



SpAceD juNkies

TEAM MEMBERS

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Background

Background

- There are currently around 30,000 pieces of debris larger than a softball in space
 - This is a result of collisions , rocket launches, and elements that astronauts have left behind.
- This poses danger to satellites in orbit.
- Satellites have to move out of the way of the debris to avoid being damaged
- Although space junk has not had a large impact on space exploration so far, the debris has the ability to damage satellites and spacecraft.
- Although other products have been designed to capture space debris, those products are not focused on finding reusable means for the debris.

Product Description

- Our robot will go through the space debris orbiting Earth and collect reusable items.
- It will be sent to the International Space Station (ISS) in a capsule (or another space station in the future) for astronauts to primarily control its operation.
- The primary audience would be Researchers and Scientists in the aerospace industry.

Product Objective and Purpose

- Prevent the debris from having a large impact on space exploration, potentially causing damage damage satellites and spacecraft.
- Collect parts that scientists could reuse from the debris orbiting space through the camera based sensing
 - Debris could be analyzed to make improvement to next set of satellites/spacecraft
 - If debris can not be reused by scientists, it could be sold as souvenirs or used as an artifact in a museum

Problem Formulation

Problem Statement

- Our product will be deployed in space to detect and collect debris and return them to the ISS.
- The astronauts will then evaluate the debris to determine if there is any valuable usage on board the ISS.
- The remaining debris will be returned to Earth in the capsule for disposal or further examination to determine if it will be useful.

Design Requirements

For this project, our demonstration of a space debris should:

- Be graspable or workable by a robotic manipulator
- Have some need for autonomous interaction
- Be easily obtainable and testable here on Earth

Constraint of Standards and Regulations

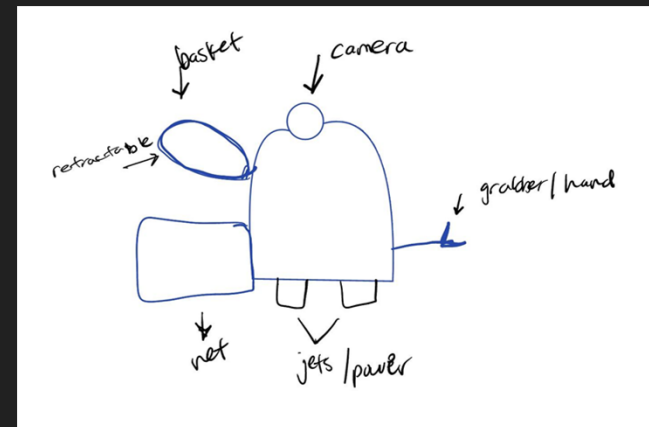
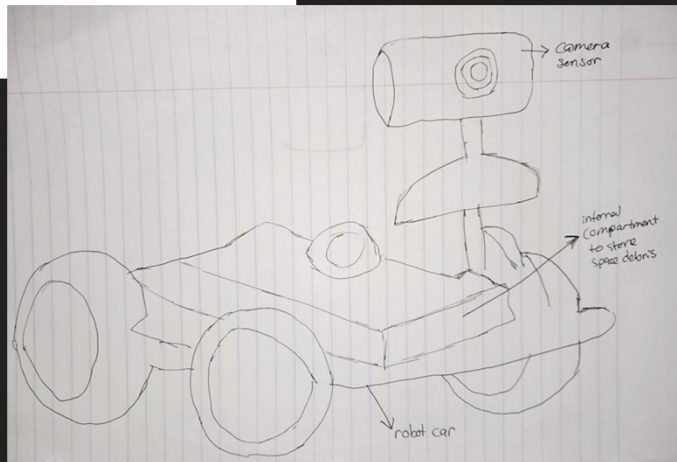
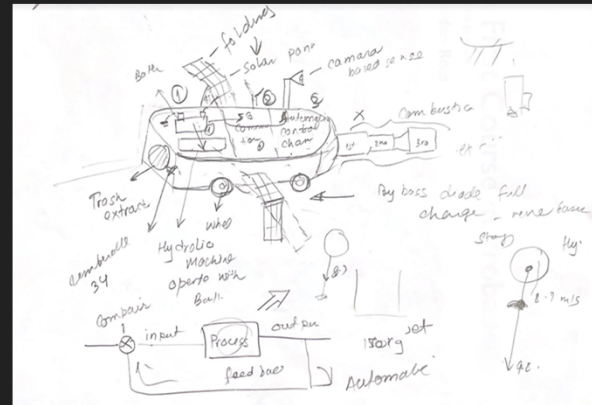
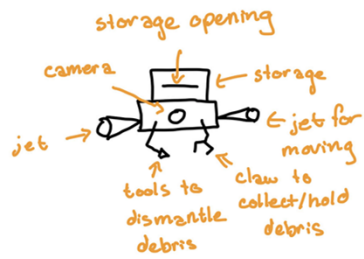
- Researchers and scientists in the aerospace industry could be the main user of the design
- The test platform needs to be readily usable by anybody, including non engineers.
- Inside a lab environment, it is bulky and difficult to manage the device via a host PC.
- A button allows an easy user interface that makes it operable in different environments.

