ARACHNID 6 WHEELED ALL TERRAIN EXPLORER WITH 7 DOF ROBOTIC ARM

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ABSTRACT

- Arachnid: *noun* An arthropod of the class *Arachnida,* such as a spider and scorpion.
- Adaptive Dynamic System: Using a Stewart Platform, control of C.G and balance of body is achieved over all terrain.
- Robotic Arm: Designed with 7 Degrees of Freedom, with the ability of high accuracy.
- A* + Fuzzy Logic: Implemented in the automated Navigation system on board the rover.
- Tests, experiments and Instruments to detect the presence of sugars, amino acids and lipids all indicators of life.

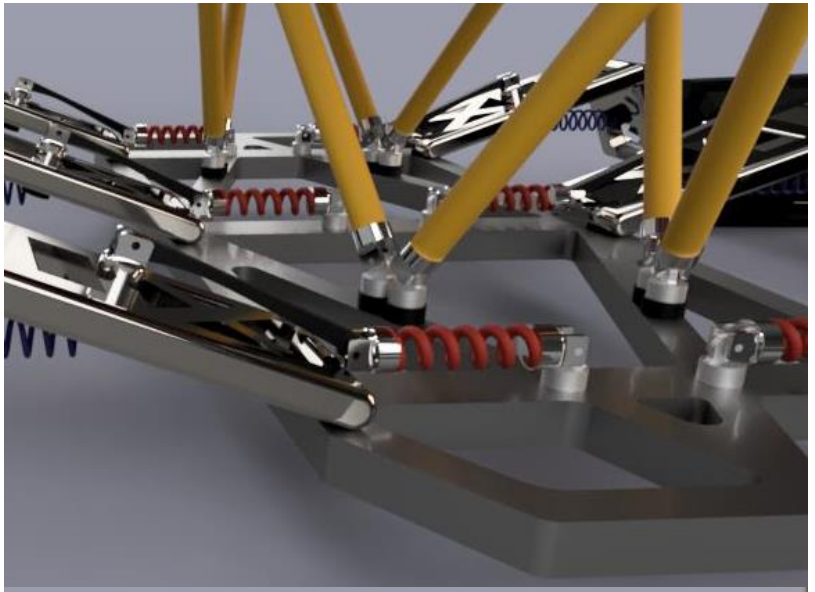
Design Philosophy

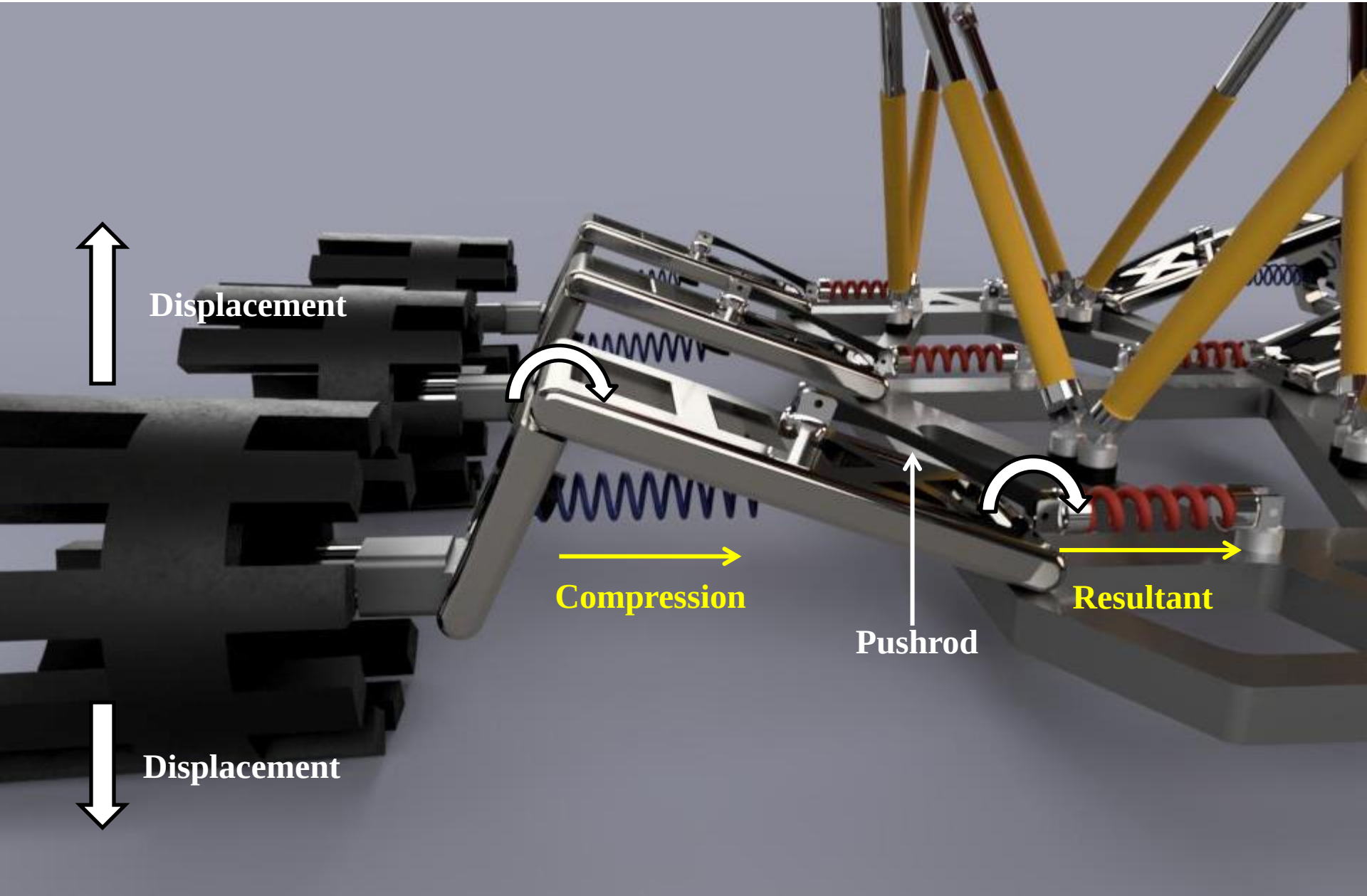
- Arachnids have an ability to climb over complicated obstacles.
- Their, multi-segmented co-dependent legs contribute to distribution of forces along each element enabling smooth landing and traversal.
- Dimensions are dependent on Martian Topography and Vehicle Dynamics.
- This sort of leg arrangement is common across species that thrive within multiple habitats that comprise of water and land or sometimes a mixture of both.

