EXT.R.A.C.T.I.N.A.T.O.R.

(EXTraterrestrial Robotic Accumulator of Cavity Trapped Ice Not Accessible To Ordinary Residents)

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Abstract

EXTRACTINATOR is a remotely controlled device designed to collect water from ice deposits found below lunar and martian surfaces. Through the integration of numerous subsystems, EXTRACTINATOR is capable of mining through various layers of sand, clay, stone, and concrete, while simultaneously measuring drilling parameters that allow for the identification of the layers being drilled through. After mining through the overburden and reaching ice, the drill retracts and an extractor enters the hole that's been made. The extractor has a heating probe that melts the ice and a pump that then delivers the melted water to the filter. Finally, the filter produces the end result of clean water.

Prototype

1. Structural and Mounting System

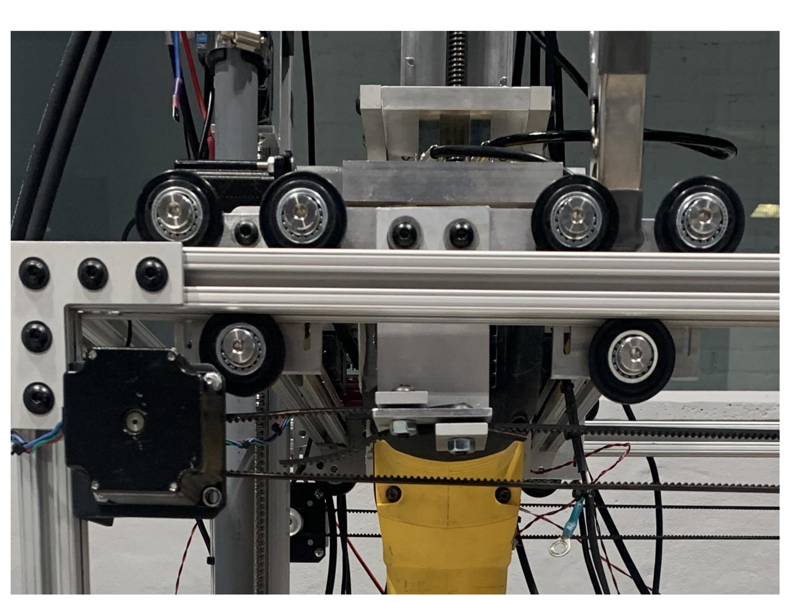
A t-slot framing system made of 1" thick pieces of 80/20 and held together by plates and brackets supports the overall system.

2. Drilling

A commercial grade rotary hammer drill with a 22.5" long masonry style bit is used to excavate through the overburden layers and provide a clear path to ice.

3. Extraction System

Through the use of cartridge heaters and temperature and optical sensors, the extractor is capable of melting subsurface ice and determining the radius of the resulting hole.



