Maynooth University
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An IoT-based sensor inspection system.

Business Plan

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1. Executive summary

OpenIOT proposes a smart factory safety inspection system based on the Internet of Things. This system will eventually realize the intelligent factory inspection workflow of "sensor module monitoring - manual online evaluation - instrument problem diagnosis". This proposal will detail the company and its products, the members and shareholders of the company, an analysis of the relevant market and competition, our marketing and sales strategy going forward, and relevant financial projections.

1.1 Company and Product Description

OpenIOT is a 5-member startup (each member owns equal equity) that encompasses the development, manufacturing, marketing, and sales of an IoT-based smart factory safety inspection system. This product implements 24/7 real-time anomaly detection and is able to be customized to fit local conditions. As an important carrier of industrial development, industrial parks bear the important responsibility of ensuring the production safety of employees, but at present, the apparatus and equipment such as pipeline cables and waterway pumps in China's enterprise parks generally lack regular inspection and abnormality checking, and some industrial production sites have harsh environments, making manual inspection operations difficult and safety risks greater. The safety problems of plant inspection cannot be effectively solved, resulting in frequent damage to relevant production phase I equipment, causing huge economic losses and even major safety accidents.

1.2 Market Opportunity

IOT inspection system is the frontier direction of multi-disciplinary integration of automation, robotics and artificial intelligence, which has played a key role in industrial. In recent years, it has played a key role in industrial monitoring, community patrol, military reconnaissance and other fields, and can serve the "14th Five-Year Plan of Intelligent Manufacturing Development" and "artificial intelligence +" and other major national strategies [1-3]. The following is an overview of the development trend of IoT inspection system.

- The development trend of IOT inspection system and its key technologies

Intelligent inspection systems first originated in the 1980s, and the United States and Canada were the first to deploy in the power grid industry Line patrol robots were first deployed in the electric power grid industry in the United States and Canada to enable autonomous line fault detection and troubleshooting [4]. By the early 21st century, based on the booming development of computer technology boom, industrial sites in the United States, Britain, and other developed countries began to deploy pipeline, cable, chemical, and other specific inspection robots

The human system, which can achieve basic functions such as obstacle detection and instrument identification, as well as real-time data communication [5, 6]. In recent, the most popular robots in the industry are the Spot quadruped robot and the Atlas bionic robot designed by Boston Dynamics, Inc. The most popular robots in the industry in recent years are the Spot quadruped robot and the Atlas bionic robot designed by Boston Dynamics, whose intelligence can far exceed the efficiency of manual execution in specific areas such as cargo handling and object inspection, and the level of intelligence is able to significantly improve the efficiency and safety of industrial production processes in specific areas such as cargo handling and object inspection [7].

In the last decade, inspection robots have really come into the public's view in China, and technologies such as machine vision, target detection and online operation have been developed significantly. With the increasing market demand, the application scenarios of inspection robots have become more and more diversified. For example, LIDAR and SLAM mapping technologies are applied to mining intelligent inspection robots, thus achieving autonomous positioning and navigation in sandy, wet, and dark environments and significantly improving the safety of mining operations (2022) [8].

In summary, the application of the IOT safety inspection system greatly guarantees the safety and quality of industrial site inspection, reduces manual labor intensity, and realizes the abnormality detection and automatic inspection operations of high-risk environments such as underground mines, heavy chemical plants, and oil transmission station tank areas instead of manual inspection.

2. Company Description

This section outlines the members of, and advisors to, OpenIOT, along with a description of our company and product, and our long term aims going forward. A SWOT Analysis is also included.

2.1 Promoters and Shareholders

Members	proportion
1.Mr. Jiaacheng Huang,	20%
2.Ms. Binyu Lai	20%
3.Mr. Wutong Lei	20%
4.Mr. Jianhang Zheng	20%
5.Mr. Shutong Yao	20%

2.2 Advisors

Project Facilitator: Dr. Fook Lo,, Maynooth University.