SUSPENSION

- Multi-segmented similar to an Arachnid.
- Individually suspended wheels.
- Suspension effect experienced in the lateral direction to the movement.
- Resultant forces coming through do not or barely affect orientation.
- Displacement of wheel is normal to the obstacle.

- **Pushrod w/ Coilover Spring**
- **Coilover Spring**




Displacement
Compression
Pushrod
Resultant
Displacement

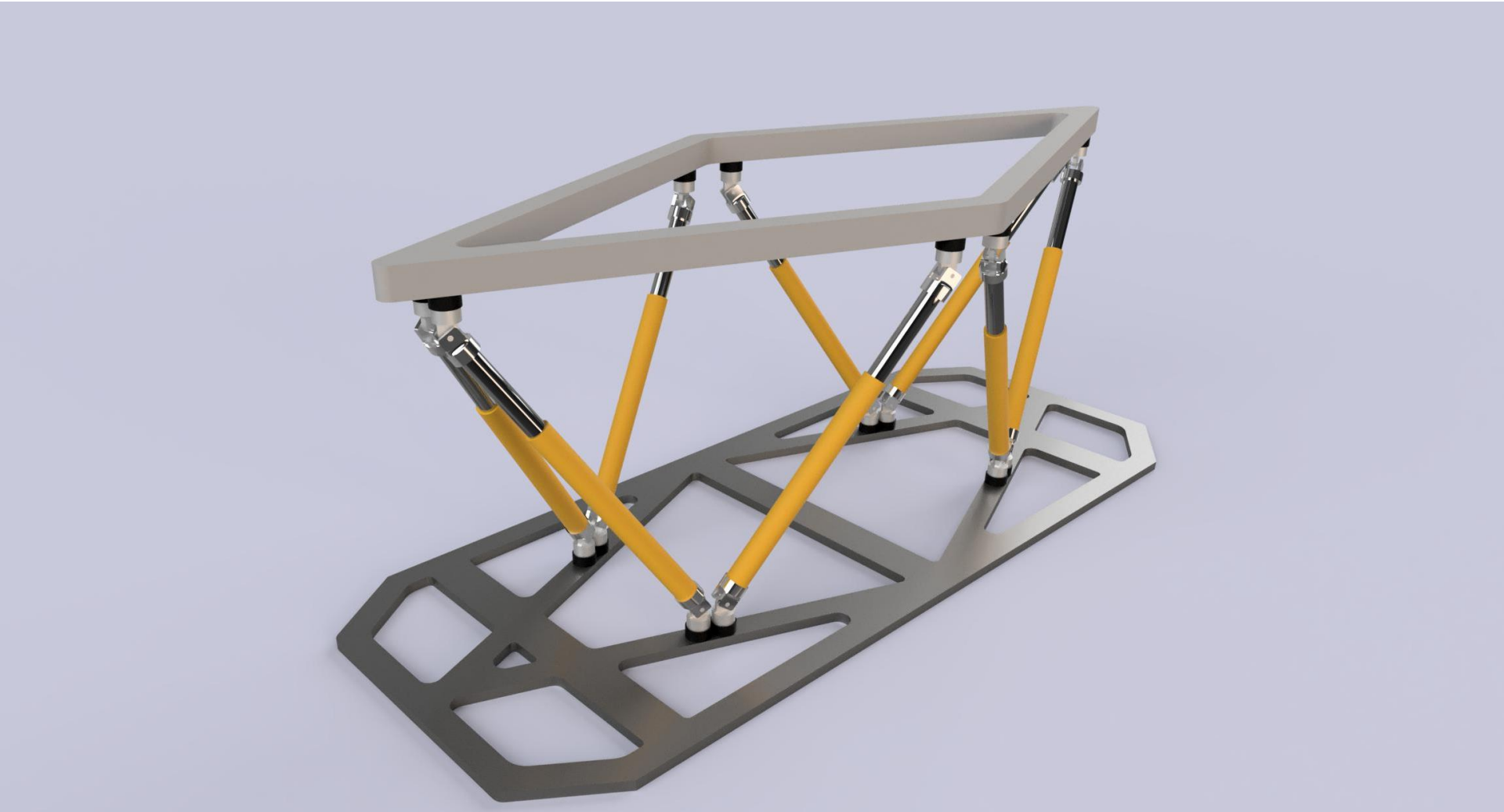
ADAPTIVE DYNAMIC CONTROL

- **Stewart Platform**

- 6 DOF Hexapod Hydraulic Lift system,
- With the separation of Rover into a Suspension Module and Chassis Module, the Stewart Platform reacts to perturbations and orientation changes.
- Two modes exist in the closed-loop control system: **Mirror Mode**

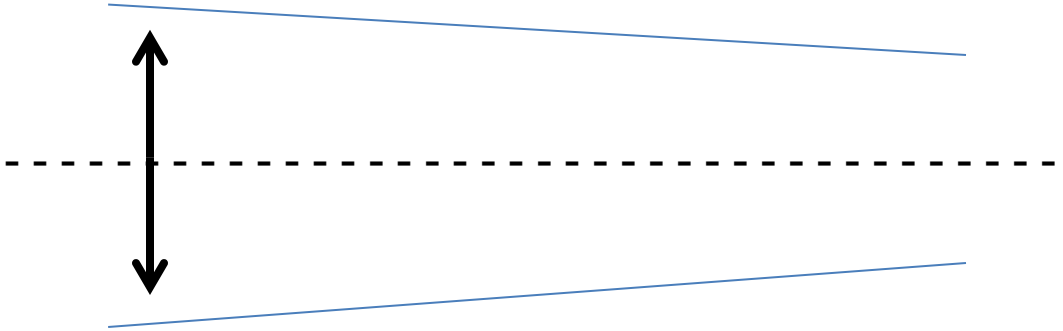
  Level Mode
- **Mirror Mode:** The Stewart platform mimicks the movement of the suspension frame and mirrors the translation and rotational displacement about x y z axes.
- **Level Mode:** The platform keeps the Chassis Module parallel to the ground at all times running a constant feedback system with calibrated data.

