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Artificial Intelligence and Internet of Things in satellite systems; challenges and opportunities

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9 May 2024

Introduction

Artificial intelligence (AI) and robotics are helping humans solve problems faster. AI was a welcome upgrade from traditional computing, which didn't offer data backups and recovery options.

Advances in AI made it useful for a wide range of scientific fields. From packaging robots to machine learning, AI is helping humans make progress in several disciplines.

But, the benefits of using AI are not limited to applications on this planet. Below are some examples of how AI is advancing current space efforts.

Several applications are possible through the Satellite Internet of Things networks. SIoT provides larger coverage, better availability than cellular networks, and better interconnection between IoTs and the Internet.

Supports Mission Design and Planning

AI is making it easier for mission design engineers to plan missions outside the planet.

New space missions rely on knowledge gathered by previous studies. But, limited data can make it challenging for current scientists to plan missions.

AI can resolve this by providing anyone with authority access to all space missions. With AI, mission design engineers can access these relevant data with only a few clicks.

One example of this solution is Daphne. Daphne is an intelligent assistant for creating Earth observation satellite systems.

Systems engineers in satellite design teams use Daphne to receive access to data. This data includes feedback and answers to specific mission-related questions.

Aids in Satellites and Spacecraft Manufacturing

Engineers create complex satellites and spacecraft using expensive pieces of equipment.

This process involves repetitive and complex tasks that need precision. Often, engineers need special rooms to manufacture satellites and spacecraft. This is to avoid potential contamination.

This is where AI-enabled systems and robotics come in. Scientists use AI and robots to lighten their burdens. This way, humans can focus on the tasks that computers can't do.

AI can help speed up the process of assembling satellites.

AI-enabled systems can also analyze the process to identify areas of improvemen

Cobots, or collaborative robots, also help in satellite and spacecraft development. Cobots interact with humans, within a mutual workspace.

They help reduce the need for human workers in clean rooms.
They perform reliable manufacturing tasks and help reduce human error.

Helps Process Satellite Data

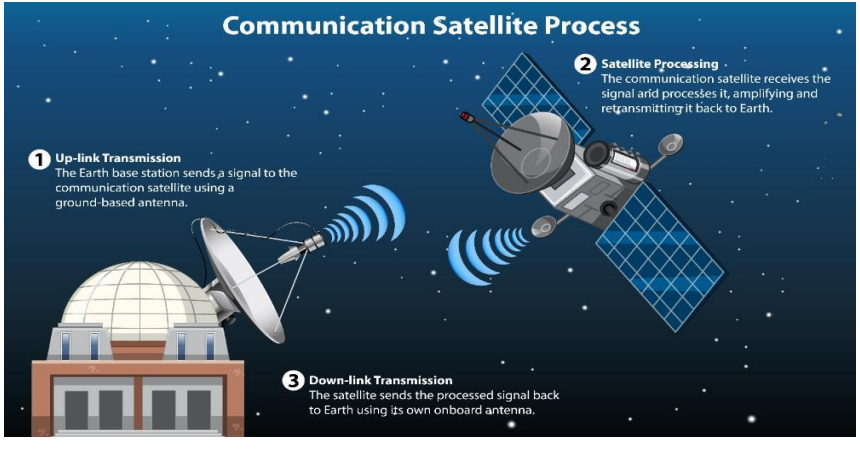
Earth observation satellites provide tremendous amounts of data. Ground stations receive this data in chunks over time.

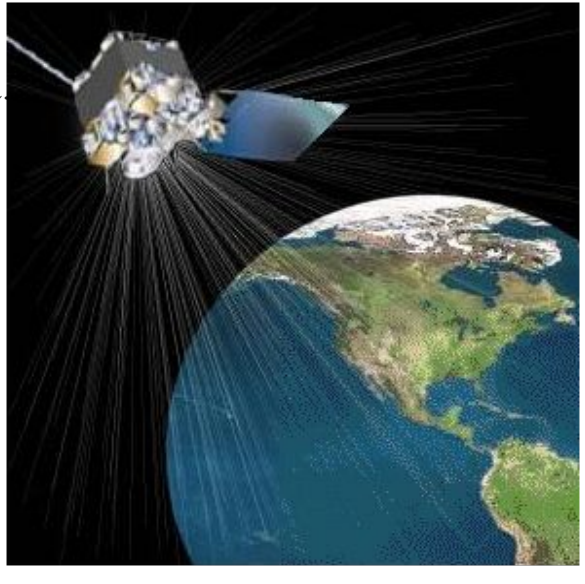
Artificial intelligence can support this effort by providing detailed satellite data analysis.

AI is an effective tool for big data analysis.

Scientists use AI to estimate heat storage in certain areas. It can estimate wind speed by combining meteorological data with satellite imagery.

It can also estimate solar radiation through geostationary satellite data.





Assists Navigation Systems

On Earth, people use Google Maps, which relies on GPS or other navigation systems.

In contrast, there are still no navigation systems in space.
But, scientists can use images from observation satellites.

One of these satellites is the Lunar Reconnaissance Orbiter (LRO). The LRO is a recon satellite that provides data to support future lunar missions.

In 2018, NASA and Intel used LRO data to create an intelligent navigation system. The system used AI to generate a map of the moon.