Constraints of Society, Culture, and Environment

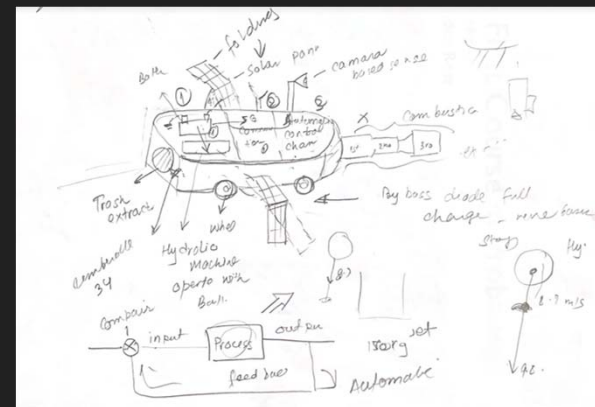
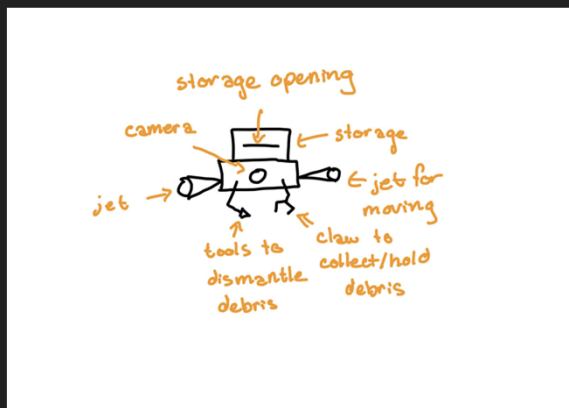
- Unfamiliar with machine learning techniques
- Good quality camera could lead to slow processing and degradation of image processing
- Battery Size and solar access could create a problem where the system runs out of power. Example: If there is no access to solar energy and the battery runs out.
- Not a clear solution to this problem

Solution Generation

Individual Designs



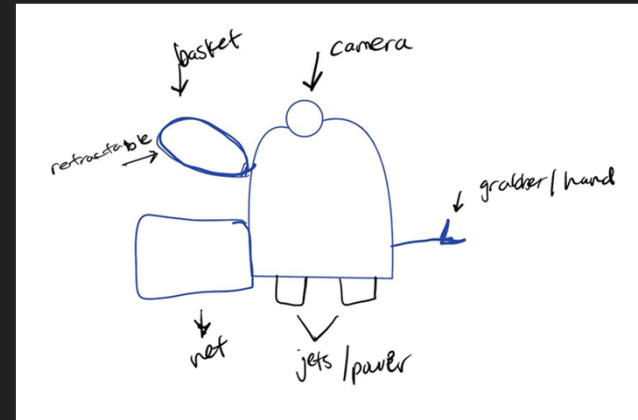
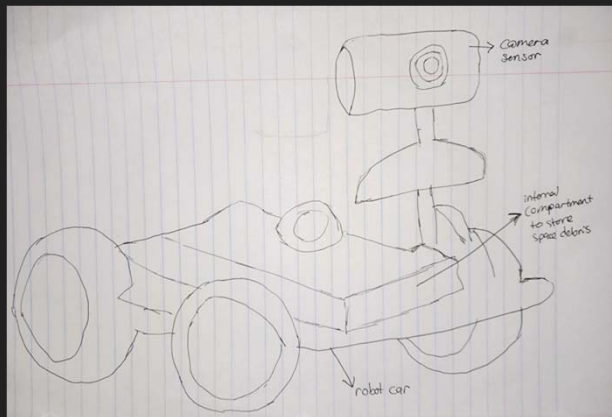
Pros and Cons