Adaptive Dynamic Control

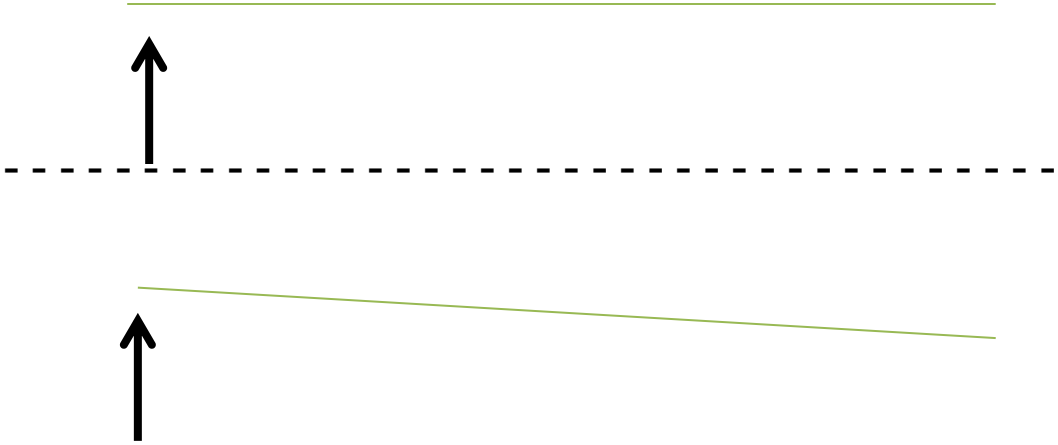


ADAPTIVE DYNAMIC CONTROL

- **Mirror Mode**

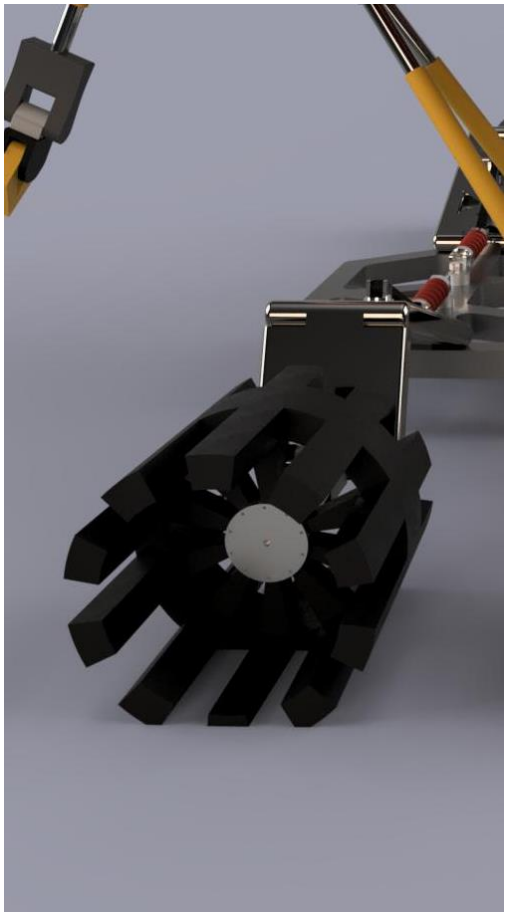


- **Level Mode**



RE-INVENTING THE WHEEL

- Segmented Wheel makes it less prone to damage.
- Each Wheel element acts as a cantilever beam and it deforms according to the obstacle encountered.
- Eliminates possibility of wheel spin in loose terrain with crevices between elements enhancing wheel traction.
