Seoul Main Office

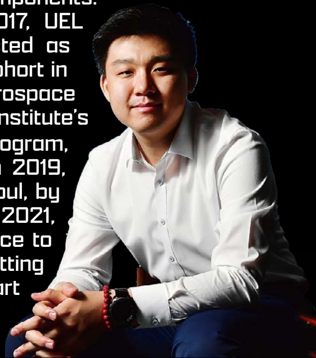
Product development, business management, external relations, software and electrical engineering, rapid prototyping, education

Ansan Smart Factory

3D printing, laser cutting, foam cutting, small-scale manufacturing, full-spectrum mechanical and structural/systems enginerering

Lunar Environment Testbed (Ansan)

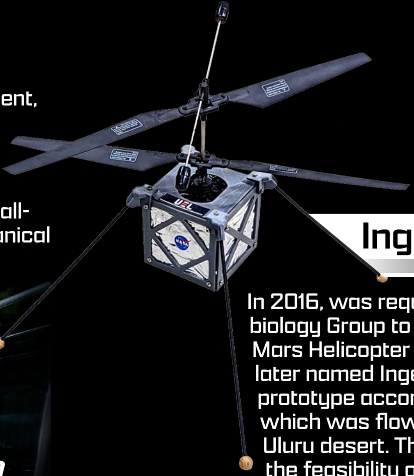
Unmanned Exploration Laboratory (UEL) (Korean: 무인탐사연구소) was founded in 2016 in Busan, South Korea by Namsuk Cho as a small-scale laboratory to develop custom mult-rotor drones. In 2017, UEL expanded purchased factory space in Yangsan for larger-scale production of drone components. In July 2017, UEL was selected as the third cohort in Korea Aerospace Research Institute's (KARI) STAR startup incubator program, becoming a KARI family company. In 2019, UEL opened up a branch office in Seoul, by partnering up with local universities. In 2021, UEL fully moved its headquarters office to Seoul to enable global operations, setting up a factory floor in the Ansan Smart Factory complex.



www.uel.co.kr

antonio.stark@uel.co.kr - Global Relations

whitewh0519@uel.co.kr - Chief Executive



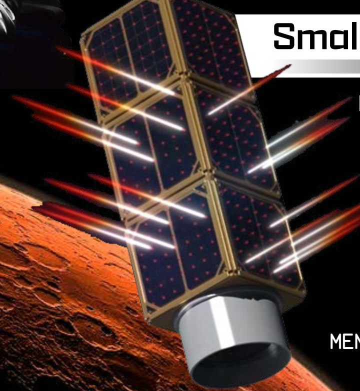
Ingenuity prototype

In 2016, was requested by NASA's space biology Group to develop a prototype for the Mars Helicopter Technology Demonstrator, later named Ingenuity. UEL manufactured the prototype according to JPL's specifications, which was flown in late 2016 at Australia's Uluru desert. The prototype was able to verify the feasibility of counterrotating dual rotors, structural integrity of top-mounted landing gear arms, and flight performance in harsh desert wind conditions

Solar-powered UAV

Developed ~10 types of solar powered fixed-wing drones, most with long-range, medium-altitude reconnaissance capabilities. With wingspans of 2-4 meters, cruising altitudes of 150-300 meters, and flight times of 6-8 hours, the UAVs were equipped with multispectral sensor packages, and were contracted to survey coastal areas, agricultural fields, and construction sites. Later models were equipped with solar panels on wings to increase flight times and operational range. Developed multiple patents, including a patent on electromagnetic shielding for payload-integrated hull bodies and navigation calibration technologies.

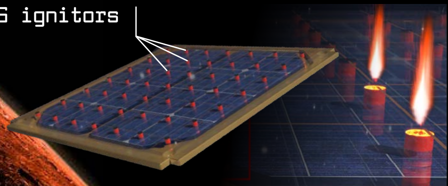
Smallsat Panel Propulsion



Developed a micro propulsion systems to be embedded inside small satellite (cubeSat) solar panels to be used for satellite reorientation and altitude control.

Propulsion systems use micro-electro-mechanical-syustem (MEMS) solid propellant ignitors as single-use thrusters organized in grid array within solar cell coating.