Motion Subassembly

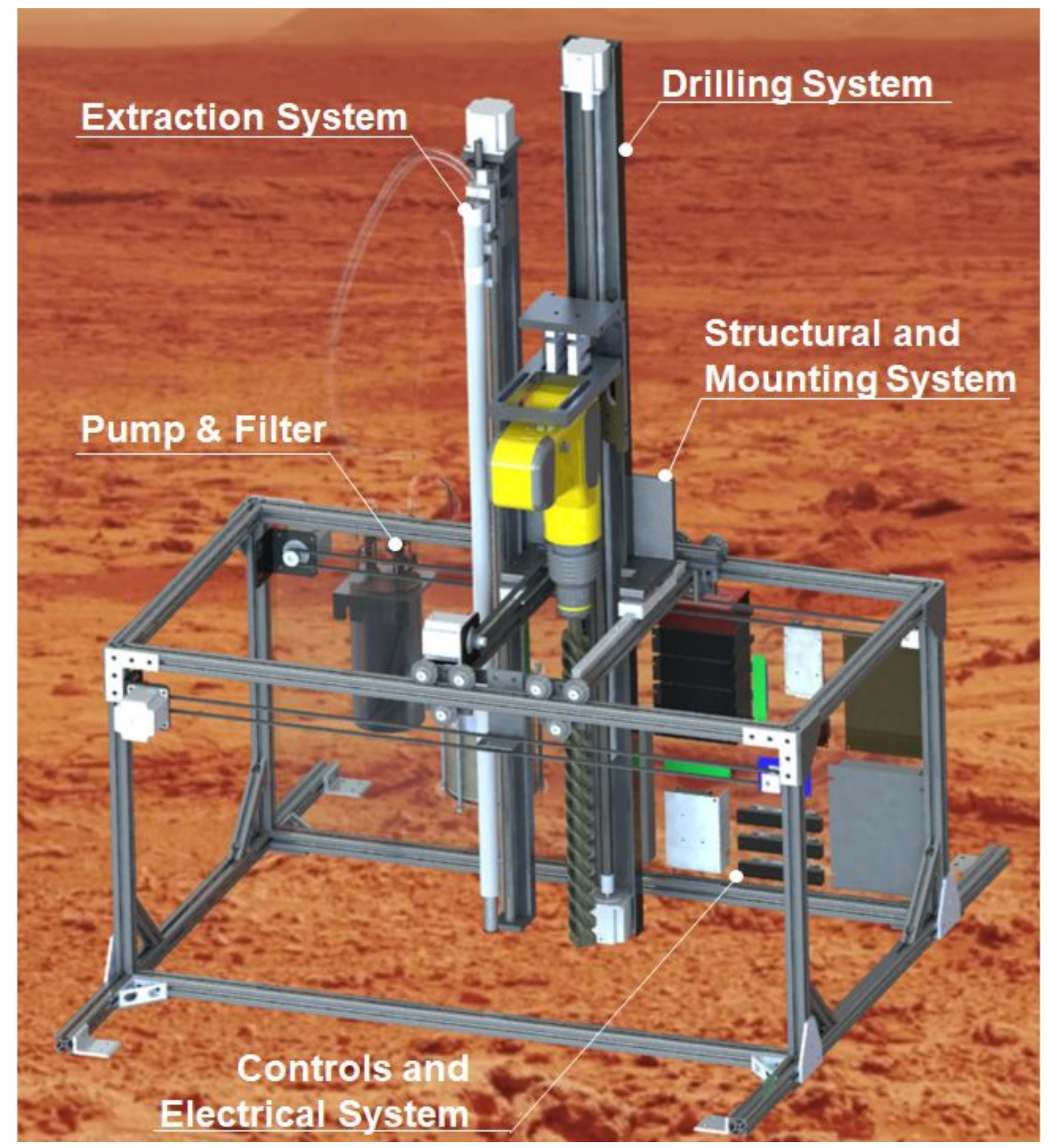
4. Pump and Filter

A peristaltic pump circulates heated water into the ice hole while delivering the extracted water to a sediment filter composed of polycarbonate housing and a multi-sand filtrate.