- Damage to an individual element has little or no direct effect on neighboring elements.
- Each element has a camber angle of 3.5^0 to accommodate deflection and maintain dynamic stability with respect to the ground.



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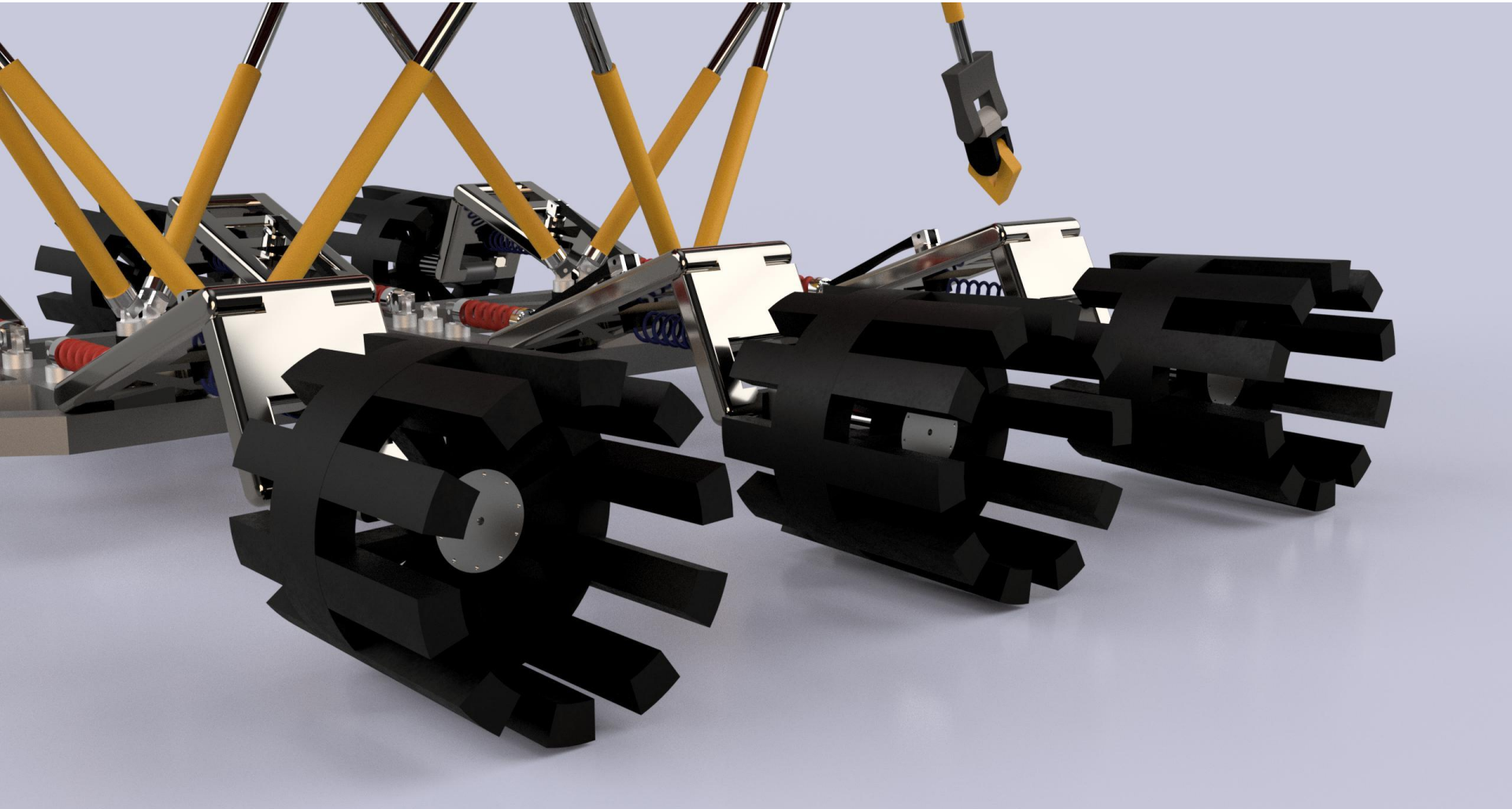
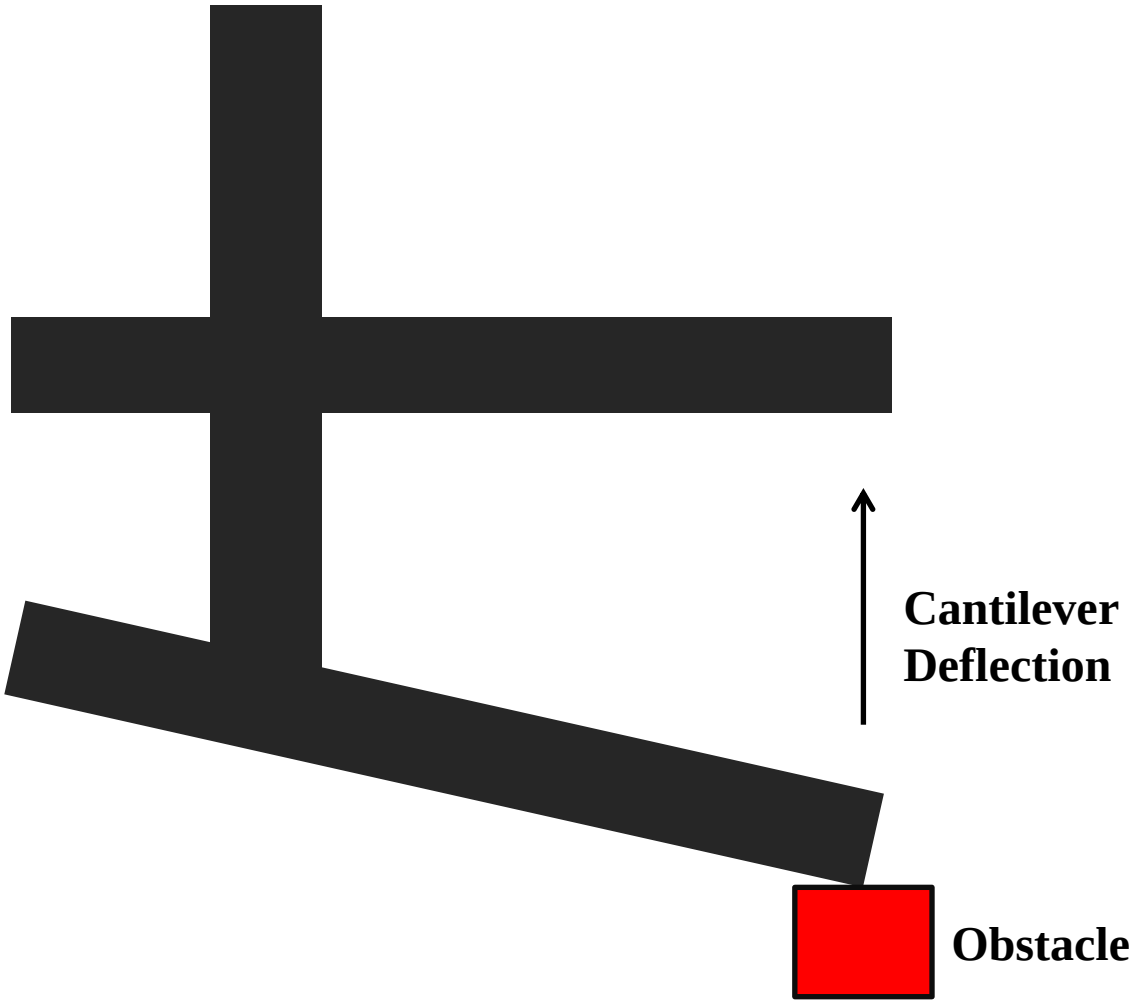