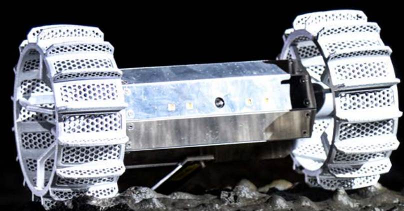
MEMS ignitors



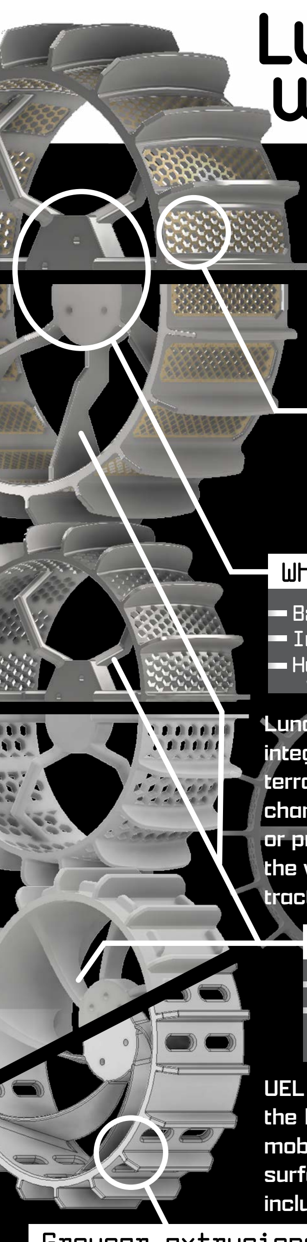
Unmanned Exploration Laboratory

ROVER

LUNAR SYSTEMS



Lunar wheels



Historic missions involving lunar vehicles experimented with a variety of wheel types, ranging from nonperforated drums of India's Pragyan rover (2019), to a bicycle wheel spoked Soviet Lunokhod rovers (1970, 1973), to the fully mesh wheels of Apollo moon buggies (1971-72)

Barrel perforation

- hexagon/square/triangle mesh
- non-perforated drum
- circle/elongated holes

Wheel hub

- Barrel width matching
- Inward/Midpoint/Outward alignment
- Hub-spoke/Spoke-hub composite

Lunar wheels need to ensure structural integrity of the rover weight against lunar terrain, need to stay afloat the quicksand characteristics of lunar regolith, expunge or prevent the buildup of lunar soil within the wheel itself, while ensuring sufficient traction against the soft terrain.

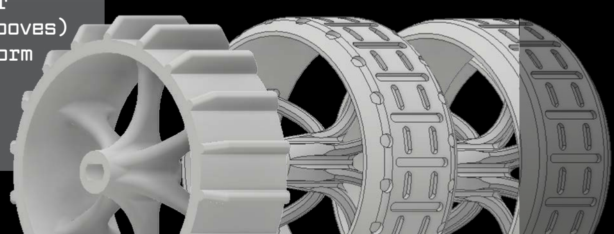
Spokes

- Straight/curved radiating out
- Stick/planar/aerofluid shape
- (Counter)rotational

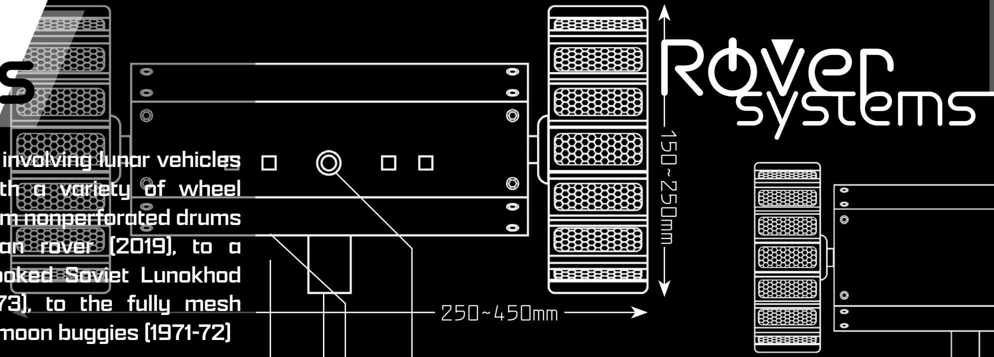
UEL experimented with multiple variations of the lunar wheel components and conducted mobility assessments on simulated lunar surface environments. UEL's latest versions include a hexagonal mesh barrel to expel accumulated soil, jointed cylindrical spokes to prevent dust collection while minimizing stress, and tapered extrusions for added traction.