Pros	Cons
<ul style="list-style-type: none"> Tools to dismantle debris is an excellent Idea because it can hold more debris in the storage 	<ul style="list-style-type: none"> Possibly not enough space for storage

Pros	Cons
<ul style="list-style-type: none"> Net may be beneficial for easy collection 	<ul style="list-style-type: none"> 12 x 12 cm is small

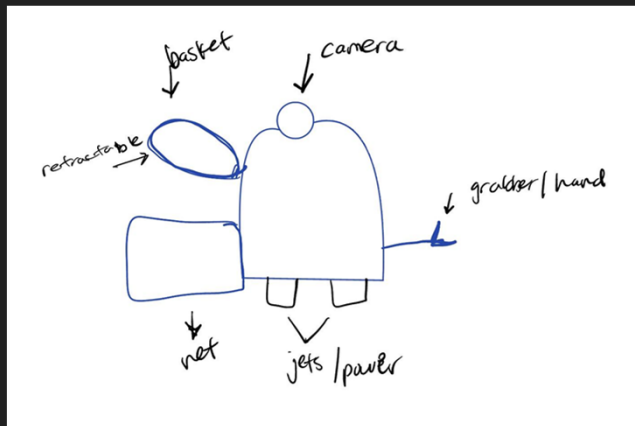
Pros and Cons



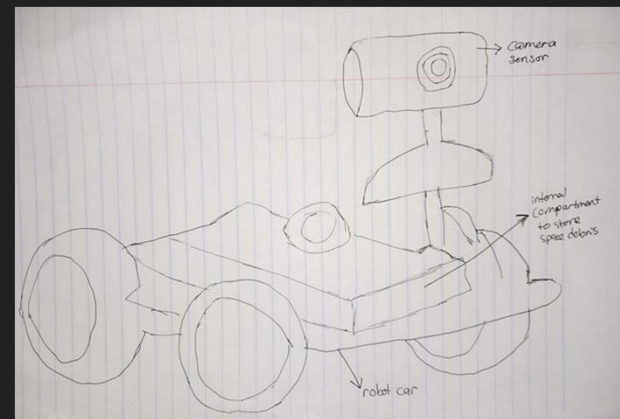
Pros	Cons
<ul style="list-style-type: none"> We are able to see if the project is worth expanding to a more sophisticated system for commercial applications once the idea can be implemented on a simpler level 	<ul style="list-style-type: none"> There may be an increased difficulty to fully automate the process of moving an object to the storage compartment due to the design

Pros	Cons
<ul style="list-style-type: none"> Two different collection areas requires less of a limit on size 	<ul style="list-style-type: none"> Could being attached to the database take more time?

Top Two:



