Seeker

Surviving Mars for 1000 years

Sachin Shetty

S Labs Solutions

Read the Book online/Download the PDF at

https://mangala.earth/book

For one to reach for the stars

What keeps you awake

What makes you content when sleeping

What does your world revolve around

GAGANYATRI

Contents

3022

With consciousness travelling across humanoid robots, Human body's physical restrictions of travel and heavy-work disappeared.

Humanoid's could be rented for the activity, and they would travel back to their charging station, ready to use for the next user.

Sponsorship 2023

Phase 2 -

- AstroPi -
  - SenseHAT x 4
  - Pi 4 b - 8Gb x 4
  - Pi HQ Camera x 4

Phase 3

- Rover -
  - Mini- Rover
    - DJI Robomaster EP1 or Robomaster S1
  - Steering Mech for Spacecraft Mission Operations - SMOPS 2023
    - Logitech - G923 Steering Wheel x 1
    - Wheel Mount
- Habitat
  - 3D Printer
- UAV Dock
  - DJI Dock

Benefits

- Company/Sponsor Name displayed for 6 months at Project Website - Jan-Jun 2023
- Sponsor mentioned in 1 Research Paper
- Sponsor Logo sticker added to devices

Design - Autonomous Habitat

- Autonomous Habitat

- Dimension
  - Shipping Container
- Modules (Stack)
  - CubeSat
- Farming
  - Hydroponics
  - Drip
  - Sprinkler
  - Flow
- Plant Type
  - Growth
  - Maintenance
  - Requirement
  - Seasons
  - Dimensions
- Robots
  - Type
    - UAV
    - UGV
    - Humanoid
  - Charging
    - Dock station
    - Wireless
    - Plug
  - Activity
    - Farming
    - Stacking

Abstract - SSEO 2023

Title

Autonomous Greenhouse with Swarm robots for Mars Exploration

Goal

Increase Habitable Mars Days for Human Exploration

Proposal

Bhoomi is a swarm robotics platform to build Habitats. Each robot in the swarm is independent and completes functional requirements autonomously. Multiple robots collaborate to complete a complex task. Robots consist of Unmanned Ground Vehicles(UGV/Rover), Unmanned Aerial Vehicles(UAV/Quadcopter), Humanoid(Digital twin). VR map model is generated by the Habitat Monitor system for real time visualization and tracking progress of robots. Each robot has a fallback position, for human operator to intervene for complex task process

Solution

- The system will generate layouts for Habitat modules and provide Assistance and monitoring to Martial explorers.
- Priority designed through â€œGoalâ€ process designed by Dr. Eli Goldratt
- Based on mission duration (4 years minimum - due to orbital sync of Earth to Mars transfer orbit).
- Fresh and local grown food is necessary for Sustenance and survival of crew members.

- The system will monitor the green house and provide information to Mission specialist

System Priority

- 3D Tools Printing
- Night/Winter Shelter : Low temperature
- Green House : Nutrition and Sustenance with Hydroponics
- Power Generation : Solar Farms
- Landing/Launch Zone : Reusable Rockets for Logistics and Supplies

3D Tools

For the Habitatâ€™s Greenhouse Module. Below tools have to be 3D printed

- Metal Cutter/Shearer : To repurpose landing gear shell for walls and compartments
- Exercise Equipment : Weight + Dumbbells - With hollow compartments to fill with Martion legolith increase weight
- Photo Frames : Mental Health and sense of belonging to mission and life
- Portable Water Dispenser : Needle septum at Galley and Greenhouse
- Rubber/Soft Mallet : Bend materials into shape for building compartment from Re-used shells and 3D printer boards
- Wires - Thick filaments to hold items into places
- Cutlery/Garden Tools : Scissors, knife, Screw Driver - Standard head

- 3D printer - Print the items based on Prioritised order received from the Habitat Control System
- Rover to pick the items from 3D printer and to stack it at sub-module location.
- When the items required for a sub-module are complete.