RE-INVENTING THE WHEEL



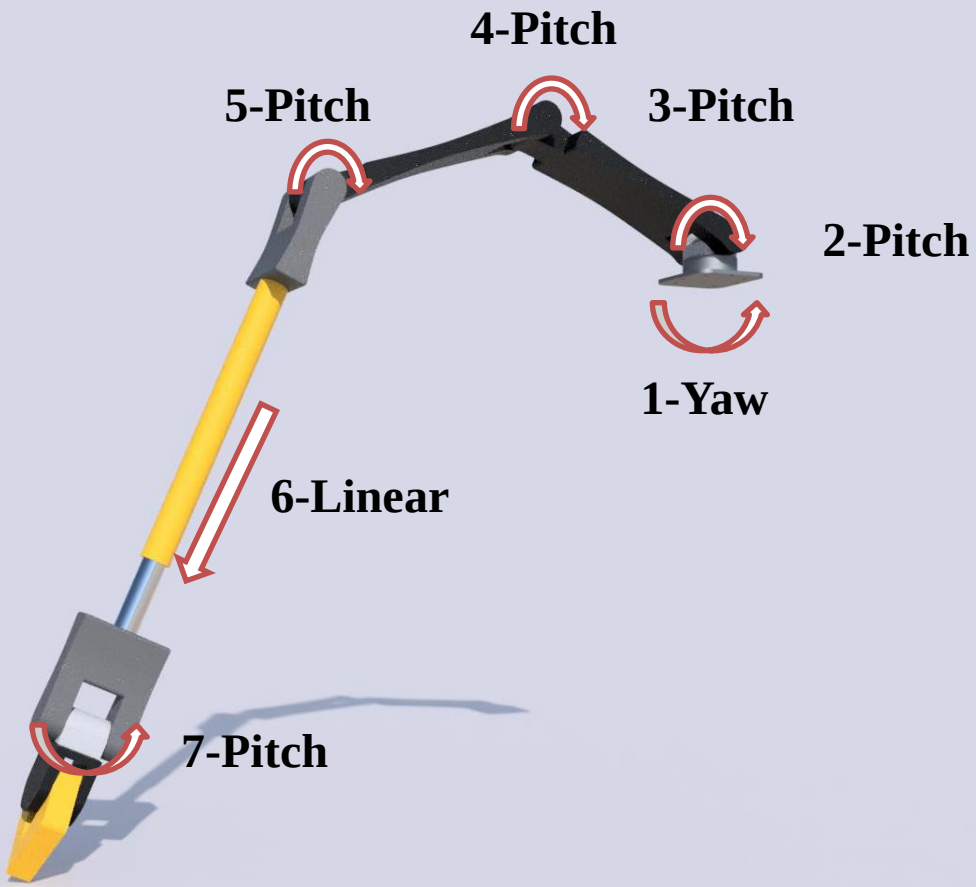
7-DOF Robotic Arm

- Introduction of Linear Motion in the 2nd Link of the Arm.
- Enables it to reach down a given target without affecting orientation enabling it work within a smaller work volume.
- When tasked with drilling or excavation duties, the Linear Actuator assists with the transmission of force along the axis of drilling.

Gear Drives:

Yaw: Planetary
Pitch: Harmonic
Roll: Direct drive

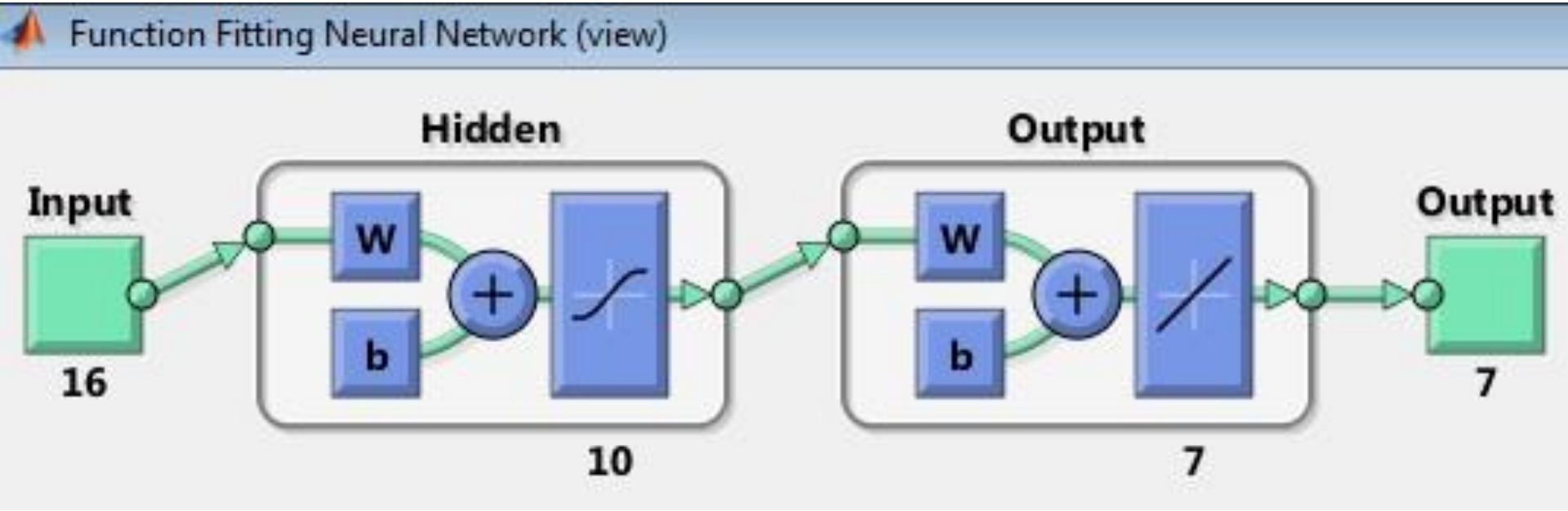
7-DOF Robotic Arm



ELECTRONICS & SOFTWARE SIMULATION

- Electronics are housed inside a closed compartment with temperature feedback control which maintains the system at nominal conditions.
- The onboard computer which monitors and controls the actuators and sensors has a computing power equivalent to that of a laptop.
- The Rover Control System is executed with an indigenous Artificial Neural Network where various test cases were used and tested using MATLAB Simulation.

ARTIFICIAL NEURAL NETWORK



ARTIFICIAL NEURAL NETWORK

- Various test positional data were fed into Artificial Neural Network and the results were acquired and validated in order to determine the efficiency of the Neural Network.
- Above mentioned test data was acquired from simulations carried out in ADAMS View.
- Data acquired were of Rover navigation and Robotic Arm Movement.
- The feedback system is created using vision system.