2.3 Products and services

2.4 (1) Hardware build: intelligent IOT module and dynamic inspection module

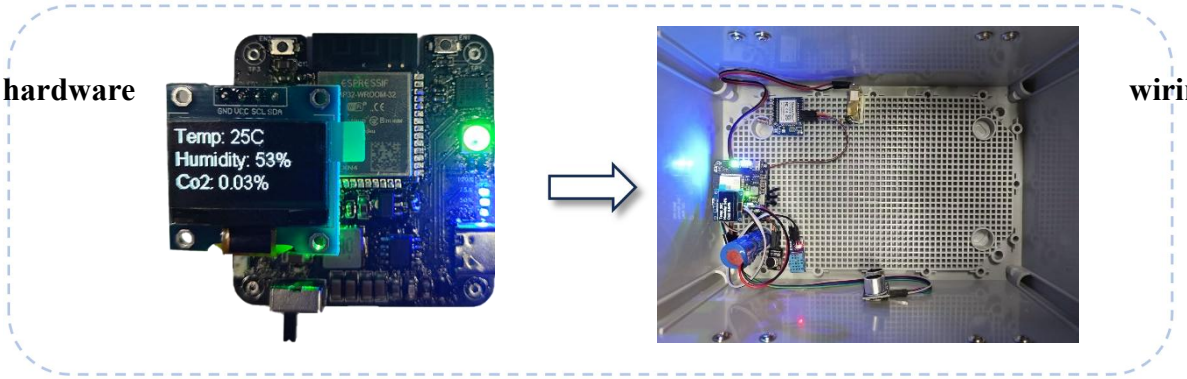


Fig. 1 the hardware wiring specification of the Smart IoT sensor module

The ESP32 system-on-chip (SoC), designed and developed by Espressif, is selected as the main control chip and IoT communication module. It is a low-power and high-performance SoC with an integrated wireless module that supports both Wi-Fi and Bluetooth communication technology.

The ESP32 can perform low-power background tasks, has rich resources and flexible communication

methods. In particular, the ESP32's built-in wireless module supports Wi-Fi, and we use the ESP32 as a sensor for ADC acquisition and iot communication The circuit boards in Figures 2 are designed as a Sensor for ADC acquisition and IOT communication.

The IP5306 sensor power management chip is selected as the power management unit. The power management circuit can be used for charging and battery supply management, including single-cell lithium battery charging, direct current 5V input power supply, and 4-LED power display. Additionally, it can communicate with the microprocessor via the I2C interface, enabling automatic charging, battery power detection, and system maintenance functionalities. The schematic diagram of the charging circuit designed by us is shown in Figure 3.

In order to protect the main control board of the sensor and facilitate installation and maintenance, we designed a customized enclosure based on the size and shape of the sensor. The enclosure is made of durable polymer material, which is lightweight, and corrosion-resistant. Suitable openings are also left for interfacing with the OLED screen and external modules.

