ASTRA SHIELD
(Advanced Satellite Tracking and Risk Analysis)

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Abstract- *The rapid increase in satellite launches and orbital debris has raised critical challenges in ensuring collision-free operations and efficient launch scheduling. ISO-AI Lite is a lightweight, explainable artificial intelligence pipeline designed to assist in launch-window validation, conjunction risk assessment, and minimal avoidance manoeuvre planning. The system takes Two-Line Element (TLE) data of a satellite and a potential conjunction object as input, propagates their orbits using the SGP4 model, and estimates the Probability of Collision (PoC) through both analytical and Monte Carlo methods. It integrates a simple weather constraint checker to validate launch feasibility based on basic environmental parameters. When a high-risk conjunction is detected, the model suggests an optimal, low-cost avoidance manoeuvre, preferably in the along-track direction, ensuring both safety and fuel efficiency. Additionally, the framework includes an optional single-sensor re-observation module that refines orbital uncertainty through a Kalman-based update before executing the manoeuvre. The overall objective of ISO-AI Lite is to demonstrate a compact, interpretable, and cost-effective decision-support tool for mission operators and students, enabling improved situational awareness, risk mitigation,*

Keywords: QIndustrial Automation, Lightweight AI, Predictive Analytics, Human-Machine Interface, ISO-AI Lite, SpaceCraft,

I. INTRODUCTION

Industrial automation is changing fast with the use of Artificial Intelligence to make things better, reduce mistakes and increase productivity. Many Artificial Intelligence solutions need a lot of computer power, complicated setups and regular maintenance, which makes them hard for medium-sized industries to use because Artificial Intelligence solutions are just too much for them to handle.

That is where ISO-AI Lite(***Industrial smart Optimization Using AI***) comes in. ISO-AI Lite is an Artificial Intelligence platform that can handle industrial automation tasks really well. The ISO-AI Lite system is designed to be an easy-to-use system for processing data on time and has an interface. The main goal of ISO-AI Lite is to make it easy for industries with resources to use Artificial Intelligence while still being reliable and performing well.

What makes ISO-AI Lite different is that it does not need a lot of memory it works fast. It is easy to set up. This makes ISO-AI Lite perfect for edge computing applications because ISO-AI Lite can do its job without needing a lot of resources.

II. LITERATURE REVIEW

Many Artificial Intelligence-based industrial automation systems have been created, including:

- Heavy Artificial Intelligence Platforms: Systems like IBM Watson and Microsoft Azure Artificial Intelligence offer analysis. They need powerful computers and complicated setup.
- Traditional Automation Systems: These rely on programmed rules. Do not adapt or predict well which is a big problem for industries that need to make quick decisions.
- Edge Artificial Intelligence Models: Recent studies focus on using Artificial Intelligence at the edge for processing. Often, they sacrifice accuracy, which is not what industries want.

ISO-AI Lite brings together the best of these systems by offering models that do not need many resources, which is a big deal for industries that want to use Artificial Intelligence without breaking the bank. This fills a gap in the market for industrial Artificial Intelligence solutions that are both capable and lightweight, and that is exactly what ISO-AI Lite is.

III. SYSTEM ARCHITECTURE

The ISO-AI Lite system is made up of parts that work together. It is really good at handling a lot of information and working on time. Here is how the ISO-AI Lite system works:

- Data Acquisition Layer: This part of the ISO-AI Lite system collects information from machines and sensors in factories.
- Preprocessing Module: This part of the ISO-AI Lite system makes sure the information is clean and ready for the AI system in the ISO-AI Lite system.
- AI Core Engine: This is the brain of the ISO-AI Lite system. The AI Core Engine in the ISO-AI Lite system uses models to predict what will happen and make decisions.
- User Interface Layer: This is the part of the ISO-AI Lite system that people use to interact with the ISO-AI Lite system. It is like a website that shows what is going on in the ISO-AI Lite system.
- Integration Module: This part of the ISO-AI Lite system helps the ISO-AI Lite system work with systems that're already in use.