Design I



Design II

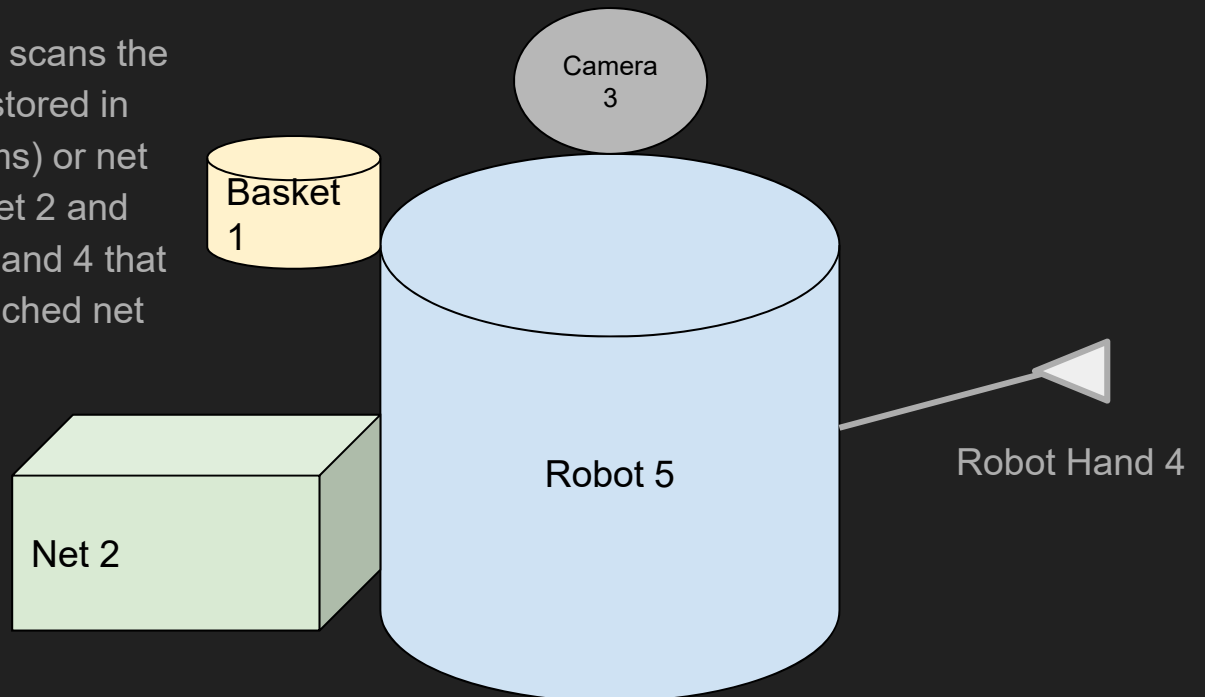
Decision Matrix

	Storage Space	Space Wt	Available Tools	Tools Wt	Movement	Movement Wt	Computing Equipment	Computing Wt	Results
Design I	7	0.3	6	0.3	4	0.1	4	0.3	5.5
Design II	5		3		6		6		4.8

Top Solution Design

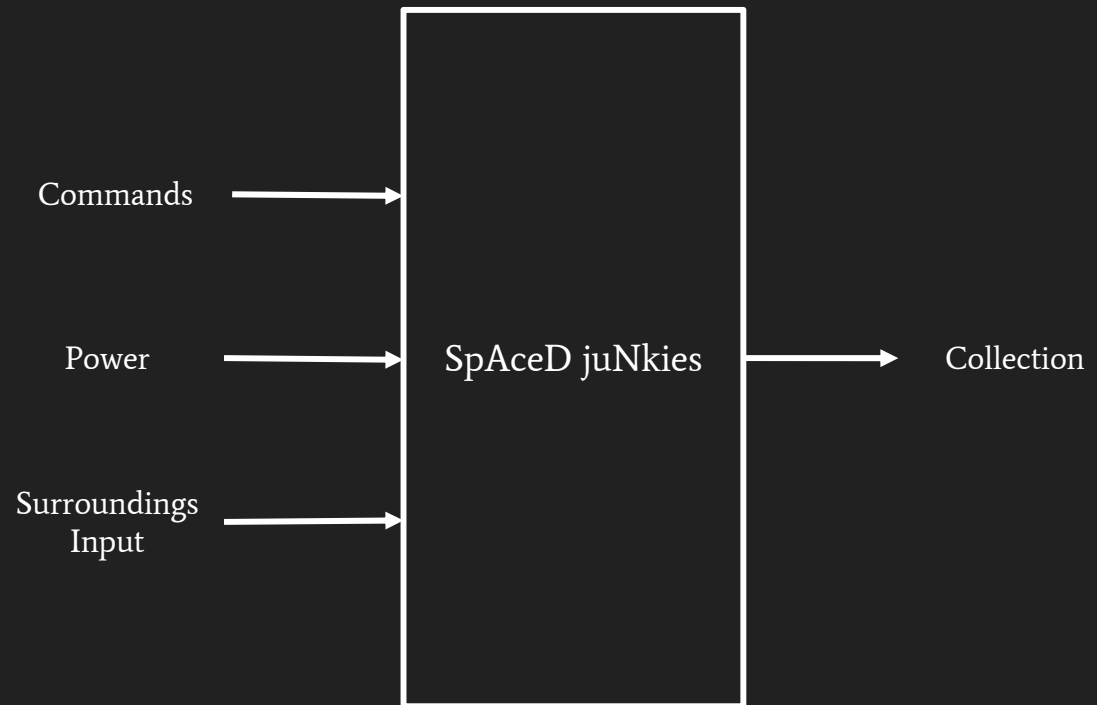
Schematics of the Top Solution Design

The on board camera 3 based sensor scans the debris and determines if it should be stored in the attached basket 1 (for smaller items) or net (for larger items) 2. The robot has a net 2 and basket 1 connected to it and a robot hand 4 that will grab debris and place it in the attached net 2/basket 1.