Monitors Satellite Health

Operating satellites involves complex processes. Equipment malfunctions and satellite collisions can happen anytime.

To resolve this, satellite operators use AI to track satellite health. AI-enabled systems can check on sensors and equipment. They can also alert scientists when something needs their attention.

In some cases, AI-enabled systems can even perform corrective action.

Scientists use AI to control the navigation of satellites and other space assets.
AI uses previous data to recognize satellite patterns. After this, AI systems can change the path of the craft to prevent collisions.

AI can also support communication between Earth and space.

AI can help control satellite communication to address potential transmission problems.

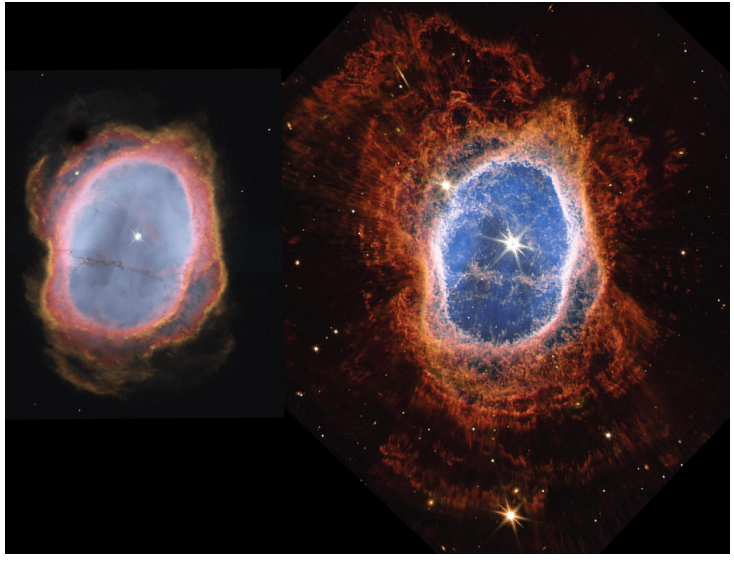
Enhances Satellite Imagery

Satellites produce several images every minute. They process huge amounts of data each day.

These data include weather and environmental imagery. These satellites also capture images of the Earth, which comes with several challenges.

AI helps interpret, analyze, and understand satellite images. With AI, humans have the ability to review the millions of images produced by space assets.

AI can analyze satellite images as they are being taken. It can even identify issues with the images if there are any.



Another advantage of using AI is that, unlike humans, AI does not need breaks. This means that AI can process more data faster.

Using AI for this purpose also removes the need for large amounts of communication to and from Earth. This can reduce processing power and battery usage while streamlining image gathering.


IOT &
Satellite

Applications of Satellite Based IoT Systems - SIoT

Several applications are possible through the SIoT networks. SIoT provides larger coverage, better availability than cellular networks, and better interconnection between IoTs and the Internet.

Mission-critical applications are more reliable through the SIoT networks due to their better availability than cellular networks, like some typical applications of SIoT networks.

1- *Mission Critical Applications*
During natural disasters such as floods, cyclones, hurricanes, landslides, earthquakes, and tsunamis the cellular infrastructures suffer major damage. It has been observed that these networks go out of operation for a long time.

2- Location Dependent Services
Accurate location details are needed in several applications such as military strikes, enemy object tracking, and precision measurements. Therefore a GPS using satellites and IoTs is better than the other alternatives.

3- *Surface and Air Navigation Systems*
Modern navigation systems are very advanced. They need the exact motion and position-related information. Due to its critical nature, these systems need real-time information about their operations. This real-time information can be provided through the mission-critical applications of SIoT.

4- *Smart Agriculture*

In order to utilize the resources smartly IoTs can be utilized. Precision farming uses just the exact amount of resources and provides optimized harvest. So, it is called smart agriculture. Information for smart agriculture can be gathered through the sensors of SIoT networks. Through the SIoT sensors the farmers can monitor the water level, temperature, fertilizer concentration, humidity and several other parameters.

5- Location Tracking

Location tracking is a fundamental requirement in several applications. Some of the instances are: police track the criminals for nabbing, kids are tracked by the parents, in logistics consignments are tracked by both the senders and recipients, flights are tracked by the air traffic control, animals are tracked by their owners, pets are tracked for their safety and so on.

6- Smart Healthcare

Healthcare has several aspects such as hospitalization, surgery, prehospitalization care, nursing, telemedicine, and remote health monitoring. All these aspects can be supported by SIoT services.

Mission Critical Applications of Satellite - Based IoT Systems

1- Transportation,

2- Remote healthcare,

3- Public safety,

4- Entail management,

5- Home and industrial automation,

6- Wildlife tracking,

7- Naval fleet management,

8- Transparent logistics

and many more.

Conclusion

1- AI is advancing space exploration efforts.

2- AI doesn’t only improve the quality of life on Earth. It can also make space exploration possible.

3- AI have various benefits in space to enable the safe venture into the unknown.

4- IoT enables a large number of services and applications which have revolutionized the way we interact with our surroundings.

5- IoT have ability to remotely monitor and manage objects is leading to advancement in several Applications.

Thanks for Listening