VISION SYSTEM

- Utilizing the Rover's stereo vision system and belly cameras, various images are acquired and these images are processed using MATLAB.
- The data are acquired from the processed image which identifies obstacles and various other objects in the vicinity of the rover.
- The position of obstacle on the image is matched with the real time location of the object which is fed in to the Neural Network which in turn is used the guide the Rover and Robotic Arm movements.

Data Acquisition and Control System

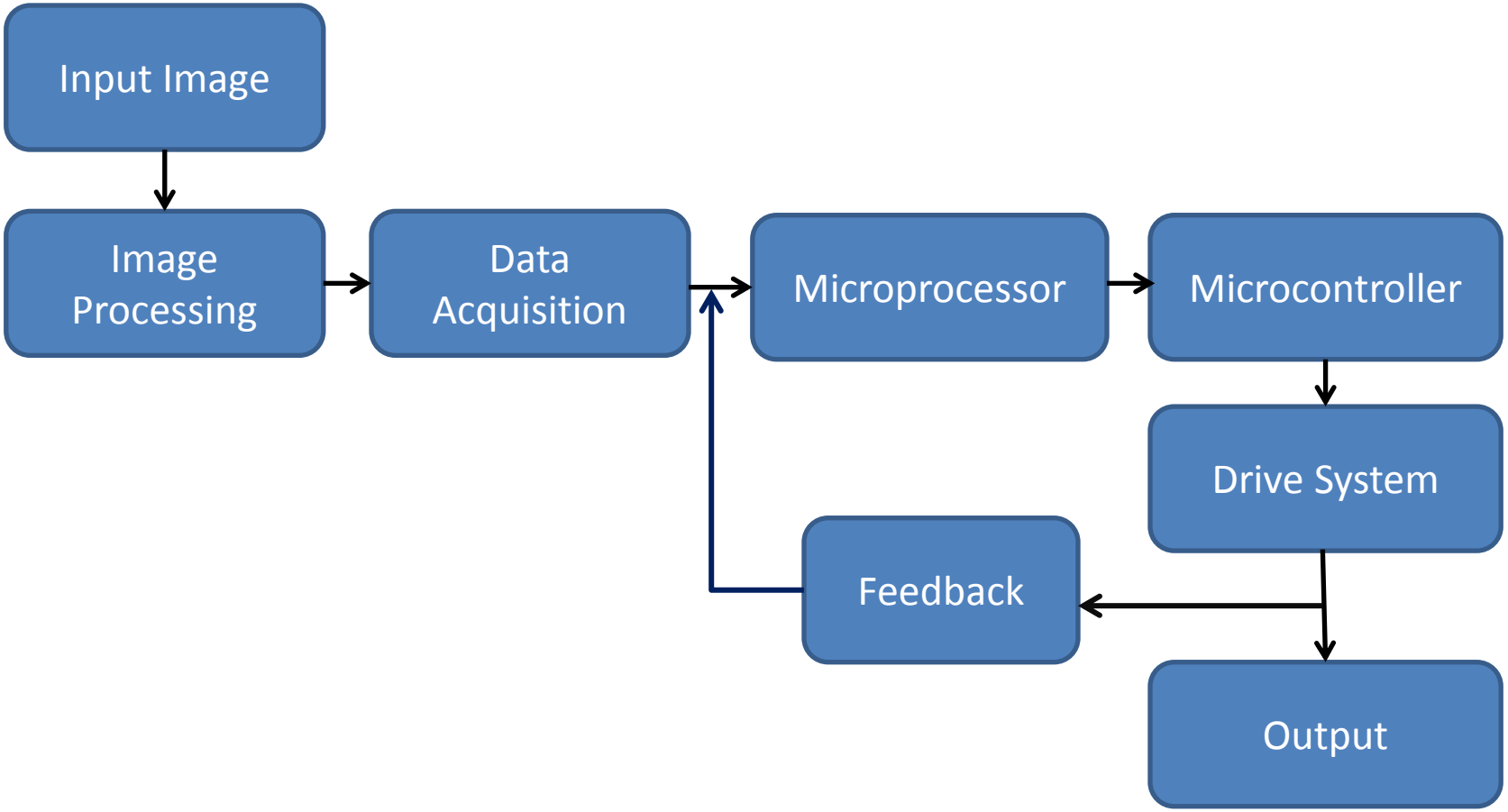
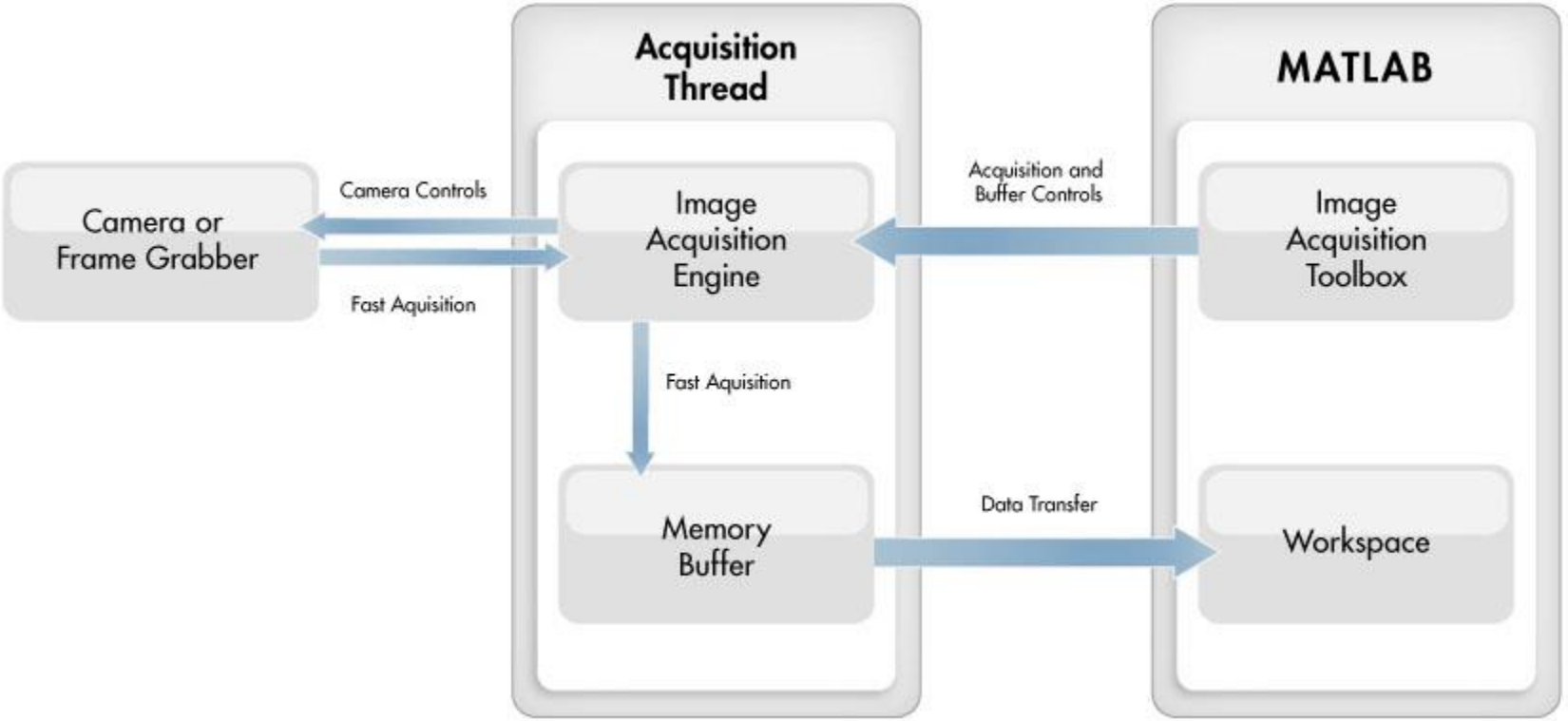


