which relies solely on user knowledge. This makes the system more reliable and accurate. Despite its shortcomings owing to the lack of direct manipulation of the surface of the rock specimen by applying any reagent or conducting any test since only image analysis and mVOC sensors are used herein.

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Science Payload:

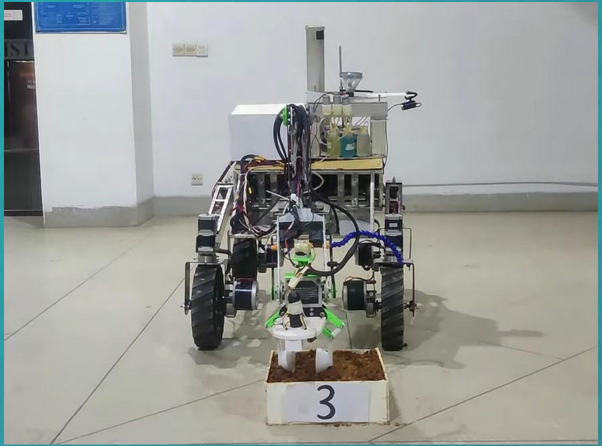
- Unique points and inspirations (3-5 sentences)

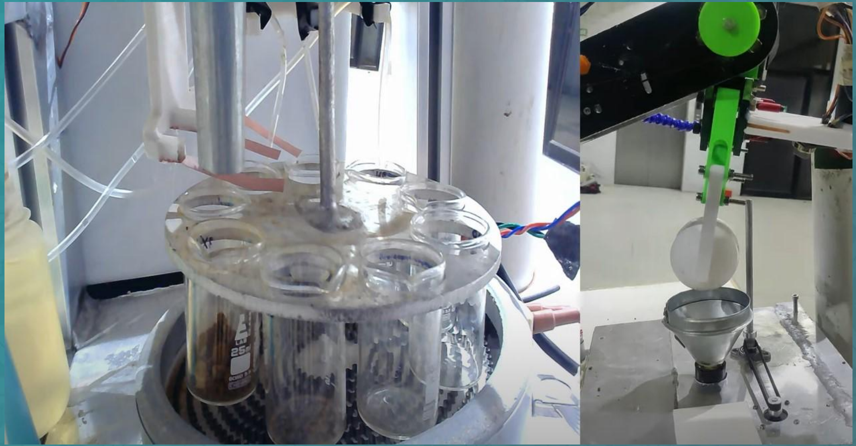
The rover uses a 5 DOF arm with a specialized gripper to collect soil samples, which penetrates a minimum depth of 10cm underground. A testing chamber has been mounted on the back of the rover containing 9 beakers for contamination-free sample storage, and distilled water along with a pH sensor to measure the soil pH. The samples, along with data collected by onboard soil moisture and temperature, wind speed, and radiation sensors, are to be sent back to the base station for immediate transportation and evaluation. USB microscope feedback and images of the rock samples captured by the camera are fed into Jetson nano, where we have used VGG-16 as the transfer learning model, with our custom dataset of 8139 rock samples, to tune the DNN model for predicting the type of rocks and further classification. Moreover, a Munsell chart is used to detect the level of total organic carbon present in rock samples by analyzing the data collected by the colour sensor onboard.

ROVER DESIGN

Science Payload:

- Visuals of the system (2 photo/screenshots)





ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Science Payload:

- Technical Specifications including mass and battery duration (3-5 sentences)

In the science payload, the arm used to collect soil from the sampling site has 5 degrees of freedom, which provides the rover with better motion capabilities and precision. The testing chamber is a 300 mm x 300 mm x 100 mm aluminium box containing 9 beakers and a reagent bottle containing distilled water, weighing 1 kg with a height of 100 mm. The soil sample collection payload of the rover contains a USB camera, a panoramic USB camera, and several sensors e.g. soil moisture/humidity, temperature, wind speed, and radiation sensors to form a better idea of the designated sampling site. Again, the rock sample analysis mechanism contains a USB Microscope, mVOC sensors detecting alcohol, aldehyde, ammonia, and carbon dioxide, and a colour sensor to detect the presence of extant or extinct lives or the absence of life on the surface of the specimen. The sensor board of the rock sample analysis mechanism contributes 205 g to the total weight of the science payload.