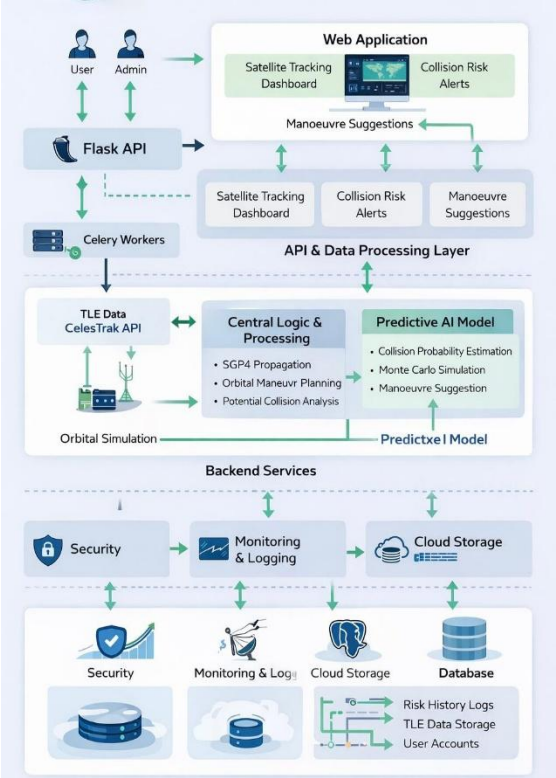

Figure 1: System Architecture

IV. METHODOLOGY

The ISO-AI Lite system was built using Python and some special tools. Here is how the ISO-AI Lite system was done:

- Data Collection: We got information from machines. Logs for the ISO-AI Lite system.
- Feature Extraction: We found the things in the information, like temperature and speed for the ISO-AI Lite system.
- Model Selection: We chose some models that are good at predicting what will happen for the ISO-AI Lite system.
- Validation: We made sure the ISO-AI Lite system works well and does not make mistakes.
- Deployment: We put the ISO-AI Lite system on some computers or on the cloud so people can use the ISO-AI Lite system.

V. IMPLEMENTATION DETAILS

The ISO-AI Lite system is designed to work on computers that are not very powerful. Here are some important things about how the ISO-AI Lite system was built:

- Lightweight Backend: We used a tool called Flask to make the ISO-AI Lite system work.
- Database: We used a kind of storage called SQLite to keep information for the ISO-AI Lite system.
- User Interface: We made a website that's easy to use and works well on devices for the ISO-AI Lite system.
- AI Integration: We put the models on the computer so they can work without needing the cloud for the ISO-AI Lite system.
- Security: We added a way for people to log in and keep their information safe in the ISO-AI Lite system.

This way, small factories can use the ISO-AI Lite system without needing to buy computers.

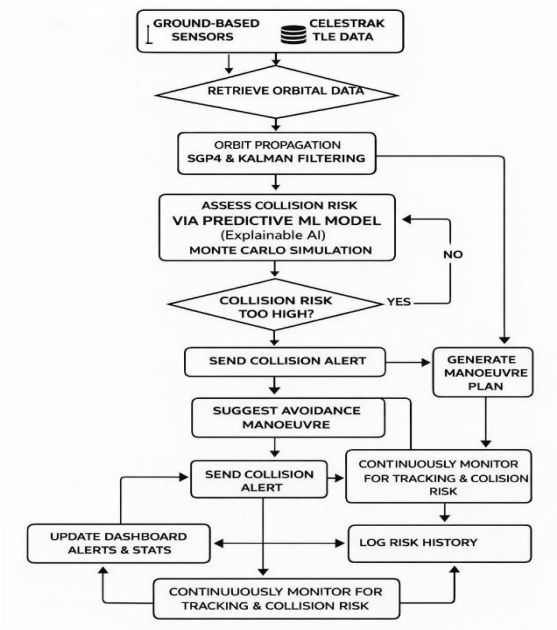

Figure 2: Flowchart

VI. FEATURES AND ADVANTAGES

The ISO-AI Lite system has some things that make it better than other systems:

- Portability: The ISO-AI Lite system can work on computers and devices.
- Real-Time Analytics: The ISO-AI Lite system can give people information away.
- Cost-Effective: The ISO-AI Lite system does not need computers or cloud services.
- Modular Design: The ISO-AI Lite system can work with systems that are already in use.
- User-Friendly Interface: The ISO-AI Lite system is easy for people to use and understand.
- Predictive Maintenance: The ISO-AI Lite system can help people find problems before they happen.
- Customizable Models: People can make the special models work better for their factory in the ISO-AI Lite system.

