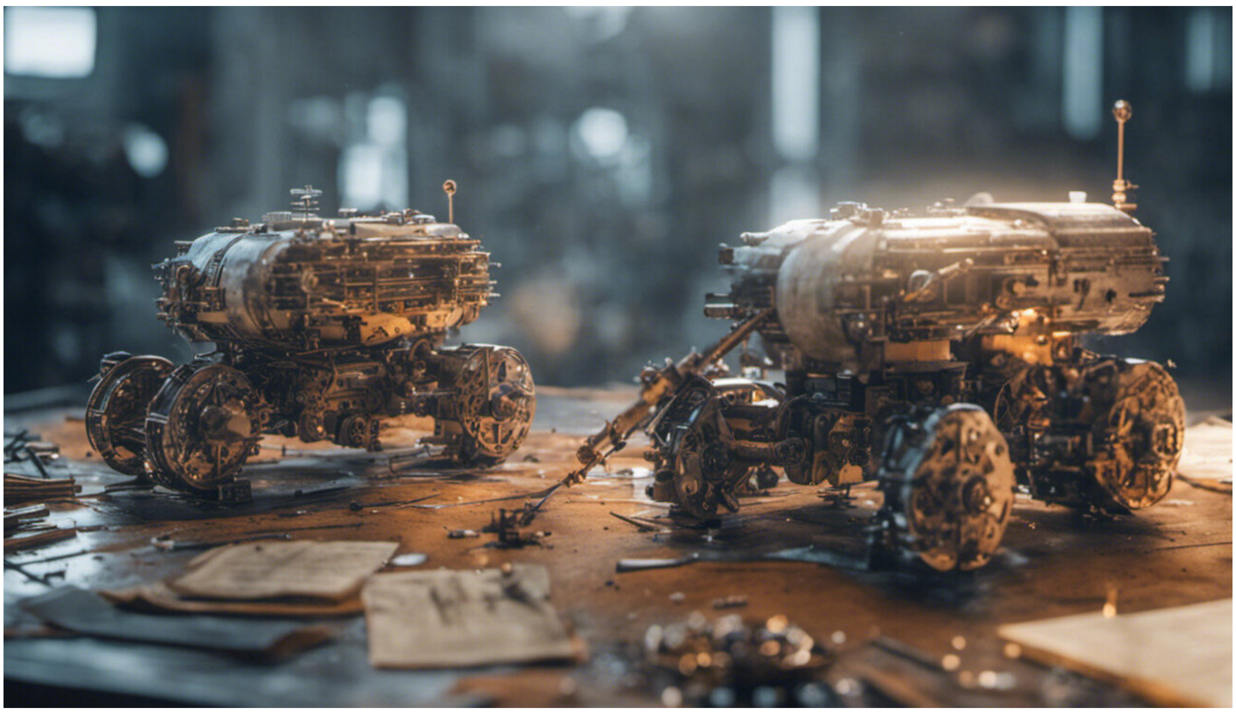
How robot explorers are making the finds of the future

March 31 2016, by Robert Richardson, University Of Leeds



Credit: AI-generated image (disclaimer)

Gone are the days when archaeology was just a whole load of sand, dust and bones. These days the real explorers are all about the robotics.