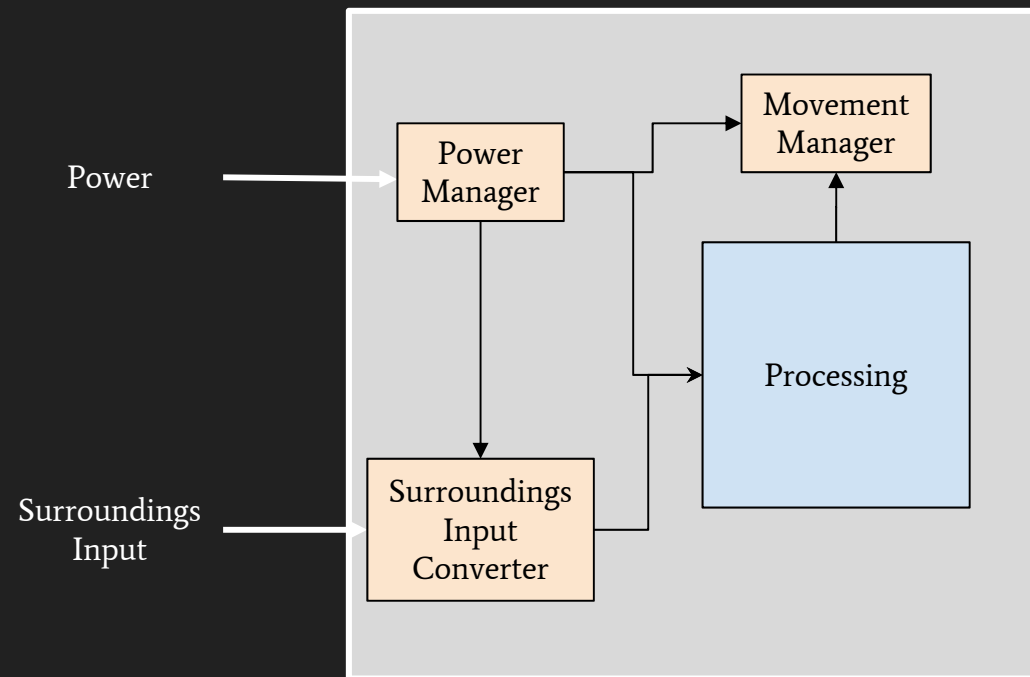
Big Picture

- Inputs
 - Commands (pictures and location)
 - Power Input
 - Surroundings Input
- Outputs
 - Movement and collection
- Functionality
 - Use information from the user to go to a location and collect materials to bring back to the user.



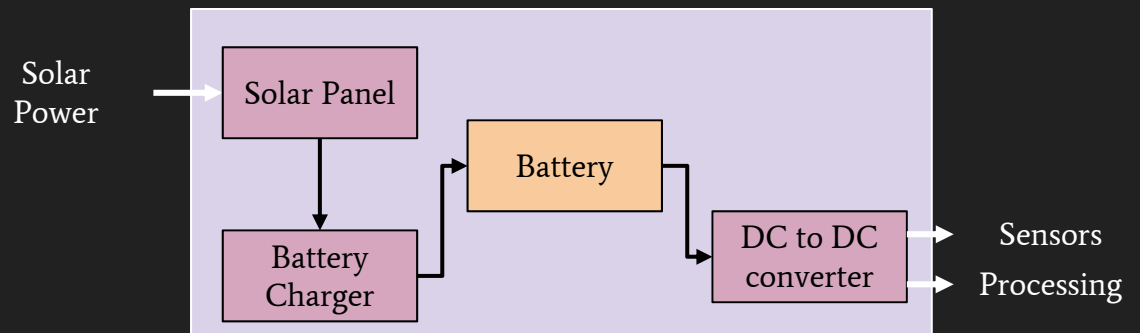
System Block Diagram

- Inputs
 - Power
 - Surroundings Input
- Output
 - Movement according to the given instruction
- Functionality
 - Manages/ controls how the robot moves.



