Frontiers in Computing and Intelligent Systems
ISSN: 2832-6024 | Vol. 16, No. 2, 2026

Sky Ranger: Industrial-Grade AI Drone Inspection Platform

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Abstract: Equipment inspection for power, petrochemicals and new energy is not just an operation; it is the lifeblood of industrial safety. But let's be honest, manual inspection is a bother. They are slow, risky, time-consuming and money-consuming. That is why we built Sky Ranger. With the help of artificial intelligence and the Internet of Things, a new kind of high-precision inspection technology that can cover all areas above, below and around structures has now been developed. The three main uses of SLAM 3D navigation are AI models that integrate all kinds of data and the NVIDIA Jetson edge device. It will find a fault in the field 98 per cent of the time. It is 8 times faster than a crew of people and saves 60% in costs. To be honest, the ROI is good. It will help the company go digital and will also be in line with China's "dual-carbon" goals.

Keywords: Inspection Platform; SLAM 3D Navigation; NVIDIA Jetson Edge Hardware.

1. Introduction

The Lifeblood of Power: Petrochemicals and New Energy. But doing it by hand is a mess. It will take more than four hours for someone to visit a typical 35kV substation. It is not even a bother. The accident rate of petrochemical sites in a given year due to falls and other causes is about 1.2%. Do not neglect it. The annual cost of the inspection department in the power industry is about 20 billion yuan. One highly skilled inspector is about 350,000 yuan per year. [1]

Now, the low-altitude economy is beginning to develop. All parts of the country have developed industries of intelligent manufacturing and related policies. By 2025, the amount of investment in the low-altitude economy under MIIT will reach 50 billion yuan. Demand for drone inspection in the power and petrochemical industries is increasing by 35% each year, and the "5G + Industrial Internet" pilot project can receive as much as 3 million yuan in subsidies. Drones will be the future. The problem is that the off-the-shelf drones do not meet the specific requirements of the industry. Their sensors miss some information, they cannot construct a 3D model of the site, they are too expensive, and they do not have actual services. Although there has been some good research at home, we still need to build a high-performance, personalised AI platform for these industries. [2]

2. Research Significance

2.1. Theoretical Significance

We are building the first practical technical system for industrial drones based on SLAM, multimodal data fusion and edge computing. It's not just about flying; it is the entire system of drones, sensors, AI and edge computing. It provides the foundation for the study of industry. We are also designing custom hardware and algorithms according to the special requirements of Power, Petrochemical and New Energy. This is to solve the problem of expensive inspection equipment for small and medium-sized enterprises.

2.2. Practical Significance

Sky Ranger has been developed to address the problems of high cost, low speed and danger in the old inspection method. It is about 8 times faster than a person. It will take care of all the corners in a big project. A substation job that used to take half a day now takes a short time. It's an expenditure issue. You have cut the investment by 60%. Rentals are only 500 yuan per day; even a small company can afford smart inspection. Safety is the main victory. You take people out of danger and make the risk almost zero. It meets the safety requirements of the country. And there will be fewer patrol cars, thus reducing carbon emissions. It is a way for the company to go green and achieve the "dual-carbon" goals. [3]

3. Core Technologies and Service Design

3.1. Development of the Core Technology

Our three goals are to deal with the serious circumstances, find the causes of these problems, and promptly analyse the data. Therefore, we have constructed the three independent technology modules. We have constructed a 3D Trajectory Algorithm based on SLAM. It can show the range of a factory in a few centimetres. Add AI obstacle avoidance and path planning to be able to change altitude smoothly in the range of 5-200 meters and fly in all directions from 0 to 360 degrees. It is 30% lower in cost than the old fixed-route drones.

Many places have been added to our AI model. After being trained on more than 100,000 defect images, it can now recognise more than 50 types of industrial flaws with 98% accuracy. It is 40% better than the single-sensor method. We also have an NVIDIA Jetson for Edge Computing, which is the Xavier NX. It can be dealt with at that time. Analysis Time has dropped from 5-10 seconds to only 50 milliseconds. It will promptly issue a danger warning and accelerate the emergency response.