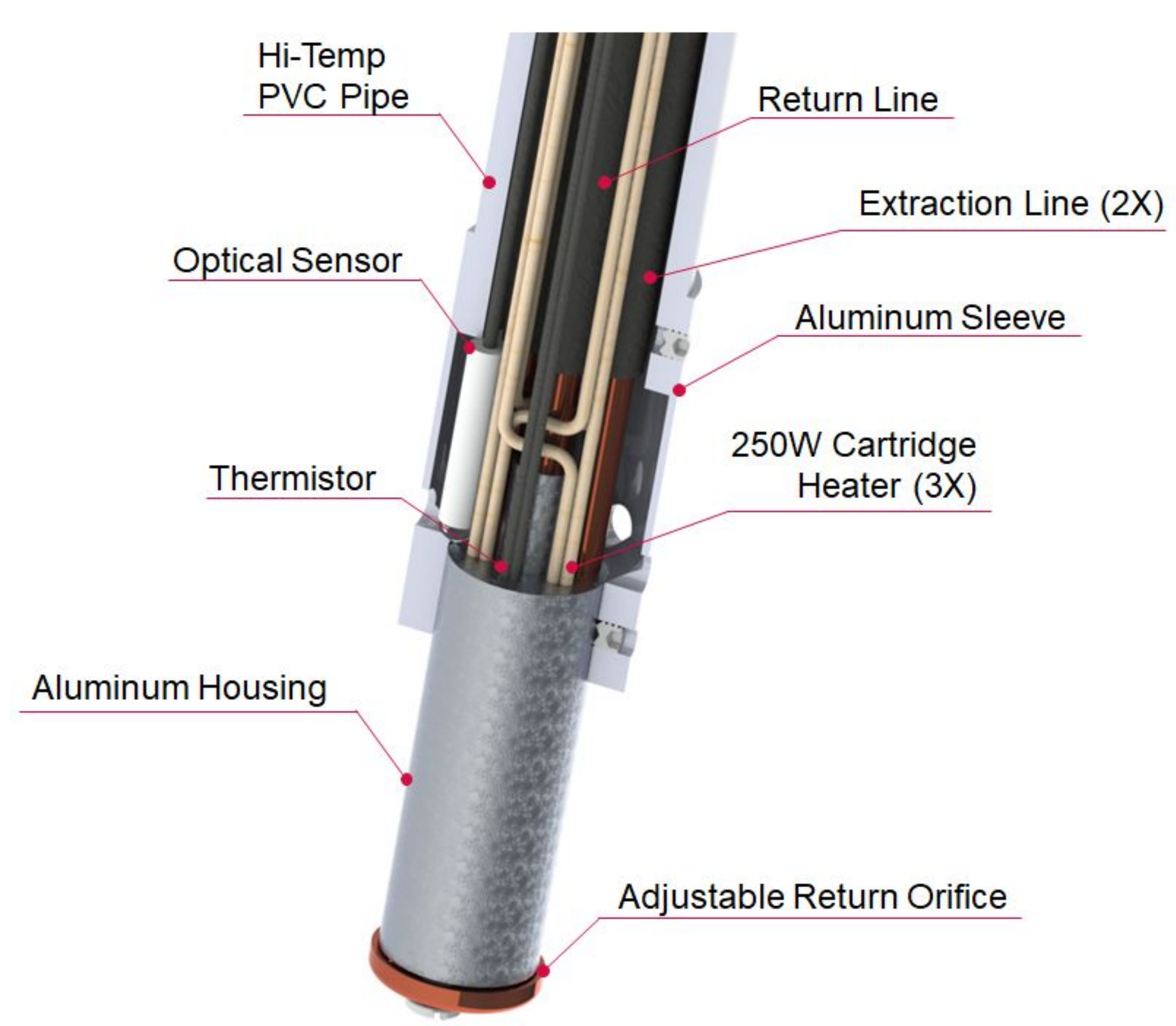
Filter Assembly

5. Controls and Electrical

The controls and electrical system are governed by a single microcontroller which sends and receives commands to and from a host computer. Speeds, positions, etc. can all be controlled and monitored. Data collected from each subsystem is used to calculate the MSE of each material being drilled through. This, in combination with stepper motor feedback, aid in creating the digital core.