Power Manager

- Inputs
 - Power from battery
- Outputs
 - Power supply to system
- Functionality
 - Manages where power input goes and converts for the next module.



Power Manager

Solar panel

- Inputs
 - Sensed DC voltage
- Outputs
 - Voltage
- Functionality
 - Measures the DC current and DC voltage for the microcontroller unit

Battery Charger (DC to DC Converter)

- Inputs
 - Solar Panel Voltage and Current
- Outputs
 - Battery Voltage and Current
- Functionality
 - Converts input voltage to an output voltage the next module can use.

DC to DC Converter

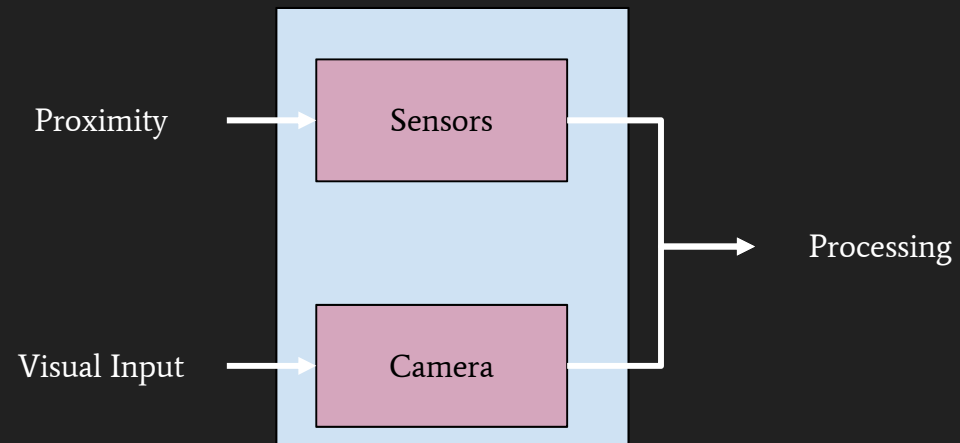
- Inputs
 - Battery Voltage and Current
- Outputs
 - Processing and Sensors Voltage and Current
- Functionality
 - Converts battery current and voltage to an output voltage the next module can use.

Battery

- Inputs
 - Voltage
- Outputs
 - Voltage
- Functionality
 - Holds voltage for future use

Surroundings Input Converter

- Inputs
 - Sensors, camera
- Outputs
 - Raw Image/Sensor Data for Processor
- Functionality
 - Gets information from sensors and camera to indicate to the microcontroller what steps should be done next.



Surroundings Input Converter

Sensors

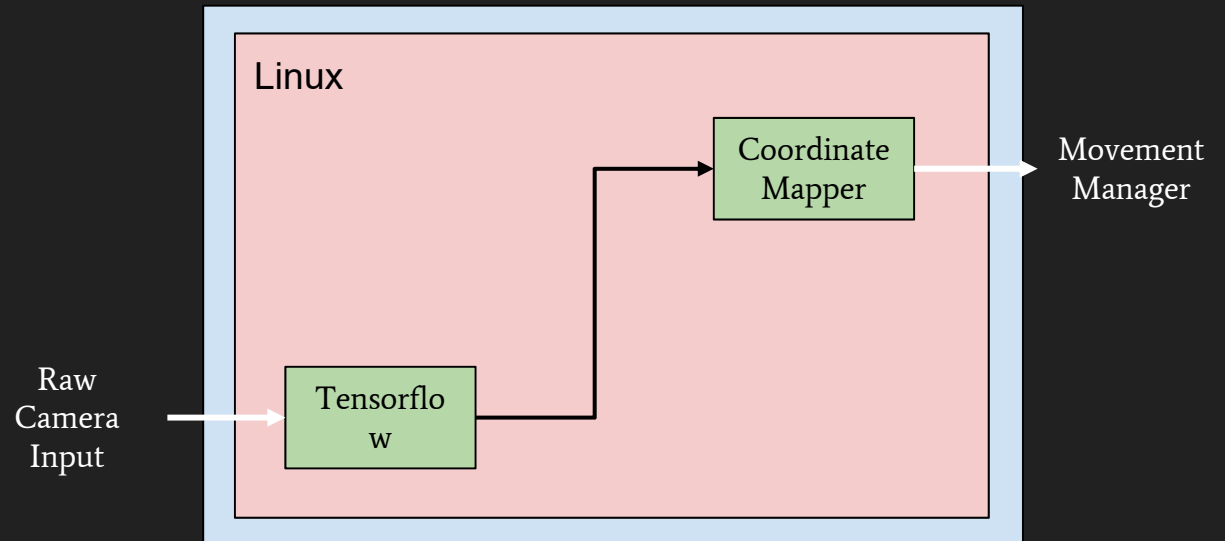
- Inputs
 - Proximity to nearby objects.
- Outputs
 - Raw proximity data
- Functionality
 - Detects proximity to nearby objects and sends data to the processing unit.