Grouser extrusions

- Drum friction (no grouser)
- Inverse grouser (grooves)
- Laterally uniform extrusions
- Tapered extrusions



Rover systems

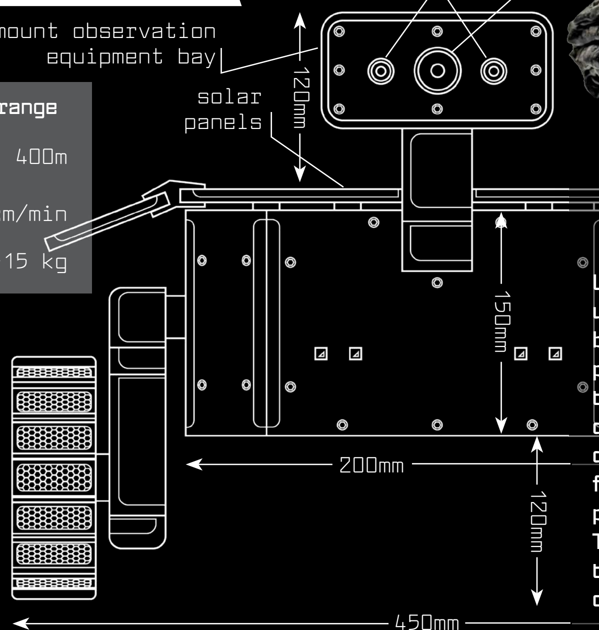


"Scarab" 2-wheel rover

Lightweight exploration rover for small payload requirements, and for tight space (lunar caves) surveyor missions

Operational range /charge	150m
Max. speed	200cm/min
Weight	2,000-5,000 grams

"Haetae" 4-wheel rover



Operational range /charge	400m
Max. speed	400cm/min
Weight	10-15 kg

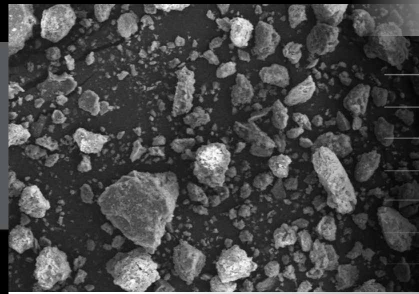
KOHLS-1

Lunar Regolith Simulant

UEL has ample supply of the Korea-Hanyang Lunar Simulant-1 (KOHLS-1), which emulates the physical and chemical characteristics of lunar soil (regolith). KOHLS-1 is based on the "lunar soil 14163" returned from the Apollo mission, with core emphasis on: (1) chemical composition, (2) particle size distribution (3) particle shape, and (4) density.

UEL's commercial sample of KOHLS-1, featuring a miniature Scarab rover

KOHLS-1 was confirmed to closely resemble the particle size distribution of LS-14163 via sileve filtration analysis, with X-ray diffrction analysis (XRD) showing similar chemical compositions, with the exception of FeO, which was replaced with Fe_2O_3 in the KOHLS-1 due to the existence of oxygen in Earth's atmosphere.



Scanning Electron Microscopy (SEM) analysis of KOHLS-1

chem.	KOHLS-1	LS-14163	diff.
SIO_2	54.56	47.3	+7.26
TIO_2	0.70	1.6	-0.9
Al_2O_3	16.73	17.8	-1.07
Fe_2O_3	5.68	-	+5.68
FeO	-	10.5	-10.5
MnO	0.18	0.1	+0.08
MgO	2.32	9.6	-7.28
CaO	5.44	11.4	-5.96
Na_2O	2.28	0.7	+1.58
K_2O	3.38	0.6	+2.78
P_2O_3	0.21	-	+0.21

Regolith-polymer 3D printing

UEL has also developed in-situ resource utilization (ISRU) construction technology by mixing lunar regolith simulant with plastic polymers before a heated extrusion process that melts the combined mixture. The result is a 3D printing process that can be used for low-density structural walls for lunar habitat walls, or for high-density tiles and bricks for launchpad plating, tiles, or lunar building core structures. The 3D printing process itself may build walls via thick extrusion tips, or can be subdivided to build columns or trusses via thin extrusion tips.