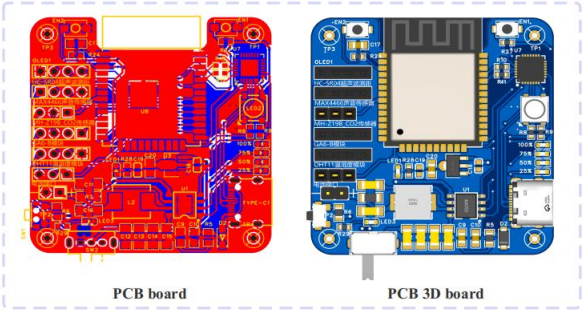


Fig.2 a Sensor for ADC acquisition and IOT communication

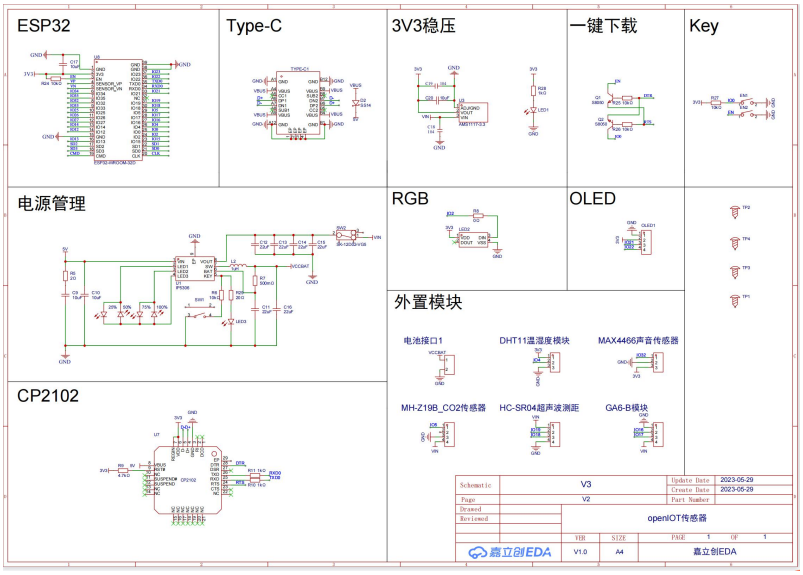


Fig.3 The schematic diagram of the charging circuit

(2) Software Services: High Performance Distributed Service System

In the software part, this system service is based on the distributed architecture of Kitex, an open-source framework, and follows the DevOps development process. to achieve the effect of agile development and improve development efficiency and system security. Specifically, the software service mainly includes the following Seven building blocks: client, business layer, operation support layer, service layer, data layer, database and infrastructure layer.

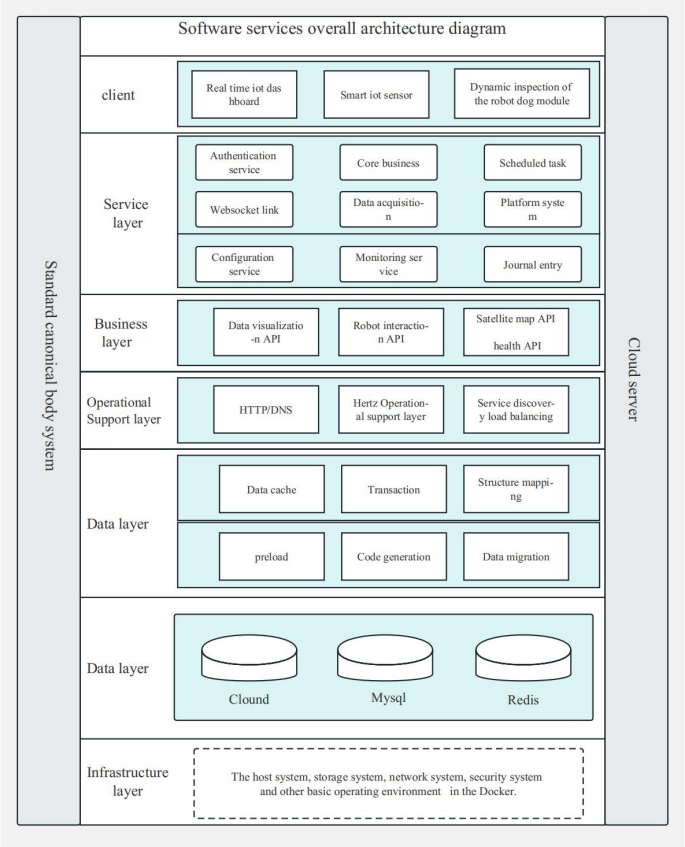
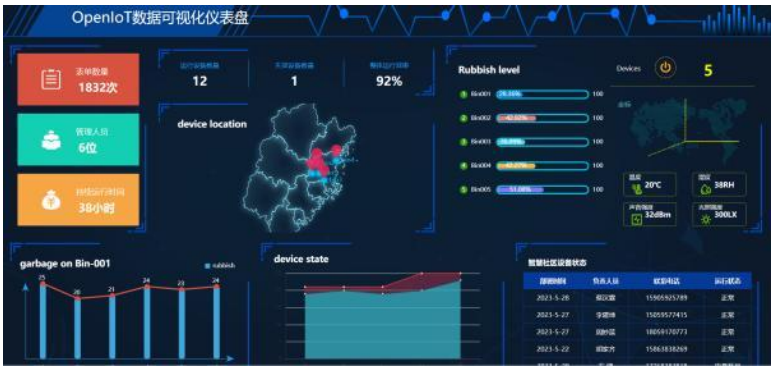