3.2. Product and Service Design

"Sky Ranger" is a complete package that includes hardware,

software and services for power, petrochemicals, new energy, etc. It is an industrial drone that can operate in Level-6 wind conditions for 45 minutes and has sensors; the cost is about 50,000-80,000 yuan. You can also rent it for 500 yuan a day. We develop the main technology ourselves and outsource the generic parts to maintain a good gross margin of 65%.

The three levels of our data service are Basic Detection, Premium Subscription and Custom R&D. Pay only for what you need. We can also provide some personalised technical support, offer 24-hour rapid response service, and free of charge provide software upgrades. It is a good place for all-weather smart inspections.

4. Market Analysis and Profit Model

4.1. Market Analysis

The Market for Industrial Drone Inspection is being developed. Both the policies and the demand are rising. The government is giving out actual cash to support the development of the low-altitude economy and smart industry. The size of the world's market in 2024 will be about 261.9 billion yuan. China was about 70 per cent. By 2025, the amount of China's drone inspection market will exceed 50 billion yuan. The growth rate of Power, Petrochemicals and New Energy is all more than 35% per year. It will be very popular. [4]

The big players have the entire market, but are weak in specialised sectors. Their things are either lacking, too expensive, or do not offer personalised services. "Sky Ranger" is about to fill this gap. The proportion of the problems we can solve technically is 98 per cent. We have relatively low-cost hardware, and rentals are even cheaper. Add our own services, and we will be very busy. We will focus on SMEs in the power, petrochemical and new energy industries, but we will also accept custom orders from large enterprises. Prices are different in different areas; to find the reason for a fault in a 35kV substation, there will be an annual cost of 150,000 yuan, and for every 100 metres of pipeline leakage, a fee of 80,000 yuan will be charged; to solve panel problems in a 100-megawatt solar farm with an area of 120,000 square metres, it will cost 120,000 yuan annually, and this equipment must be installed.

4.2. Construction of Profit Model

We need to keep doing business for a long time; "Sky Ranger" will be based on hardware sales, data services and government cooperation. Hardware sales and rentals are our main source of cash flow at present. The margin for our 50k-80k kits is about 65%. We expect more than 30% of the renters to buy. In the future, we will sell large hardware packages to big customers for 500k-800k each. We will have about 6 million yuan in hardware sales at the beginning.

Data analysis is where the actual, steady money comes from. The Margin is still over 80%. Our three tiers of service work together. We are looking at more than 10 million yuan per year from data services. After a client is registered on the platform, they will stay there. Therefore, the company's increase in annual income will be no less than 50%. Government Cooperation will bring some funds too. We have applied for the MIIT and MOST innovation funds. We are expecting many grants. That money will be reinvested in R&D and Marketing. It's a good loop: Policy funds tech, tech makes money, money expands the market.

5. Marketing Strategy and Team Management

5.1. Marketing Strategy

We are promoting "Sky Ranger" by putting forward three things: technology, social responsibility and economic benefits. For the tech part, we will show off our main advantages in a manual, case study and video. We have been to some industry conferences and worked with universities to build partnerships. For social good, we have released a "Carbon Neutrality White Paper" to demonstrate the reduction in emissions. We will run some pilot projects with the local government to support our safety guarantees. To create business value, we will work with the channel to promote our brand.

Our business model is a "triple jump"; first of all, we have cheap rentals and free trials. Gathering the Data. Second, we will apply for the government's reduction in expenses. Third, we have hardware sales and subscriptions. Finally, we will design some special plans for the overseas market and power infrastructure construction abroad.

5.2. Team Management

The "Sky Ranger" team is a group of students from the Software Engineering class at Suihua University. Instructor Zhou Shiying leads us. Yang Yaqiong takes the lead. Zhao Haoyu, Liu Yuhan, Wang Xiyue and Meng Xiangxue are well-known people who have a long history in the industry. Since we are students, we have a special arrangement for dealing with school and the project. We divided into three groups: Technology, Marketing and Operations. Everyone knows their job. We have been using online meetings and tools such as Feishu and Tencent Docs so that we do not step on each other's toes. We will all rush together to complete the work before the big deadline.