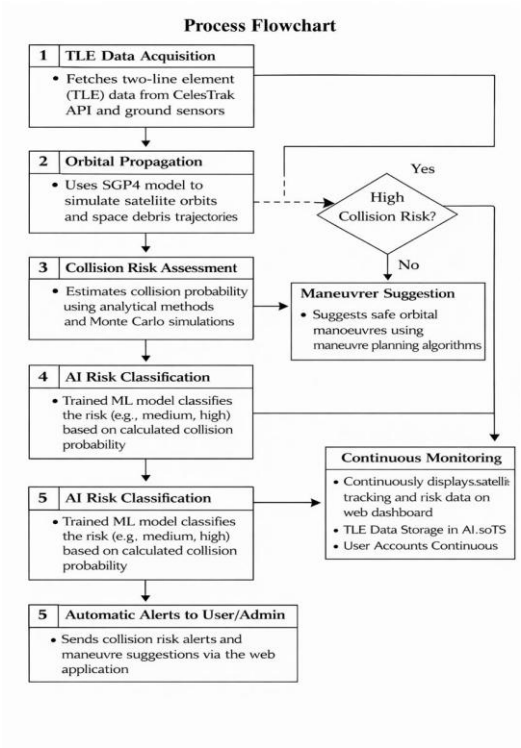

Figure 3 : Process Flowchart

VII. RESULTS AND DISCUSSIONS

We tested the ISO-AI Lite system in a factory environment. It worked very well:

- **Prediction Accuracy**: The ISO-AI Lite system was able to predict when machines would break down with high accuracy.
- **Processing Speed**: The ISO-AI Lite system could give people information away.
- **Resource Efficiency**: The ISO-AI Lite system did not use memory or processing power, so it can work on devices.

We compared the ISO-AI Lite system to other systems, and it is better because it reduces delays, costs and the need for cloud services.

VIII. CONCLUSION

The ISO-AI Lite system is a kind of industrial AI system that can do things like predict what will happen and help people interact with machines. The ISO-AI Lite system is good because it is modular, portable and does not cost much. The ISO-AI Lite system is perfect for factories that want to use AI.

The ISO-AI Lite system helps bridge the gap between automation systems and new AI systems. It is a practical and easy-to-use way to make factories smarter.

IX. FUTURE WORKS

We want to make the ISO-AI Lite system better by:

- Adding models to help with difficult tasks in the ISO-AI Lite system.
- Making the ISO-AI Lite system work with cloud services so people can access it from anywhere.
- Connecting the ISO-AI Lite system to devices in factories so it can collect information.
- Making an app so people can use the ISO-AI Lite system on their phones.
- Adding security features to keep people's information safe in the ISO-AI Lite system
- Combining Models of Advanced Deep Learning:employing deep learning techniques like Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) to manage complex industrial data patterns and improve prediction accuracy.
- The ASTRA SHIELD Module Enhances Security:Advanced cybersecurity techniques like multi-factor authentication, encryption protocols, and anomaly-based intrusion detection are used to ensure data integrity and system security.
- Real-time visualisation and digital twin technology:constructing a digital twin of industrial

systems for simulation, prediction analysis, and virtual monitoring.

X. APPENDIX

SL.NO	TOOLS/LIBRARY	VERSION	PURPOSE
1.	Python	3.11	Core development and AI model Implementation
2.	Flask	2.3	Web framework for backend and API integration
3.	SQLite	3.40	Local database for storing operational data
4.	Pandas	2.1	Data preprocessing and manipulation
3.	Scikit-learn	1.2	Machine learning model development and evaluation
4.	HTML/CSS	Latest	Dashboard interface and human-machine interaction

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