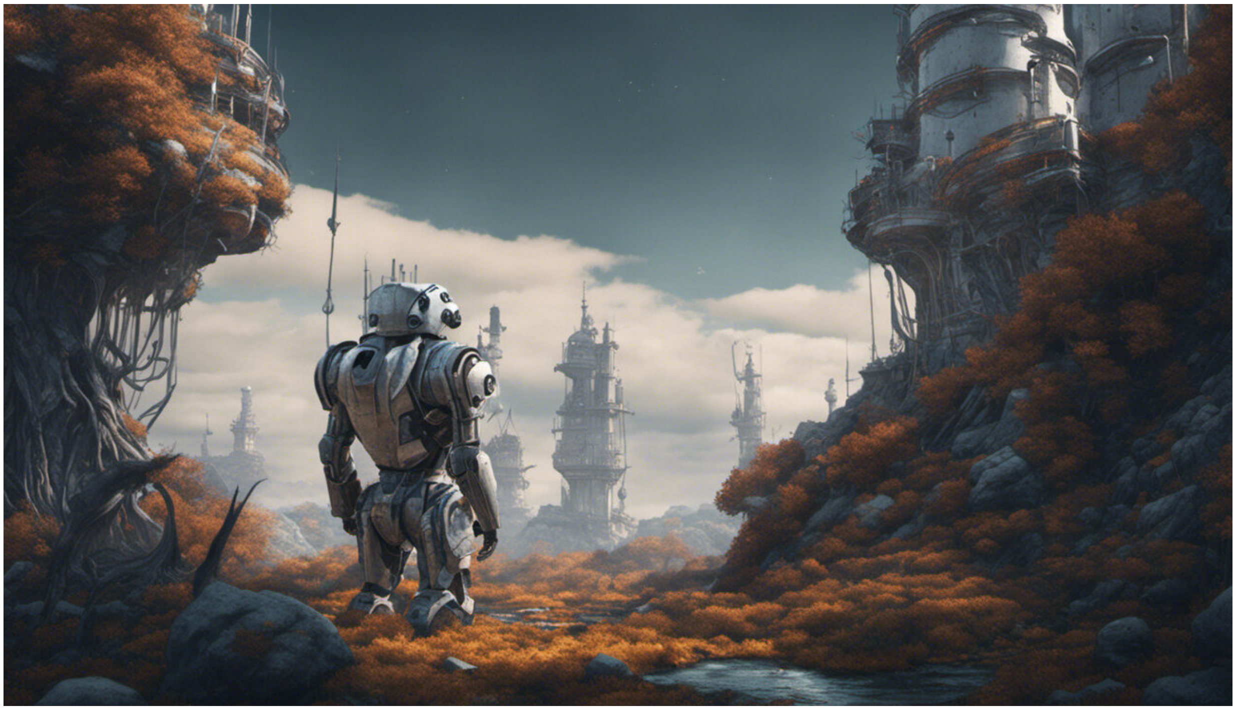
As technology has progressed, archaeological tools have become more sophisticated, including the potential to undertake scientific investigation with zero disturbances of the surrounding material.

With the use of "non-invasive archeology" amazing discoveries can be made, such as the recent ground penetrating survey that appeared to indicate Shakespeare's skull might not be in his tomb.

While these developments are all very useful, non-invasive technologies cannot, and never will, provide perfect resolution of the features within hidden spaces. Also, in many cases, there is still a need to physically extract samples for further scientific study – to perform carbon dating to determine the age of artefacts for example.

When less is more

It may well be that as in the case of Shakespeare's skull, disturbance of a site is not allowed for cultural or religious reasons. But in situations where further investigation is permissible, the usual next step after a "big find" in archaeology is to create a hole large enough for humans to enter – though this often has enormous impact on the integrity of the site.



Credit: AI-generated image (disclaimer)

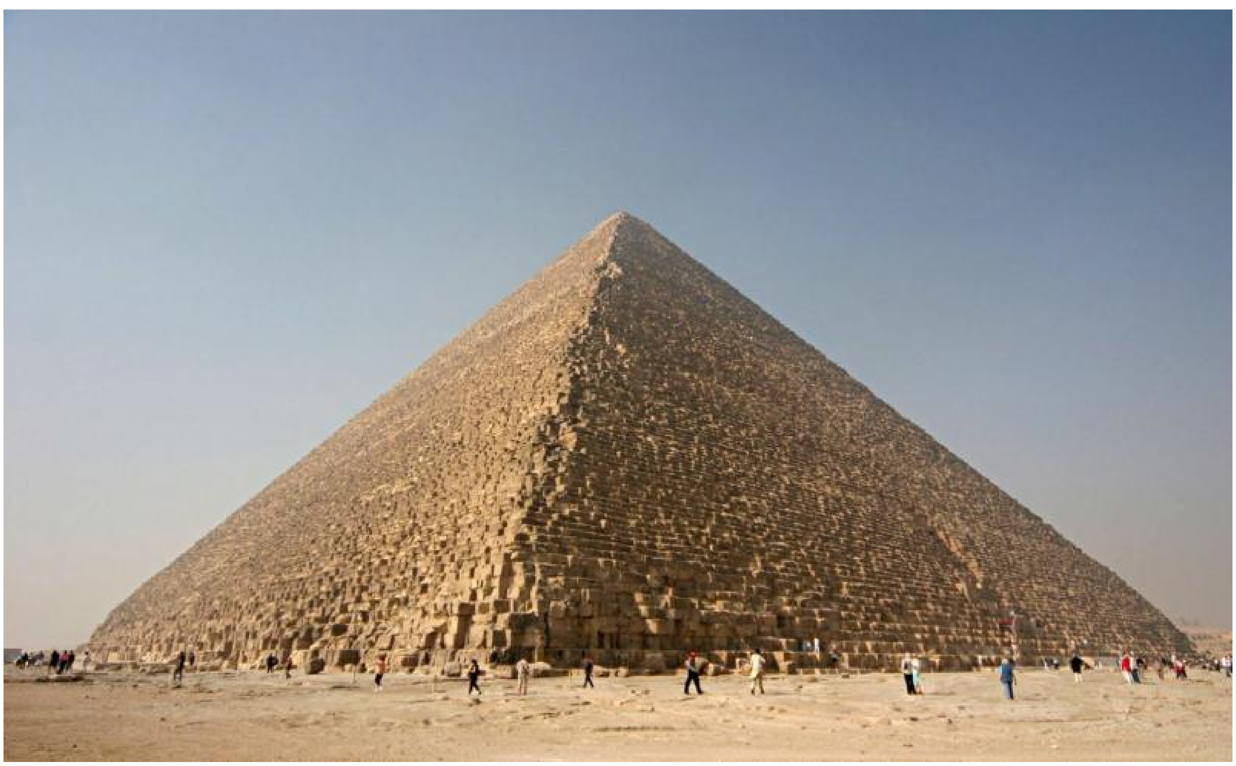
An alternative approach is to use "minimally invasive" archaeology enabled through robotic technology – just like the one we've developed in collaboration with Scoutek UK to explore the Great Pyramid of Giza in Egypt.

