EXO-PLANETS DISCOVERY USING ARTIFICIAL INTELLIGENCE

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ABSTRACT

The discovery of exoplanets—planets orbiting stars outside our solar system—has significantly advanced our understanding of the universe. Traditional methods of detecting exoplanets, such as the transit and radial velocity techniques, generate massive amounts of data that are challenging to analyze manually. In recent years, artificial intelligence (AI), particularly machine learning algorithms, has emerged as a powerful tool to process this data efficiently and accurately. AI models can be trained to identify subtle patterns in light curves and distinguish genuine planetary signals from noise or false positives. This approach accelerates the discovery process, enhances the accuracy of detections, and enables the identification of smaller, Earth-like planets that may have otherwise gone unnoticed. The integration of AI in exoplanet research represents a transformative step in astronomy, offering a scalable and intelligent method to explore the vast datasets produced by modern space telescopes like Kepler and TESS.

Key Words: Exoplanets, Artificial Intelligence (AI) , Machine Learning (ML), Deep Learning, Transit Method, Kepler Space Telescope, TESS (Transiting Exoplanet Survey Satellite), Light Curve Analysis, Neural Networks, Data Classification, Planet Detection.

1.INTRODUCTION

Have you ever wondered if there are other planets like Earth in space? Scientists are trying to answer that question by searching for exoplanets—planets that orbit stars outside our solar system. Over the years, telescopes like Kepler and TESS have collected huge amounts of data by watching stars and looking for tiny changes in their brightness. These changes can happen when a planet passes in front of a star, blocking some of its light.

But here's the problem: the amount of data is so large that it's very hard for humans to look through it all. Also, not every change in light is caused by a planet—it could be a star acting strangely or just random noise in the data.

That's where Artificial Intelligence (AI) comes in. AI is a type of computer program that can learn from examples. Scientists train AI to recognize patterns in the data and figure out which ones are likely to be real planets. This makes the search much faster and more accurate.

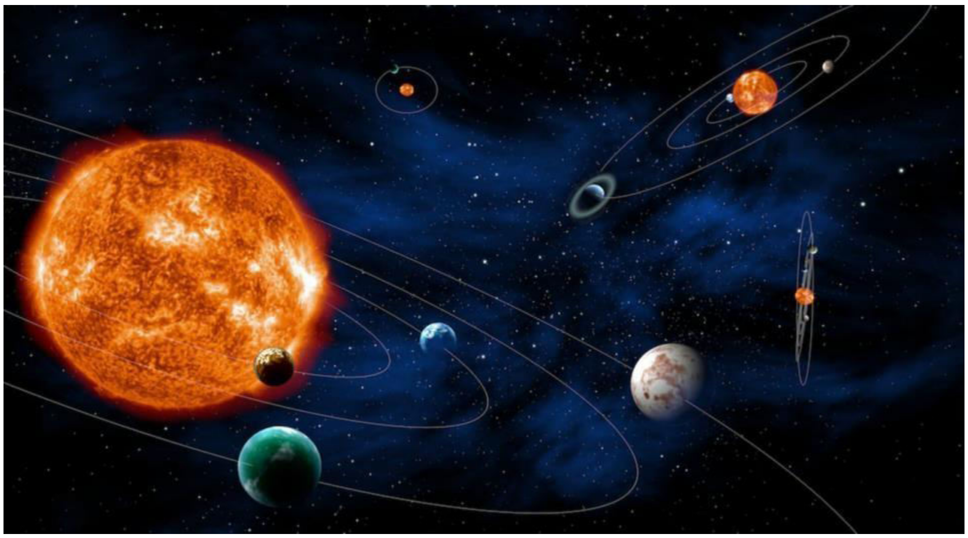

Fig. 1: Solar Planet

2.LITERATURE REVIEW

Understanding Exoplanets

Exoplanets are planets that orbit stars outside our solar system. Scientists are eager to study these celestial bodies to determine if they can support life. Recent research has made significant progress in detecting and classifying exoplanets using machine learning and computational models.

Key Studies:

Assessing Exoplanet Habitability through Data-driven Approaches

This comprehensive literature review analyses 15 seminal papers in the field, highlighting the role of machine learning in exoplanet detection and classification. The study emphasizes the importance of diverse datasets, such as Kepler and TESS, in improving accuracy.

Predicting Habitable Exoplanets using Deep Learning

Researchers have developed a deep learning-based anomaly detection approach to identify potentially habitable exoplanets. This method uses convolutional neural networks (CNNs) to analyze data and predict habitability.

Exoplanet Detection using Machine Learning : Studies have shown that machine learning techniques, such as Support Vector Machines (SVMs) and Deep Learning models, can effectively detect exoplanets and classify them as potentially habitable.

Detection Method

1.Transit Method :

This technique involves measuring the decrease in starlight as a planet passes in front of its star. The transit method is widely used to detect exoplanets and determine their size and orbit.

3.METHODOLOGY

Step 1: Collect the Data

Data comes from space telescopes: it's mostly brightness graphs (called light curves) of stars over time.

A drop in brightness may mean a planet passed by.

Step 2: Train the AI

Scientists feed the AI thousands of examples:

Light curves with real exoplanets.