Fig.2 Overall Software Service Architecture Diagram

(3) Interactive systems: real-time data visualization and interactive dashboards

In the interaction part, in order to build a user-friendly system interaction mode, this project defines a graphical dashboard for IoT hardware based on the Echarts framework to provide real-time data visualization results to business users, and present data to relevant staff in a more intuitive way through a series of chart styles in an attempt to create a convenient and efficient user experience, Figure 5 shows the real-time visualization platform of this system and the system interactive dashboard. Details of the specific development features are as follows:



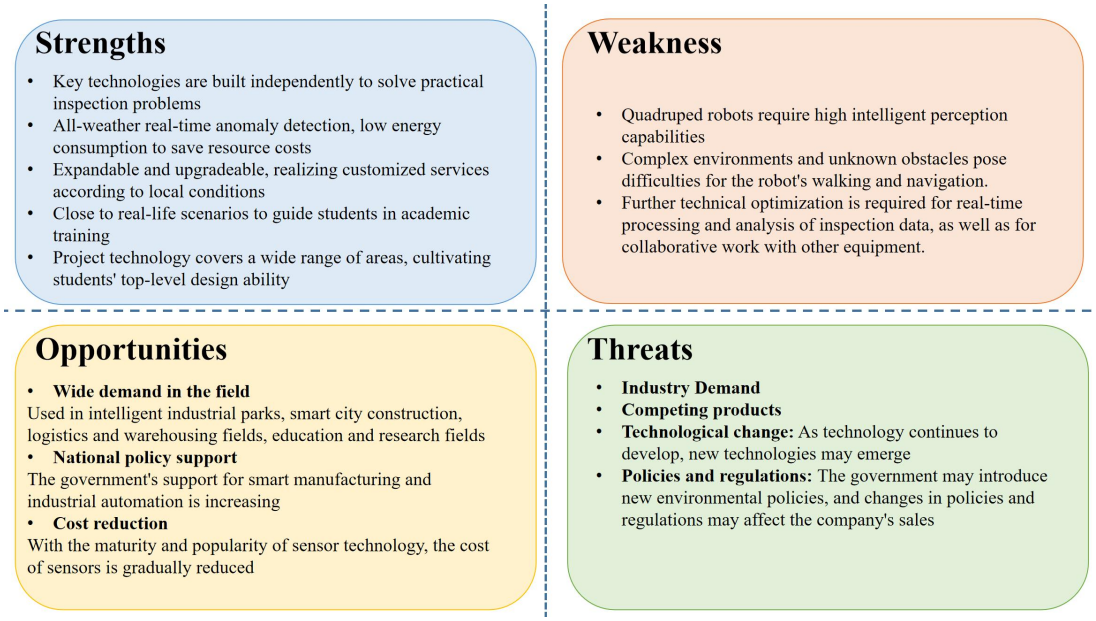
Data Visualization

Fig.5 Data visualization platform

2.5 Long Term Aim of the Business

1. **Marketing:** The company wants to promote the presence of its products through as many channels as possible. For example, social media, etc., to call the public's attention to industrial safety and to safeguard people's lives. Short videos can be used to introduce to the public how the IoT-based smart factory safety inspection system can protect people's lives. Thus, the effect of expanding the sales target can be achieved.
2. **Expandable and scalable, realizing customized services according to local conditions:** The proposed system takes real-time and continuous inspection of industrial instruments as its goal, and provides greater scalability and upgradability on the basis of meeting basic inspection requirements and system security. i.e., it can be customized for different instruments in different industrial scenarios. The service can be customized for different instruments in different industrial scenarios. At the same time, the inspection target of the quadruped robot can be added, deleted, and checked in the console on the Web side; the sensor module of the intelligent IOT is left with the corresponding sensor module. The sensor module of Wisdom IOT has a corresponding interface for subsequent hardware upgrade, so as to realize customized services according to local conditions.
3. **Mass Production:** We are committed to getting products into mass production, but getting there requires licensing the design to a manufacturing company to make it happen. When mass production is achieved, we need to discuss good profitability with the manufacturer. Another option is to have our designs mass produced in factories that now have various accessories, and then use assembly lines to synthesize the products. This would require higher labor costs, but the cost of the machine would be reduced.

2.6 SWOT Analysis



3. Marketing Strategy

This section sets out our strategies for reaching our target market, arousing their interest in our product, and actually delivering the product to them in sales.