Minimally invasive robotic devices can investigate hidden spaces through small holes, changing shape to move safely and efficiently while collecting valuable scientific information – perhaps even flying to avoid all contact with the archaeology.

Our Egypt robot was designed to climb 50 meters at an angle of 40 degrees within a 200mm square hole and carry a range of tools such as a drill, camera and sensor to measure the thickness of stone. The expedition discovered writing which had been hidden for thousands of years.

The beauty of robotics is that the technologies deployed can match site configuration. So for example if a visual inspection is required at a distance close to the entrance point, then the use of endoscope technology (a small camera and light within a flexible tube) could be used through a hole as small a millimetre in diameter.

At this scale, very close up images can be obtained, but providing enough light to illuminate the space for a large scale inspection is unlikely to be feasible. As the hole size increases, image quality is improved and tools such as grippers and sample collectors can be used. At a size of 12mm's diameter a full range of tools can be used on the tip that can reach up to three metres away.



A robot explorer took pictures from inside the pyramid, which revealed painted hieroglyphs and lines that may have been made by stonemasons. Credit: Nina No/Wikepedia, CC BY

Other techniques such as structure-from-motion – which uses maths to align separate images – can construct 3D models from a collection of images to survey the space.

And as the quality of cameras and software increases, the quality of these visual mapping techniques will also increase – and approach the sub-millimetre accuracy currently achieved by laser scanners, which are presently too large for minimally invasive archaeology requiring a hole at least 40mm in diameter.

More than meets the eye

If the area to be explored is some distance from the entry point, then a mobile robotic device is required – we are currently developing robots that can enter a space through a small hole and then reconfigure to form a useful "fuller sized" robot. And we have already created a robot that can enter through a 40mm diameter hole and then reconfigure from a straight bar to form a conventional robot. This robot can then explore up to 100 metres from the entrance hole.

Then there are the flying robots – otherwise known as drones. Although these are currently not small enough to fit through the smaller holes, we are investigating reconfigurable drones and "blimps" that can be inserted into confined spaces and then inflated.

There are large challenges to overcome in using drones in these situations, such as battery power – operation time is typically less than 20 minutes – avoiding a crash and communications, all which make them a risky option.

Some of these limitations might be overcome through advanced control systems and the rapid advance of battery technology. And we are currently investigating these issues as part of a grand challenge to use robotic technology to "repair cities" – potholes and gas leaks may not sound sexy, but these are the issues which can make a big difference to the everyday lives of residents.

It's clear that where the future is concerned, be it in the field of archaeology or on the city streets of Leeds, robotics can offer us new ways of doing things – often where humans have previously fallen short.

So while we don't need to worry that robots are taking over our jobs just yet, perhaps sometime in the future, they will be able to tell us for sure, whether Shakespeare's skull is in its rightful resting place.

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