'Mole-bot' optimized for underground and space exploration

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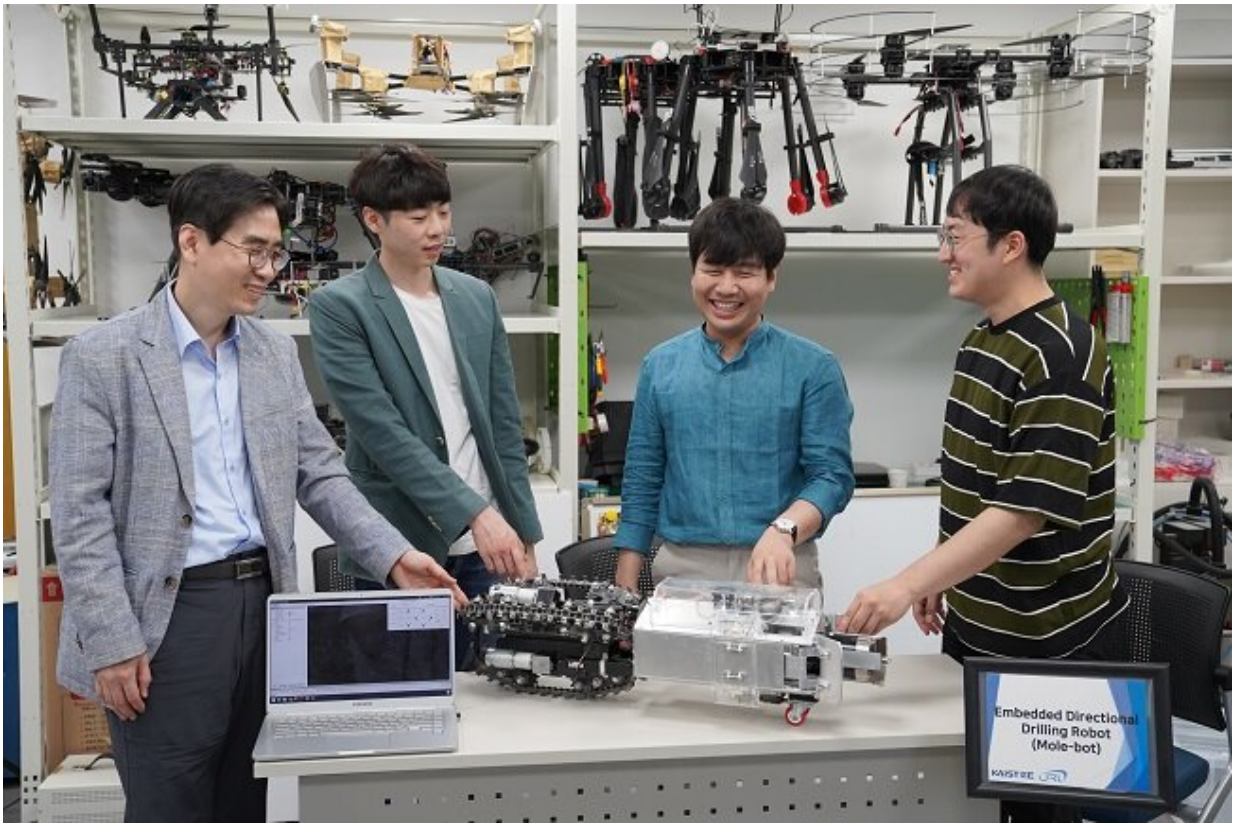


Professor Hyun Myung, Ph.D. candidate Junseok Lee, researcher Christian Tirtawardhana and Ph.D. candiate Hyunjun Lim. Credit: Korea Advanced Institute of Science and Technology

Mole-bot, a drilling biomimetic robot designed by KAIST, boasts a stout

scapula, a waist inclinable on all sides, and powerful forelimbs. Most of all, the powerful torque from the expandable drilling bit mimicking the chiseling ability of a mole's front teeth highlights the best feature of the drilling robot.

The Mole-bot is expected to be used for space exploration and mining for underground resources such as coalbed methane and Rare Earth Elements (REE), which require highly advanced drilling technologies in complex environments.

The research team, led by Professor Hyun Myung from the School of Electrical Engineering, found inspiration for their drilling bot from two striking features of the African mole-rat and European mole.