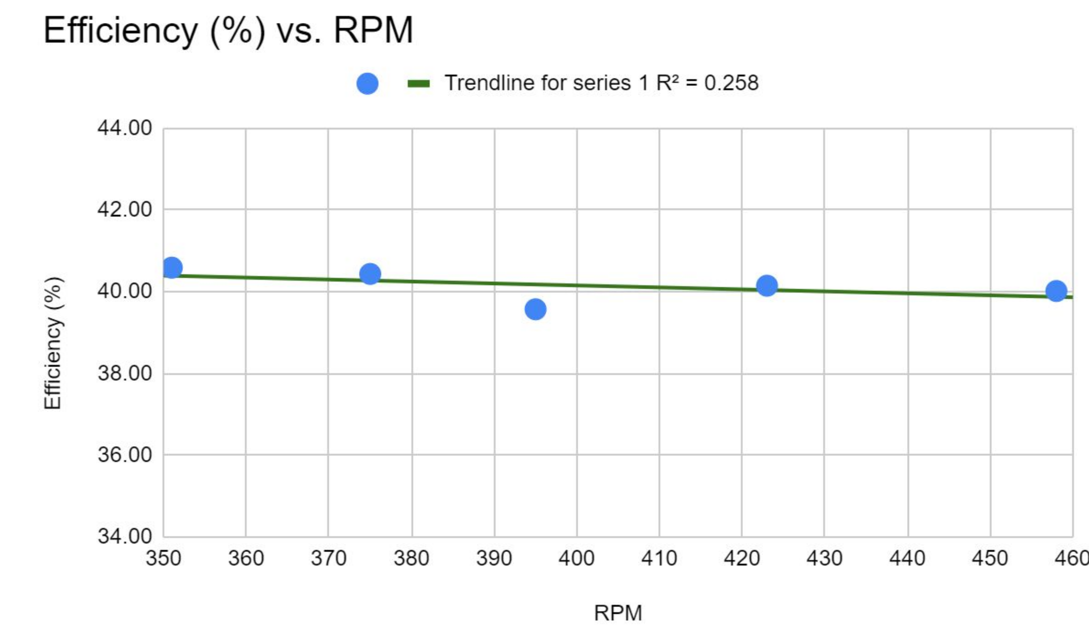
EXTRACTINATOR System Model

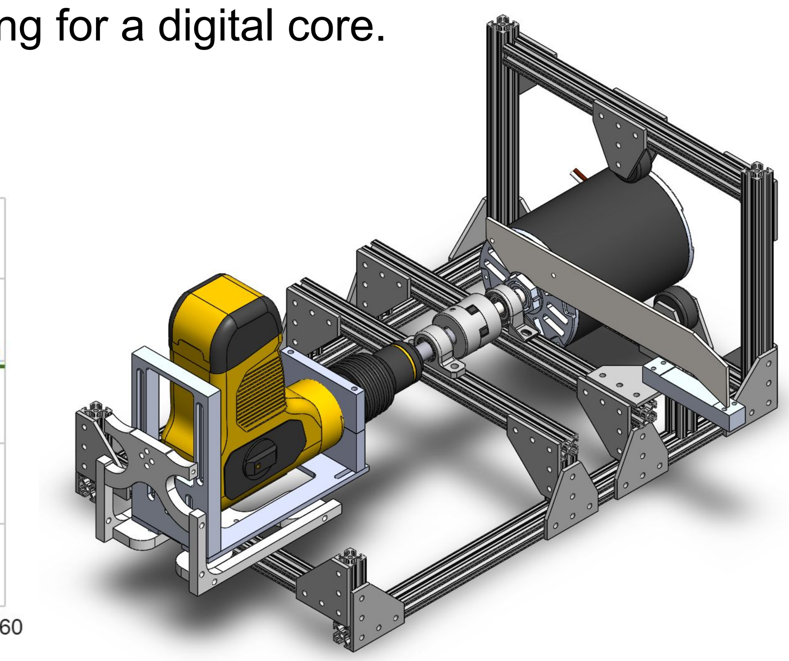


Section View of Extraction Probe

Refining EXTRACTINATOR

To accurately prospect for a digital core, a dynamometer was designed and built to measure the electrical and mechanical power in and out of the drill respectively. These measurements were used to find the drill's efficiency and improve the control system's torque calculations. With more accurate torque calculations, the error in MSE has been minimized, thus improving the accuracy of prospecting for a digital core.





Paths to Flight

Water Extraction on Mars

1. Atmospheric Pressure: 0.004 atm to 0.0086 atm
   - Due to the lower atmospheric pressure on Mars, ice will sublimate when heated.
   - A pressurized dome that covers and seals the top of the drill hole, and an onboard compressor or small canister of compressed gas to pressurize the hole, would ensure liquid water can be obtained.
2. Surface Temperature: -140℃ to 30℃
   - Mars' cold temperatures would quickly refreeze any melted water exposed to the environment. The extractor's rubber lines would also fail at low temperatures.
   - Heating the water to higher temperatures, running the pump continuously, and adding salt made from perchlorate ions found in Martian soil would prevent the water from refreezing. Additionally, the rubber extraction lines would have to be replaced with cryogenic hoses heavily insulated with aerogel.
3. Surface Gravity: 3.71 m/s^2
   - The lower gravity on Mars allows for the use of a weaker pump.
   - Since the filter relies on gravity to move water through the system, an additional pump may be needed to speed up the filtration process.

Digital Prospecting on the Moon

1. Surface Temperature: -173℃ to 127 ℃
   - The Moon's extreme temperatures would cause system and component failures.
   - Solar cells, an RHU, and liquid coolant would provide EXTRACTINATOR with the temperature regulation necessary to keep it operating effectively.
2. Surface Gravity: 1.62 m/s^2
   - The microgravity environment of the Moon makes it difficult to achieve the weight on bit necessary for lunar drilling and makes it impossible to resist the reaction force created by the weight on bit.
   - To be able to drill downward, and to avoid pushing itself off the Moon's surface and into space, microspine grippers need to anchor EXTRACTINATOR to the Moon's surface.

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