IMAGE PROCESSING USING MATLAB



SOIL ANALYSIS

- Experiments, Instruments and Sensors used to detect the presence of life.
- Indicators of life include and are not restricted by the presence of sugars, amino acids and lipids.
- Integration of suitable methods for Martian Applications.

METHOD:

- Introduction of bacterial strains to behave as biological sensors and detection the occurrence of ice nucleation.
- Erwinia Herbicola strain responds to the presence of tryptophan (Amino Acid).
- E. Herbicola of a different strain demonstrates ice nucleation activity in the presence of sucrose or fructose.

Citation: Microbial lipid and amino sugar responses to long-term simulated global environmental changes in a California annual grassland - Chao Liang, Jessica L. M. Gutknecht, and Teri C. Balser

JUSTIFICATION

- Lipids have high resistance to enzymatic degradation compared to proteins or nucleic acids.
- Amino Acid's relative stability, their high abundance on Earth and their many roles in biological processes, they are considered relevant molecular biomarkers.
- Presence and production of sugars as energy sources for living organisms. coordinating metabolic fluxes in response to the changing environment and in providing cells and tissues with the necessary energy for continued growth and survival.

Citation: Biota and Biomolecules in Extreme Environments on Earth: Implications for Life Detection on Mars - Joost W. Aerts, Wilfred F.M. Röling, Andreas Elsaesser and Pascale Ehrenfreund; Sugar Sensing and Signaling - Matthew Ramon, Filip Rolland and Jen Sheen

SCIENTIFIC EQUIPMENT

- **Near Infrared Spectroscopy:**
- Done by measuring the structural values of a sample with light reflectance and absorption of particles and voids within the sample materials to obtain information such as moisture content.
- Allows for a detail analysis of soil properties using only a small undisturbed core sample.
- One such application is the detection of Organic Carbon in soil samples.

Citation: Methods of Soil Analysis Using Spectrophotometric Technology – Katrina C

THANK YOU FOR YOUR PATIENCE

For further discussion on the same, contact us at the following:

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