We have a short time for R&D sprints and focused offline meetings. We are evaluated on both our study results and the progress of the project monthly. Good work is praised, bad behaviour is punished. It keeps everyone fed and going.

6. Development Prospects and Applications

6.1. The Unavoidable Trend of Intelligent Inspection.

Manual inspection cannot keep up with the speed of industrialisation. Companies want to solve the problems in advance, not after they have happened. Drones are a good choice; they are fast, safe and cheap. The "dual-carbon" and safety policies of the country have also changed. With the development of 5G-A, digital twins, BeiDou positioning and wireless charging, drones will be more and more intelligent. We will be conducting all-weather, all-round inspections. It is about to be very popular in the market. [5]

6.2. Technology Maturity and Validation

"Sky Ranger" is not just an idea. It Works. We have carried out tests at the 35kV substation in Nanjing, the petrochemical plant in Jiangsu and the 100MW solar farm in Shandong. Therefore, the defect recognition accuracy is 98 per cent, 38 per cent higher than that of general-purpose drones and about 800 times more effective than the human eye; thus, the inspection time for the substation has been reduced from 4-6

hours to 30 minutes and the cost has dropped by 60 per cent. All of the pilot partners were happy and signed up for more. Our Drones are sturdy and can operate in poor weather. Our own algorithms are very particular. We have added Wireless Charging and Digital Twin. We are about to go public.

6.3. Market Size and Development Plan

We have a good plan. Years 1-2: Concentrate on the East and North of China (Jiangsu, Shandong, Hebei, Beijing). Target SMEs. Obtain 100 customers and achieve 10 million yuan in revenue. Build a strong local party. Years 3-5: Go national. Expand into Steel, Rail and Highways. Build a Sales and Service Network. Reach 100 million yuan in revenue and be a leading company in China. Year 5+: Go global. Set goals for Southeast Asia, the Middle East and Africa. Jointly export the technology and services of enterprises abroad. Raise 1 billion yuan in annual income.

6.4. Future Technological Improvements and Scenarios

"Sky Ranger" will continue to change. In terms of technology, we will add 5G-A and digital twins to the construction of the "Space-Air-Ground" network. We will put up some outside wireless charging stations for the drones. We will strengthen the AI for multi-drone swarms. Scenario-wise, we are moving away from power, petro and new energy. Steel Mills, Mining, Disaster Relief and Forest Fire Prevention. We will directly work with the company's ERP system. In terms of services, we are no longer just performing inspections; we are now constructing all-China "Health Management Systems" that can offer predictive maintenance and build an all-China service centre for repairs and training. We want to be the people who use it.

7. Summarization

Power, petrochemicals and new energy have been stuck with slow, dangerous and expensive manual inspections for too long. We made "Sky Ranger" to address this. It is an industrial-grade AI drone system that can meet the demands of these industries. We did not only add technology. We have built a practical, all-round solution of hardware, software and services. It will be a smart, unmanned and efficient inspection. We have completed the market research, constructed an excellent profit model, and even developed a management system that is suitable for our student team. We have a good plan for growth and technological upgrades; "Sky Ranger" will be concentrated in the industrial vertical. We will fill the gaps in technology, cost and service. There will be actual economic and social benefits to the test. We are helping to promote the industrial digital revolution and the low-altitude economy. We will continue to work hard, improve technology, and expand our base. We aim to be the best in the business and support the "dual-carbon" and low-altitude development goals of the country for all industries along the way.

Acknowledgments

Phased Research Achievements of the Suihua University-Level Project "Sky Ranger: Industrial-Grade AI Drone Inspection Platform (Project No.: shxy202564) under the 2025 Heilongjiang Provincial College Students' Innovation and Entrepreneurship Training Program.

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