Camera

- Inputs
 - Visual Inputs / Motion
- Outputs
 - Raw photos
- Functionality
 - To collect photos from the surroundings.

Processing

- Inputs
 - Power, Raw surroundings data
- Outputs
 - Movement commands
- Functionality
 - Manages how the robot moves.



Processing

Microprocessor

- Inputs
 - Surroundings input convertor unit
- Outputs
 - Battery, Solar panel, sensor, camera
- Functionality
 - To control a singular function in a device. It does this by interpreting data it receives from its I/O peripherals using its central processor.

ML Software

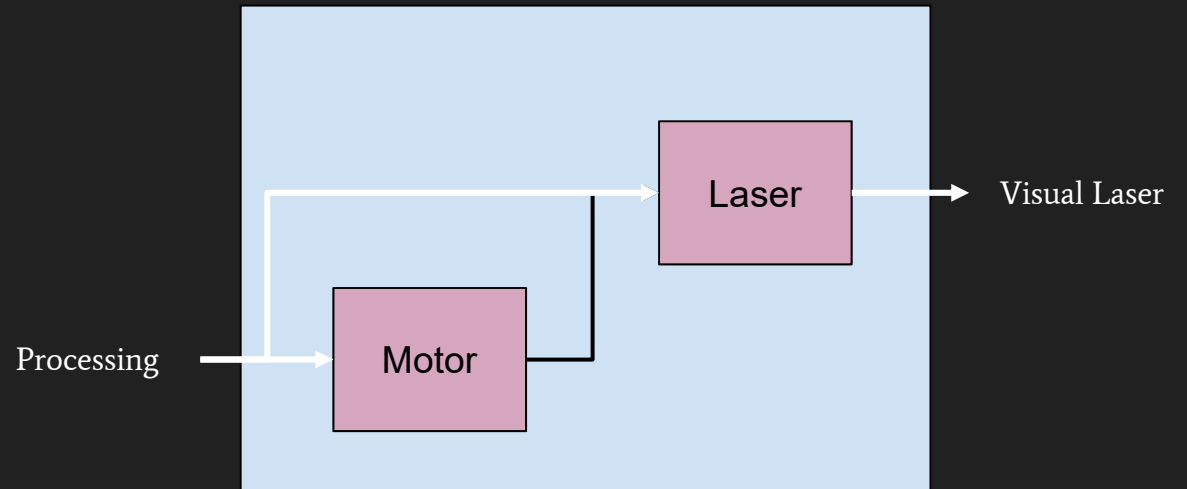
- Inputs
 - Raw Camera Input
- Outputs
 - Location
- Functionality
 - Analyzes the raw camera input and converts to usable locations.

Coordinate Mapper

- Inputs
 - Location of the object
- Outputs
 - Commands for the motor to move the laser
- Functionality
 - It gives the instruction to the motor (i.e.-movement)

Movement Manager

- Inputs
 - Processing unit/ Power manger
- Outputs
 - The movement of the laser
- Functionality
 - To point at the detected object of interest at the camera frame/ Track the object of interest.



Movement Manager

Laser

- Inputs
 - On/Off (from processing module)
- Outputs
 - Beam of light
- Functionality
 - Indicate where the object is.

Motor

- Inputs
 - Processor
- Outputs
 - Laser
- Functionality
 - It controls the laser's movement

How it works

1. Get information on what the robot is looking for
2. Find the object
3. Collect the object
4. Deliver it back to the user

Future Works

What next?

