

11 – The Role of Robots

SUMMARY

An AI-humanoid robot could be a member of Initial Permanent Crew conducting useful tasks 24/7. Other dexterous robots would plant, harvest, process, and maintain the greenhouse areas. They could also continuously clean and maintain facilities. Indeed, robots would probably outnumber human crew at every level of development.

ROBOTS VS HUMANS

Categories of Roles

In space advocacy circles there is a recurring argument about who is better for space -- robots or humans. The advocates for robots argue that robots are cheaper and don't require life support. The advocates of humans argue that humans are much faster than robots and have better judgement.

But these arguments miss the point. Robots are better for some things and humans are better for other things. This page will detail what situations are best for each.

But first, let's clarify the three settings in question. Those are:

- Exploration
- Development
- Settlement

The debate and confusion most often result from not distinguishing between those settings.

Exploration

The greater speed of humans notwithstanding, robots are almost always better than humans for scientific exploration. For probes exploring the outer solar system this is a given. Only robotic probes can currently explore places beyond Mars. The radiation during transit and long-duration life support requirements make exploration by humans impossible in these locations.

For the Moon and Mars, robots still easily beat humans for several reasons. On a per-mission basis, they are far cheaper than sending

astronauts. If we were to mass produce Spirit and Opportunity rovers for Mars, each mission would cost about \$400 million whereas the first human mission to Mars would typically cost about \$150 billion. So, we could conduct about 375 robotic missions for each crewed mission. Most importantly, those robots could go to 375 different locations whereas humans could only go to one location or just a handful if they were to drive around. Science return is highly dependent upon where one goes. So, the more places one goes the more unique science is returned. And scientific rovers are lasting for many years. So, even though they are slower each telerobot could cover a substantially equivalent distance as human explorers.

Understanding Context

Those that argue for humans say that robots are not smart enough to understand the context of what they are looking at. They say that, until we have true AI, only geologists in the field can interpret what they are looking at. This completely ignores how teams of our best geologists on Earth can be virtually "present" on the Moon or Mars via telepresence. Those robots that we have on Mars are as smart as the scientists who operate them. So, that argument doesn't fly.

No Exploratory Role for Humans?

However, even though there are strong practical reasons for why robots beat humans for exploration in almost every context, there is none-the-less a strong reason why we shouldn't "let the robots have all of the fun" but should hold them back in favor of astronauts conducting scientific exploration.

For both the Moon and Mars, there could be a very extensive International Exploration Phase provided that the per-seat price was low enough. This extensive phase, driven by the motivation of national pride, could be just the thing needed to increase flight frequency and so further reduce the cost of passenger transport thereby opening the way for private settlement.

It is the position of the Space Development Network advocates that NASA's Commercial Landed Payload Service (CLPS) should limit small "commercial" landers to prospecting and perhaps small-scale demonstrations and NOT to visit exciting science sites prior to international astronauts visiting them.

Telerobotics Versus Autonomy

Workers on Earth controlling lunar telerobots would experience a 2.6 second speed-of-light round trip time delay. This means that the telerobots could perform tasks with full human intelligence controlling them. With the time delay, actions would be slowed but, operating 24/7, considerable work could be accomplished telerobotically prior to crew arrival.

But if a task could be safely, fully automated and done with about the same efficiency of teleoperations then those robots would be allowed to operate autonomously. A hybrid would be supervised autonomy where the teleoperators (perhaps controlling multiple telerobots) give high-level instructions and the robot determines the individual steps to accomplish those goals. Driving while avoiding hazards is one task that now could probably be fully automated. And if a robot gets stuck, a fellow robot could free it.

Development

Space development means building up infrastructure including the systems to utilize local resources. Teleoperated robots could set up power systems, harvest and process ice, and set up inflatable habitats, dock equipment into ports, and perhaps even start growing food in the greenhouse.

Dexterous telerobots could remove worn parts designed with quick release mechanisms and replace them with new spares. In this way, small mass spare parts could keep telerobots working thereby producing products (e.g. water or metals) at quantities perhaps 100X the mass of the spare part.

After crew arrival, the relationship between them and robots becomes very interesting. The crew would maintain the telerobots, assemble more of them, and even extract metals from the lunar dirt and process them into more telerobotic parts. A small crew could maintain a very large telerobotic workforce and development would scale very large very quickly. Telerobots harvesting and processing metals could expand the number of their fellow telerobots and hence get onto an exponential curve.