ROVER DESIGN

Science Payload:

- Discuss system's adequency for it's role in competition missions. (3-5 sentences)

The science payload of the rover is considered to be sufficiently well-equipped in perspective of the mission requirements. This mechanism can successfully collect and transport soil samples, and sensor and camera data from the sampling site to the Mars Base to the rocket (for Mission 1), ensuring minimal contamination of samples and corruption of data. Additionally, a USB camera mounted on the rover captures stratigraphic photographs of the area, and also photographs of the sampling site, while the panoramic photographs are captured by the panoramic USB camera. Ignoring minor limitations that may lead to slightly less-than-perfect results in the mission, the science mechanism for collection and analysis of soil and rock specimens by using transporting and processing methods both onboard the rover and engineered into its software can be deemed foolproof and adequate for the completion of the required tasks.

ROVER DESIGN

Ground station equipment and communication system:

- What is used? Describe the system. (3-5 sentences)
- Why the system is chosen? What are the considerations? What are weaknesses and strengths? (3-5 sentences)

The ground station consists of 3 feedback monitors, transmitting antenna and rover controller. 3 separate transmitting antennas have been used for 3 different bands.

The communication system has multiple bands serving multiple purposes (2.4 GHz for longer transmission, 5.8 GHz for video transmission and also a 1.2 GHz band as backup for the 5.8 GHz band).
High Latency on long distance is one of the weaknesses of the system. Our system has a maximum range of 1 KM. When the 5.8 GHz connection fails, the video feedback switches to a 1.2 GHz FPV Camera. And when 2.4GHz connection fails, the reception of data will be paused. Until the connection is established again, all the data gets stored in a temporary device which sends them after the connection is re-established.

ROVER DESIGN

ANATOLIAN ROVER CHALLENGE

Ground station equipment and communication system:

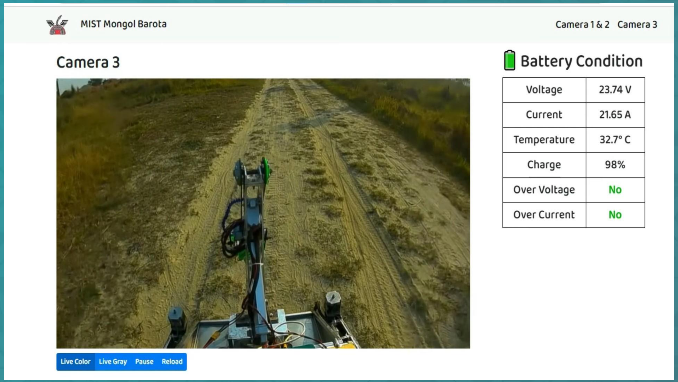
- Unique points and inspirations (3-5 sentences)

The system stores the sensor data as backup in case of connection failure. In case of any communication failure, the rover stops and waits until the connection recovered.

ROVER DESIGN

Ground station equipment and communication system:

- Visuals of the system
(2 photos/screenshots)



ROVER DESIGN

Ground station equipment and communication system:

- Technical Specifications including resilience to noise and communication range (3-5 sentences)
- Discuss system's adequency for it's role in competition missions. (3-5 sentences)

The communication system uses three separate bands for communication. The 2.4GHz (ISM) band has been used for data and command transmission. The 5.8GHz (ISM) band has been used for video transmission. And the 1.2GHz band has been used for backup video transmission.

The system provides lag free video, data and command transmission for monitoring and controlling of the rover in real time.