- More research needed on specific parts
- Research machine learning and software components
- Build and connect robot components

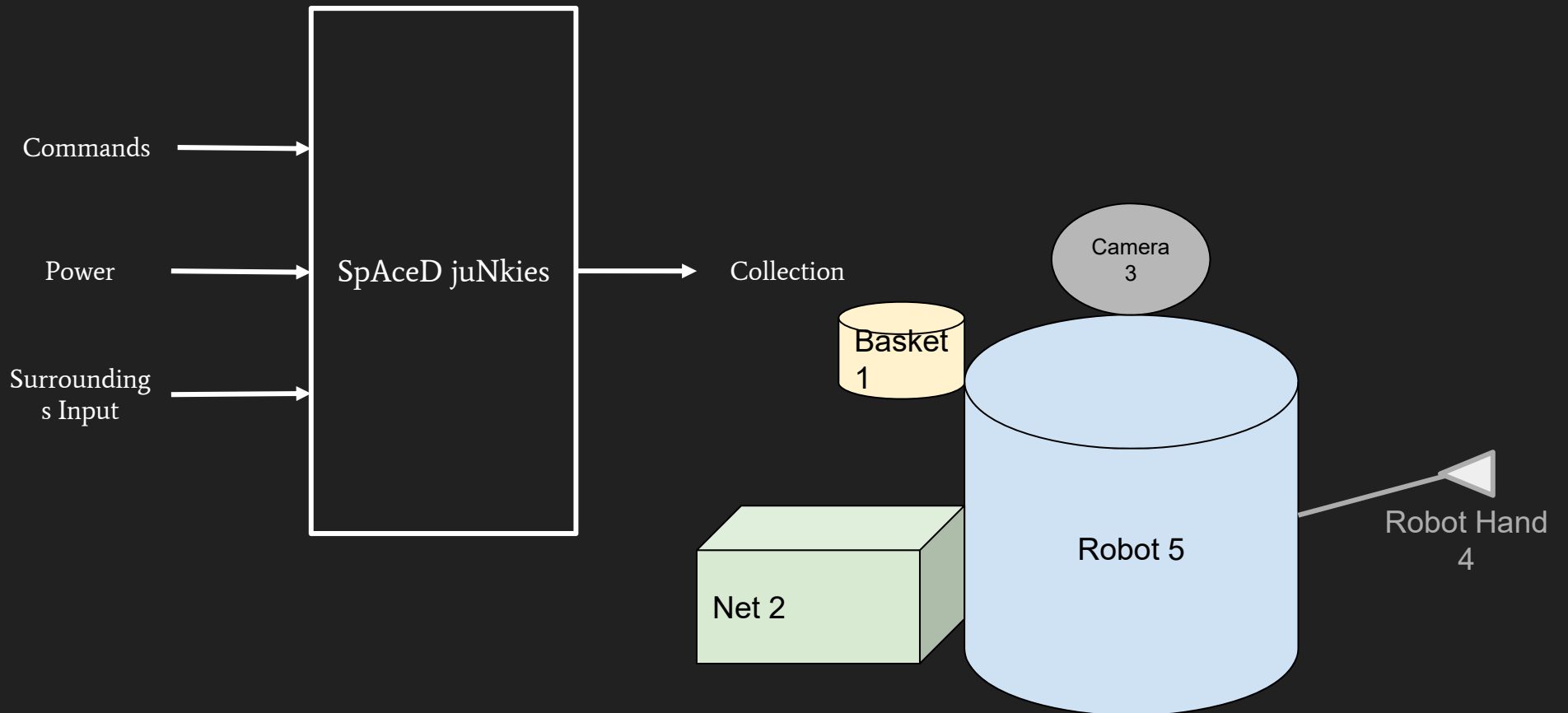
Conclusion:

To sum up, the overall concept behind this project is to develop, identify and collect the space debris with the help of autonomous robot with its camera based sensing and sensor detection.

Summary

- The product name is SpAceD juNkies.
- The robot's job will be to go through the space debris orbiting Earth and collect reusable items.
- The optical sensors sense a common object, and estimate the position of debris by sharing the measured data.
- As a result, it autonomously detects and tracks unknown debris, estimates their trajectories, and sends the results
- The primary audience would be the aerospace industry (Researches and Scientists). The aerospace industry would significantly handle space debris and collect data through the autonomous system.

Final Solution



THANK YOU
FOR LISTENING

- Nora, Autumn, Sukti, and Desvaun