"The crushing power of the African mole-rat's teeth is so powerful that they can dig a hole with 48 times more power than their body weight. We used this characteristic for building the main excavation tool. And its expandable drill is designed not to collide with its forelimbs," said Professor Myung.

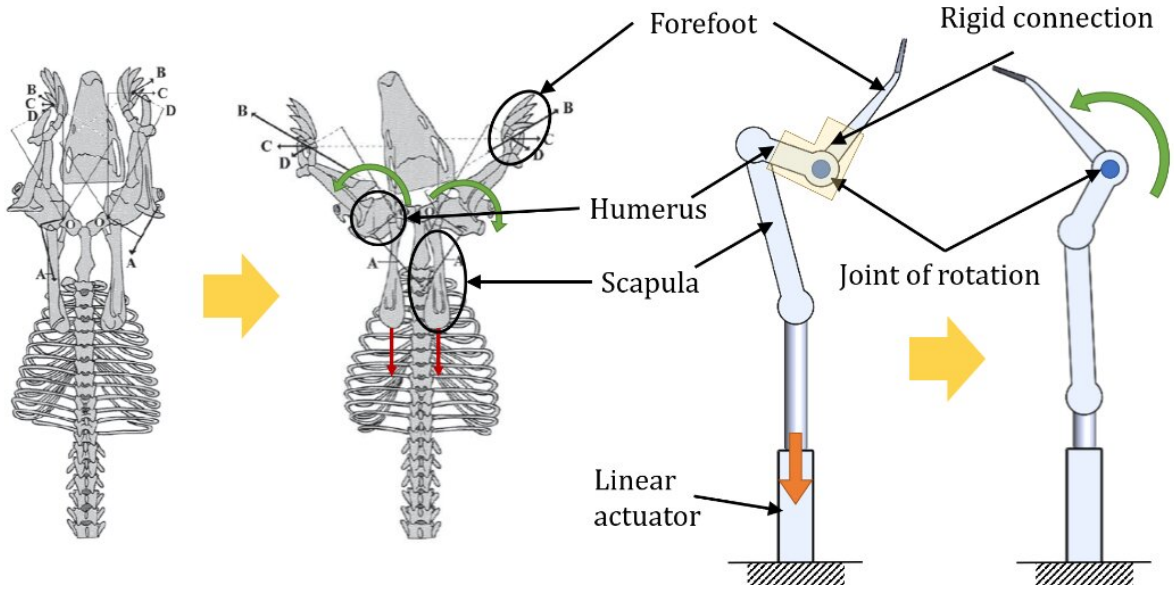
The 25-cm wide and 84-cm long Mole-bot can excavate three times faster with six times higher directional accuracy than conventional models. The Mole-bot weighs 26 kg.

After digging, the robot removes the excavated soil and debris using its forelimbs. This embedded muscle feature, inspired by the European mole's scapula, converts linear motion into a powerful rotational force. For directional drilling, the robot's elongated waist changes its direction 360° like living mammals.

For exploring underground environments, the research team developed and applied new sensor systems and algorithms to identify the robot's position and orientation using graph-based 3-D Simultaneous

Localization and Mapping (SLAM) technology that matches the Earth's magnetic field sequence, which enables 3-D autonomous navigation underground.

According to Market & Market's survey, the directional drilling market in 2016 is estimated to be 83.3 billion USD and is expected to grow to 103 billion USD in 2021. The growth of the drilling market, starting with the Shale Revolution, is likely to expand into the future development of space and polar resources. As initiated by Space X recently, more attention for planetary exploration will be on the rise and its related technology and equipment market will also increase.



Biological structure of humeral rotation and bio-inspired design of forelimbs (soil removing). Credit: Korea Advanced Institute of Science and Technology

The Mole-bot is a huge step forward for efficient underground drilling and exploration technologies. Unlike conventional drilling processes that

use environmentally unfriendly mud compounds for cleaning debris, Mole-bot can mitigate environmental destruction. The researchers said their system saves on cost and labor and does not require additional pipelines or other ancillary equipment.

"We look forward to a more efficient resource exploration with this type of drilling robot. We also hope Mole-bot will have a very positive impact on the robotics market in terms of its extensive application spectra and economic feasibility," said Professor Myung.

Provided by The Korea Advanced Institute of Science and Technology (KAIST)