Light curves without planets (just noise or other stuff). The AI

learns to recognize patterns that look like planets.

This is called machine learning—where AI "learns" from examples.

Step 3: Test the AI

The trained AI is given new, unseen data.

If it correctly spots where the planet is hiding in the light curve, it passes the test.

Step 4: AI Spots New Planets

The AI scans through tons of new data quickly.

It highlights signals that look like they came from a planet.

Step 5: Human Check

Scientists double-check the AI's discoveries to make sure they're real.

Sometimes, what looks like a planet could actually be a star flicker or a cosmic glitch.

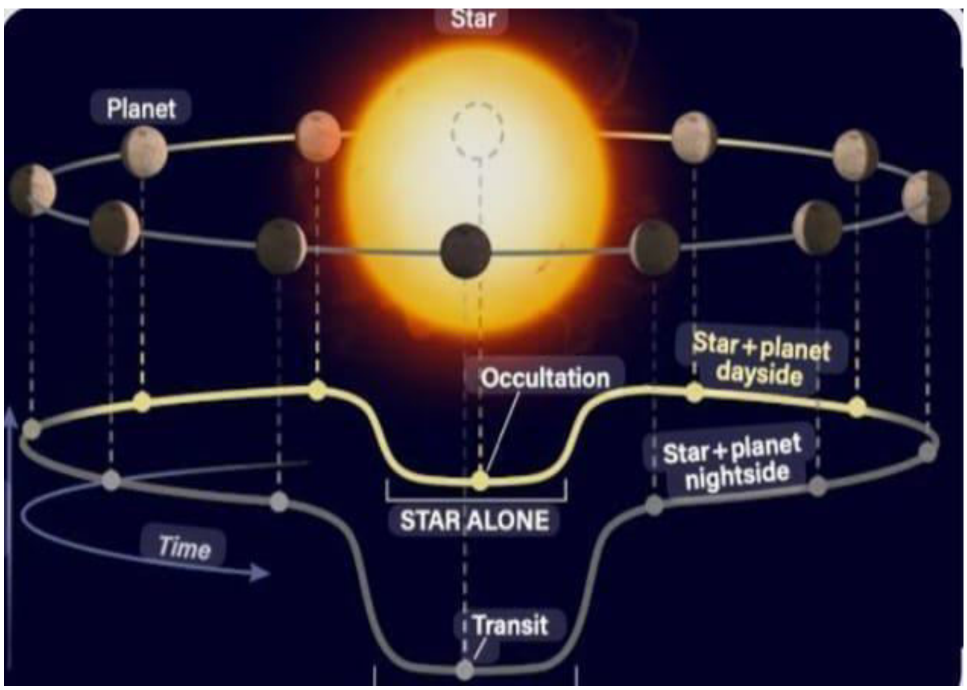

Fig. 2: Solar Cosmic Glitch

4.RESULTS AND DISCUSSION

The application of Artificial Intelligence (AI) in exoplanet discovery has significantly improved the speed, accuracy, and scale of planetary detection beyond our solar system. Using machine learning (ML) algorithms, particularly deep learning models like convolutional neural networks (CNNs), researchers have successfully identified numerous previously overlooked exoplanet candidates from datasets provided by missions such as Kepler and TESS.

Results:

Several studies have demonstrated the effectiveness of AI in detecting exoplanets with a high level of precision. For instance, NASA's team used a neural network to analyze Kepler light curves, resulting in the discovery of exoplanets like Kepler-90i and Kepler-80g.

AI models have shown an ability to reduce false positives by learning complex patterns of planetary transits and distinguishing them from noise or stellar variability.

Automated AI systems can analyze vast amounts of data faster than traditional methods, leading to the identification of over 50 new exoplanet candidates in some studies within a short timeframe.

Discussion:

The integration of AI into exoplanet research addresses several key challenges:

Efficiency: Traditional methods required manual vetting, which was time-consuming and subjective. AI enables large-scale automated analysis, significantly reducing human error.

Accuracy and Reliability: Deep learning models, once trained, can consistently apply detection criteria across all data, enhancing detection reliability.

Generalization: AI models trained on Kepler data are now being adapted to work with data from other telescopes like TESS, demonstrating transfer learning capabilities.

Challenges: Despite promising results, AI methods face challenges such as data imbalance, the need for labeled datasets, and the risk of overfitting. Moreover, the "black box" nature of some models raises concerns about interpretability and validation.

5.CONCLUSION

AI Revolutionizes Exoplanet Discovery:

Artificial intelligence (AI) has transformed the field of exoplanet research, enabling scientists to analyze vast amounts of data, identify patterns, and make predictions. By leveraging machine learning algorithms and deep learning techniques, researchers can detect exoplanets, determine their habitability, and even predict potential biosignatures.

Accelerating Discovery and Exploration

AI's impact on exoplanet research has been profound, allowing scientists to:

- Analyze large datasets from space missions like Kepler and TESS
- Identify promising candidates for further study

- Predict the likelihood of habitability based on planetary characteristics A

New Era of Space Exploration:

As AI continues to advance, it will play an increasingly important role in shaping our understanding of the universe. By harnessing the power of AI, scientists can accelerate the discovery of exoplanets, potentially leading to ground breaking findings that shed light on the mysteries of the cosmos.

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