- **Initial Target Market:** In smart industrial parks, safety inspection systems can combine sensors with other automation equipment to automate the entire production process. One can install sensors on the production line so that the line can be inspected without interruption,

thus reducing downtime and increasing productivity. In addition, sensors can also check the production line for defects and hidden dangers, prevent the production line from quality problems that cause safety accidents, improve the stability and reliability of the production line, and ensure the efficiency and safety of industrial production.

- **Full Target Market:** As industrial systems mature, we will gradually expand our application areas and may expand the market to the following areas in the future:

(1) Smart city construction: Safety detection systems can be applied to the safety monitoring of urban facilities and environments. Sensors are installed to inspect various areas and facilities of the city, such as roads, bridges, waterways, cables, etc., to ensure the safety of urban facilities and equipment. It can also assist the city administration in urban environmental monitoring, thus improving the environmental quality and sustainability of the city. This will improve the environmental quality and sustainability of the city. This will effectively ensure the quality of life of city residents and improve people's happiness and sense of belonging.

(2) **Logistics and warehousing**: Sensors can target storage centers and goods transportation vehicles to ensure the safety and smoothness of the goods transportation process, thus improving logistics efficiency. In addition, it can also assist logistics companies in inventory management and asset monitoring, thus reducing operating costs and improving asset utilization. This will provide more efficient and safe services to the logistics industry and help related companies improve their market competitiveness.

(3) **Education and research**: Through practice and experiments, students can understand working principle of safety inspection system, deepen their understanding and knowledge of hardware, and cultivate students' engineering thinking and scientific literacy. The system can be used in a wide range of applications. Moreover, especially for university scientific research, the safety inspection system can also be used as a research carrier to develop artificial intelligence, robotics, control engineering and other fields. In addition, especially for university research, the safety inspection system can also be used as a research carrier to carry out cutting-edge technology research in the fields of artificial intelligence, robotics and control engineering, so as to further improve the scientific nature of the inspection system.

- **Key Benefits:** When marketing our product, the key benefits to be highlighted include, but are not limited to:
  - **Safety:** able to cruise around the clock, providing safety for users and preventing injuries to inspectors.
  - **Personalization:** We are able to improve our products according to user scenarios to achieve personalization. For each different customer, improvements will be made according to the user's needs.
- **Who will do the marketing:** The company will keep the marketing operation plan to itself at the beginning. This will reduce costs and also allow for timely adjustments to marketing strategies that do not suit us based on performance.

4. Management Plan

In the early days, we were short of numbers and will have different heads in charge of different departments. At a later stage, people with management ability in each department will be elected to manage each department as a supervisor. Under the leadership of the general manager, the general manager will be responsible for the chairman of the board, the chairman of the board will

be responsible for the board of directors, and the supervisory board will be responsible for supervising the operation of the company. The following positions are set up: senior level, middle level, and grassroots level. The chairman, general manager and deputy general manager are set up at the top level of management. The middle level is the head of eight departments. The grassroots level is the responsibility of the management bodies under each department as well as the grassroots personnel.

Our management and sub-departments in the previous period are listed below:

Member	Role	Responsible department	Team
Binyu Lai	Chairman	1.Administration Department	Manufacturing
Shutong Yao	General Manager	1. Accounting department 2. General Manager	
Jianhang Zheng	Vice President Business Manager	1. Capital Operation Department	
Wutong Lei	Secretary Lab Reporter	1. Customer Service 2. Department Quality Department	R & D
Jiacheng Huang	Vice President	1. Engineering Department	

The functions of the eight departments are described as follows:

Administration Department: responsible for the establishment of the company's administrative management system, and the implementation of the management system to check; close working relationship between various departments.

Accounting Department: Prepare monthly, quarterly and annual basic financial statements and tax statements to maintain the healthy and stable operation of the company on the basis of financial clarity.

Customer Service Department: fully responsible for the pre-sales and after-sales work of the company's products, develop and implement various pre-sales and after-sales systems, provide effective support for the company's operations, and be responsible for the internal management of the department.

Business Department: According to the company's business development strategy and planning, research and formulate the market positioning and development plan of the company's business, draw up the corresponding implementation plan and organize the implementation.

Engineering Department: responsible for the management of the design and development of new products and new processes of the company.