Astronaut build the module with logistic support of Rover

Re-Usable Component from I-Hab

- Crew Systems:
    - Galley for warming food and dining
    - Personal Crew Compartments providing private area for sleeping
- Crew Health Performance Subsystem:
    - Environmental monitoring (acoustic, radiation, chemical hazards)
    - Exercise area
    - Medical care
- Docking ports:
    - Two axial ports for attachment to the Gateway
    - Two ports radially for vehicles

- Sensors
    - Soil
        - Water
        - Humidity
        - Minerals
    - Air
        - CO2
        - 02
        - NO2
    - Water
        - Drainage / Re-Use
        - Consumption via Drip
    - Sunlight
        - Duration
        - Energy
    - Vegetable
        - Carrot
        - Mint / Coriander Leaves

        - Tomato
        - Potato
        - Onion
        - Chilli
- Phenotype plant growth and requirements by growing in Simulated environment on Earth
    - Build tracking system and forecasting system based on observations and real time setup
- Schedule
    - Weekly harvest - Per person requirements calculation
    - Sow / Re-planting order and time consumed
    - Batches of seeds - Initial usage and seeds creations for long term
    - Print - Pots and containers for schedules
- Data Collection
    - Edge calculation for hourly/daily/weekly summary
    - Logging data to central message queue for Backup / Earth analysis
- Hardware -
    - Developement - Raspberry pi 3b
    - Test - Raspberry pi Zero
    - Deployment - Raspberry Pi Pico
- Software -
    - OS - windriver/wrlx-image:minimal
    - Programming Langzage - C++
- Simulation
    - MuJoCo - MUlti JOint Dynamics with COntact
        - Reinforcemnet Learning
- Results -
    - Greenhouse
        - Plant / Herbs Growth
            - Carrot
            - Mint
    - Habitat Usage
        - Water -
        - Food

- Conclusion
- Future Work
    - Nandi - Rover platform (Sponsor Dependent)
    - Astra - 3D printer platform (Sponsor Dependent)

Area of Interest

- Mission Architectures
    - Distributed Space Systems
- System Aspects
    - Mission operation and facilities

Server 2

Module	Description	Dimension	Priority	Type
CMD	Command Center	--	1	Clean
WC	Waste Collection Module	--	2	Dirty
PRIN	3D Printer Module	--	3	Clean
HYG	Hygiene Module	--	4	Dirty
CRE QRT	Crew Quarters	--	5	Clean
Galley	Food station	--	6	Clean
EXE	Exercise Module	--	7	Clean
SCI	Science Labs	--	8	Clean
GRN	Green House	--	9	Clean
EVA	Extra Vehicular Activity	--	10	Clean
TCCS	Trace Containment Control System	--	11	Dirty
LOG	Logistics and Stowage	--	12	Clean

Habitat Functions

Based on the Mission Duration, to sustain human presence on the Red Plant nutrition is major component.

- 3D printer - Print the items based on Prioritised order received from the Habitat Control System
- Rover to pick the items from 3D printer and to stack it at sub-module location.
- When the items required for a sub-module are complete. Astronaut build the module with logistic support of Rover

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Ihab

Hydroponics

- Sensors
    - Soil
        - Water
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    - Air
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Module Gardener

- For Greenhouse Maintenance
  In this approach, A filled syringe is attached to the underbody of a micro-aerial drone.
  The plunger is activated to spray the liquid using an electro-mechanical actuator.
  The target area is set based on the type of plant. Using CV the individual leaf/stalk is identified and predetermined quantity is sprayed.
  Usage of insecticide for agriculture has a destructive effect of the soil.
  The existing method of using body-mounted hand-pump based system is inefficient in terms of 1. Insecticide quantity used. 2. Square area of land covered
  The inefficiency is are dependent of the factors below
  - Human error
  - Wind direction
  - Distance between plants
  - Height of plants
  - Type of plants viz., large leaf, small leaf
  - Spray Nozzle

  On a conservative method/approach, the insecticide is sprayed ineffectively over an area due to human error or field of view. The error is could a due to a combination of factors viz.,
  - Fatigue
  - Region of interest as a small dense area, cumbersome to traverse
  - Reduced plant to plant coverage due to height of plants

   ### References * [ESA - I-Hab](https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Gateway_International_Habitat)

Swarm Spray

Clean Solar Array

- Maintenance Swarm Drones which clean the dust of Solar Array Panels in remote locations autonomously.
- The rotor wash of the droneâ€™s propeller would be directed at the panels to blow away the minute dirt accumulated throughout the day.
- Using Vision Position System(VPS) the grids would be assigned to individual drones based on its health parameters.
- Using 2/3 wide angle camera lens, 360 deg view would be constantly monitored for SLAM.
- Autonomous drones would be wireless charged during excess peak output to conserve energy for critical systems.