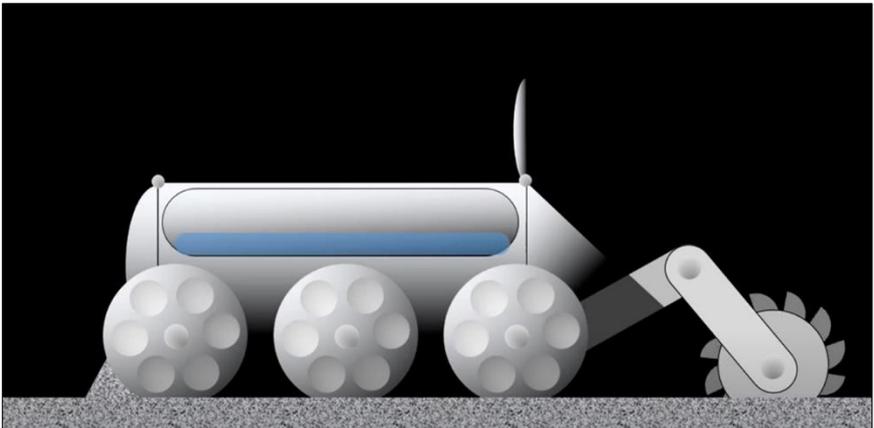
Settlement

Robots cannot do human settlement, but they can be an integral part of keeping the settlement running. There would be a division of duties. Everything that the robots could do the robots would do. Those tasks that humans could do much better than telerobots from a dexterity (not logic) standpoint the humans would do.

SPECIFIC ROBOTS

The Ice Harvester

The key robot to harvest and process the ice will be the Ice Harvester. It could be designed to perform the function of multiple pieces of hardware thereby reducing the amount of equipment mass needed to be transported to the Moon. Depending upon the vertical distribution of the lunar polar ice, this robot could use a bucket wheel excavator to scoop up the icy dirt into its body. After closing a lid, the telerobot would tumble the icy dirt and heat it thereby causing the volatiles to steam out and into a container on its body. After drying the dirt, it would open a lid and "poop" out the dry dirt, move a few meters forward and repeat the process. The Ice Harvesters would probably be operated autonomously but with oversight by people on Earth doing shifts so that they could work 24/7.

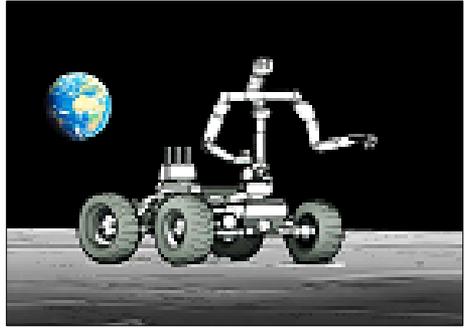


The Ice Harvester combines several functions into a single vehicle.

After its volatile tanks are full, it could back up to and connect to a power station receiving beamed power from solar drapes at which time the volatiles could be reheated and the water and organics separated through the process of distillation. The water would be transported to a PEL where it would be electrolyzed into propellant. The frozen organics would be transported to the International Base where the chemists would convert them into useable products.

Dexterous Telerobots

It is inevitable that the robotic parts will wear out with time. What to do? Here's where the dexterous telerobot (DexBot) comes in. Somewhat humanoid, the dexterous telerobots would have a head with eyes, arms and hands, and could move around not on legs and feet but on a rover body. Its uses



The DexBot.

would include: setting hardware in place after a habitat is inflated, connecting power cables, swapping out spare parts on other robots and vehicles, and preparing the habitat prior to crew arrival.

How can the Ice Harvester be kept going when breakdowns are inevitable? Initially, the DexBot would not do actual repairs to the Ice Harvesters and other robots but rather only swap out spare parts. Parts should be so designed so as to be easily swapped out using quick release mechanisms. An example of this is the modern bicycle tire that requires no tools. With a simple tug of a lever and spinning it around, the wheel can be disconnected from the forks.

Robotic Crew

Robots can also be part of the Initial Permanent Crew. Indeed, a humanoid robot (e.g. Tesla's Optimus) could be the tenth member of the team (after the dog). It could have a name, voice, personality, and be continuously upgraded to perform more and more useful tasks. It could be a high-profile demonstrator of what a domestic and working android robot could do. As a major product placement, it could generate revenue for the mission.



Robots will likely outnumber humans

Specialty robots could also be present such as robots helping in the agricultural and kitchen sections of the Initial Permanent Base. Operating 24/7, much of the day-to-day work could be offloaded to these robots. Being specialty robots, they could have

swappable appendages optimized to harvesting, processing, and cleaning.

Perhaps a robotic pet could be present as well. But I haven't yet seen one that's realistic.

There could also be a CameraBot for the Moonday night TV show. It could provide a third-person perspective of the crew whether indoors or outdoors.

WorkerBots

Eventually, when it makes economic sense, robots will begin constructing habitats using local resources. Likely by that time, robotic development on Earth will be advanced enough such that training the lunar WorkerBots in the tasks needed to construct habitats will be figured out.