Production Department: the main function is to take effective methods and measures according to the company's business objectives and business plan, starting from the requirements of product variety, output, quality, cost and delivery time.

Quality Department: responsible for implementing the company's quality policy and quality objectives, planning and organizing the operation and maintenance of the company's quality management system and performance improvement.

Capital Operation Department: responsible for formulating various financing plans for the group and its subsidiaries; providing advice and decision support for the company's capital operation matters, participating in risk assessment and evaluation of investment and financing programs, and responsible for organizing and writing feasibility analysis reports business plans, etc.

5. Operating Plan

After receiving a new order, we will work together with each other. Ask for specific requirements for IoT security patrol needs. Then we send a technician to the field for inspection, including measurement, etc. Provide the plan within 30 days, and communicate with the other party in time for modification. After finalizing the plan, the production department will make the purchase according to the demand. Then the engineering department carries out design and production. Quality control is required in this process in a timely manner. And after delivery, timely follow-up is needed to ensure the safety and longevity of the product.

6. Financial Plan

6.1 Financial Needs and Sources of Funding

The company needs start-up capital for R&D, marketing, staff recruitment and other activities. Based on market research and competitors, we expect the total start-up capital to be about $5 million. The funding sources include the following:

Founders' investment: $1 million; Angel investment: $2 million; Venture capital: $2 million.

6.2 Revenue, cost and profit forecast

Based on market demand and competitors, we expect the company's revenue to be about $1.5 million in the first year, about $3 million in the second year, and about $4.5 million in the third year.

In terms of costs, we expect total costs in the first year to be approximately $1.2 million, with labor costs being the largest, accounting for approximately 60% of total costs; R&D costs and marketing costs each accounting for approximately 20% of total costs. Total costs in the second and third years will increase as the scale increases, but the relative percentages will not change much.

Therefore, the company's projected profit is $300,000 in the first year, $1.8 million in the second year, and $2.7 million in the third year.

6.3 Financing Sources

In the second and third years, the company will need to further expand and increase its investment in R&D and marketing. Therefore, we expect a round of financing activities. Based on market conditions and the company's performance, we expect that financing can be obtained through the following sources:

Venture capital: $5 million; IPO: $10 million.

6.4 Forecast of revenue, cost and profit

Over the next three years, we expect the company's revenues and profits to grow as the company expands its business. Specifically:

Revenues:

Year 1: $1.5 million Year 2: $3 million Year 3: $4.5 million

Profits:

Year 1: $300,000 Year: $1.8 million Year 3: $2.7 million

However, as the market becomes more competitive, the company's costs will continue to rise. In particular, labor costs, R&D costs and marketing costs will take up an increasingly high percentage. Therefore, the company needs to keep an eye on cost control and maintain profitability.

References

[1] 李孟良，马盈政．我国物联网产业发展现状和建议［J］．成组技术与生产现代化，2021，
38(03)：42-46.
[2] 关新平，吕玲，等．智能工厂的感知，通信与控制［J］．ZTE TECHNOLOGY JOURNAL，2017：
65.
[3] 蔡自兴．中国人工智能 40 年［J］．科技导报，2016，34(15)：12-32.
[4] Thomas A D H, Rodd M G, et al. Real-time Industrial Visual Inspection: A Review [J]. Real-Time
Imaging, 1995, 1(2): 139-158.
[5] Alhassan A B, Zhang X, et al. Power transmission line inspection robots: A review, trends and challenges for future research [J]. International Journal of Electrical Power & Energy Systems, 2020, 118: 105862.
[6] Roslin N S, Anuar A, et al. A Review: Hybrid Locomotion of In-pipe Inspection Robot [J]. Procedia Engineering, 2012, 41: 1456-1462.
[7] Ackerman E. A Robot for the Worst Job in the Warehouse: Boston Dynamics' Stretch can move
800 heavy boxes per hour [J]. IEEE Spectrum, 2022, 59(1): 50-51.
[8] 潘祥生，陈晓晶．矿用智能巡检机器人关键技术研究［J］．工矿自动化，2020，46(10)：43-48.
[9] 孙凌宇，李鑫宝，等．石化巡检机器人设计与应用［J］．制造业自动化，2023，45(02)：145-148.