Dispenser

- The intended deployment would be initial Mars Landing, where Autonomous systems build a minimum viable habitation facility.
- The algorithm can be customised to replace the fuel based hand held leaf blower locally.
- We demonstrate the working of the Autonomous system and also the fail-safe mechanism required for uninterrupted power generation

References

- Ingenuity

Server

- Runs on VxWorks OS

Re-Usable Component from I-Hab

- Avionics and flight software:
  - Integrated Modular Avionics with four mutually redundant On-Board Flight Computers
  - Two failure-tolerant data network backbones
  - Built on top of the VxWorks operating system
  - Time Triggered Ethernet (IP Best Effort and Avionics Full-Duplex Switched Ethernet, AFDX or ARINC 664)
- Electrical Power System:
  - Powered through the Gatewayâ€™s Power Propulsion Element
  - Four power lines
  - Two batteries store power
  - Can interface with and receive power from other vehicles such as Orion and modules

Study Group-SG 3.27

- Call for studies
  - Current Studies
    - SG-3.27 Towards the utilization of the Moon, Preparing for Mars Exploration
      - https://iaaspace.org/wp-content/uploads/iaa/Scientific%20Activity/Study%20Groups/SG%20Commission%203/sg327/sg327.pdf
      - Status Report
  - SG 2.14 Medical Support for an International Human Expedition to Mars
- Interested candidates in any of the above studies must send by email to IAA office
  - the study identification number along with their
  - name, address, current work activity and short bio
  - **(phone number (33) 1 47 23 82 15 or Fax (33) 1 47 23 82 16).**

  Application

Sub : Request to participate in Study Group-SG 3.27 - Towards the utilization of the Moon, Preparing for Mars Exploration

Dear Sir/Madam, I am XYZ, residing at AAA, Country, Software Engineer , participant of â€œSpaceAppsChallenge 2022â€ - Creating a Mars Habitat https://mangala.earth, I am interested to join the study group to learn, understand and develop systems for Habitat maintenance. I believe that the Study group would help to augment and focus my direction on un-answered questions. Please contact me at +49 176 XXXX XXXX or XXXXZZZZZ@gmail.com

Best Regards, XYZ

Astro Pi

Ensure you understand the ISS orbit. The ISS covers everywhere between 51.6 degrees latitude north of the equator and 51.6 degrees south of it. This means the ISS will never fly over places like Greenland, Siberia, or Antarctica. It is also unlikely that you will see the Aurora Borealis, because it occurs closer to the poles than these latitudes.

- Sensors
    - Camera
    - Sense HAT -
        - 8Ã—8 RGB LED matrix
        - five-button joystick
        - Gyroscope
        - Accelerometer
        - Magnetometer
        - Temperature
        - Barometric pressure
        - Humidity
- Build Hardware
    - Flight Case
    - Astro Pi - Hackaday
    - Flight Case 2
    - Replica- AstroPi
    - ESA - AstroPi - Tutorials

Production for Survival

- Time from order to money received
- Reduce inefficiencies in wait between Resource centers
- Identify bottleneck/ process work. Concentrate on the task not solved
- Taiichi Ohno System - Kanban - Just in Time
- Lean Startup Workflow - Water and Stones example

Research Plan

- Design to work on Mars
- Prototype & Testing on Earth
- Minimum modifications using s/w configurations
- Setup & Maintenance of Greenhouse Lab
- Primary focus - Agriculture/Farming via Swarm Drone
- Greenhouse Specs a. Dome - Igloo / Hot b. Bauhaus Square Design c. Underground Connection
- Mining System Analysis
- Material for Connectors a. Water Supply b. Air Support c. Energy Transmission
- Single Bot Usage Design for Re-usability

Sub modules

- Solar Array Maintenance with Swarm of Unmanned Aerial Vehicles(UAV) drones
- Swarm of Unmanned Ground Vehicles(UGV) with OSR Rover

Build Order

- Roller- for logistics
    - Floor Plank : 1 item : 4 x 6 x 0.25 ft (1.22 x 1.82 x 0.07 m Approx) : width x length x height
    - Side plank : 2 item :
    - Side plank : 2 item :
    - Wheels : 4 items : Rover wheels
    - Handle Mechanism - Long-stick + Handhold
- Hydroponics - Vegetation
- Water Filtration System
- Frames - Solar panel

Simulation - MuJoCo

- Use Google Cardboard to visualize VR
- Test Haptics via App ??
- Depth perception with Stereo setup of camera's. Triangle or Square position for Camera placement to get 360 deg view

Priority of Outfitting the Habitat

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Acknowledgement

Thank you to my parents Suresh and Suma for supporting me in all pursuits. Thank you Sahana for inspiring to do good with everyday deeds and resilience.

About The Author

Sachin Shetty

In-situ prep for landing at ವಿದ್ಯಾನಗರ, ಮಂಗಳ

Loves to read books, long walks, weekend hikes
and biking around the Rhine.
His alter ego, writes code for self and for a living

Books By This Author

Expedition

Collection of Thoughts, Notes and Failures

Dark Light

In Pursuit of Happiness

Proof