SHELF-READING ROBOT SYSTEM

图客 TOOKEA

SINGAPORE COMM 互聯互通 We connect everything

HKC 香港通訊

A member of HKC International Holdings Limited (HKG:248)

Tooker Robot Core Features

1. **Trackless autonomous navigation:** The robot uses Lidar to navigate independently without the need to modify the existing environment.

2. **Adaptive navigation obstacle avoidance:** During the robot's journey, it can adaptively detect obstacles and avoid collisions with them.

3. **Accurate book localization:** Based on RFID sensing, centimeter-level book positioning is achieved, helping library staff locate mis-shelved books.

4. **Lost/ Missing book inventory:** Able to quickly inventory for lost books, achieving efficient and book management accurate.

5. **Automatic charging function:** With automatic charging function to ensure uninterrupted continuous work.

Product Models

UHF Robot

HF Robot

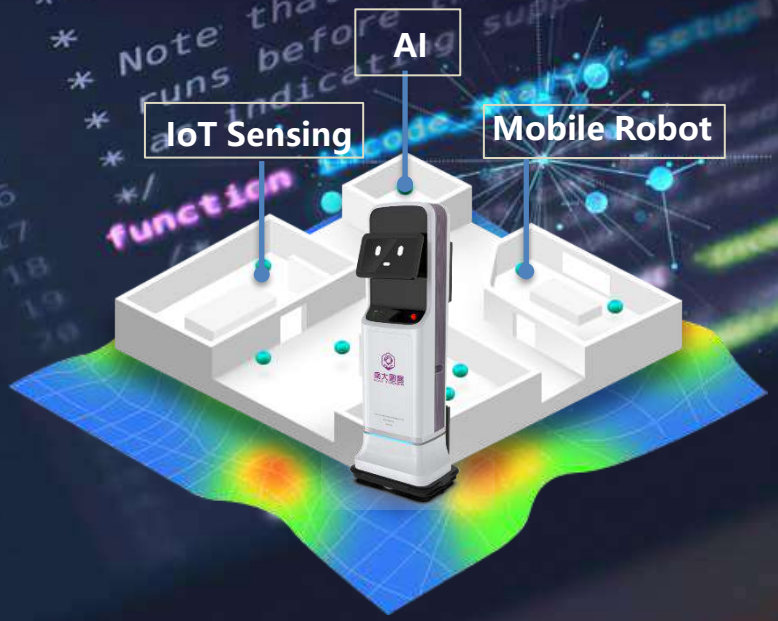
Hybrid Robot

CV Robot

Detection Rate: 99%

Localization Accuracy: 96%

Core Technology



Tooker combines Internet of Things (IoT) sensing technology, artificial intelligence technology, and mobile robot technology to achieve automated book inventory and positioning.

Book Localization

Accurate book positioning based on RFID technology.

Autonomous Navigation

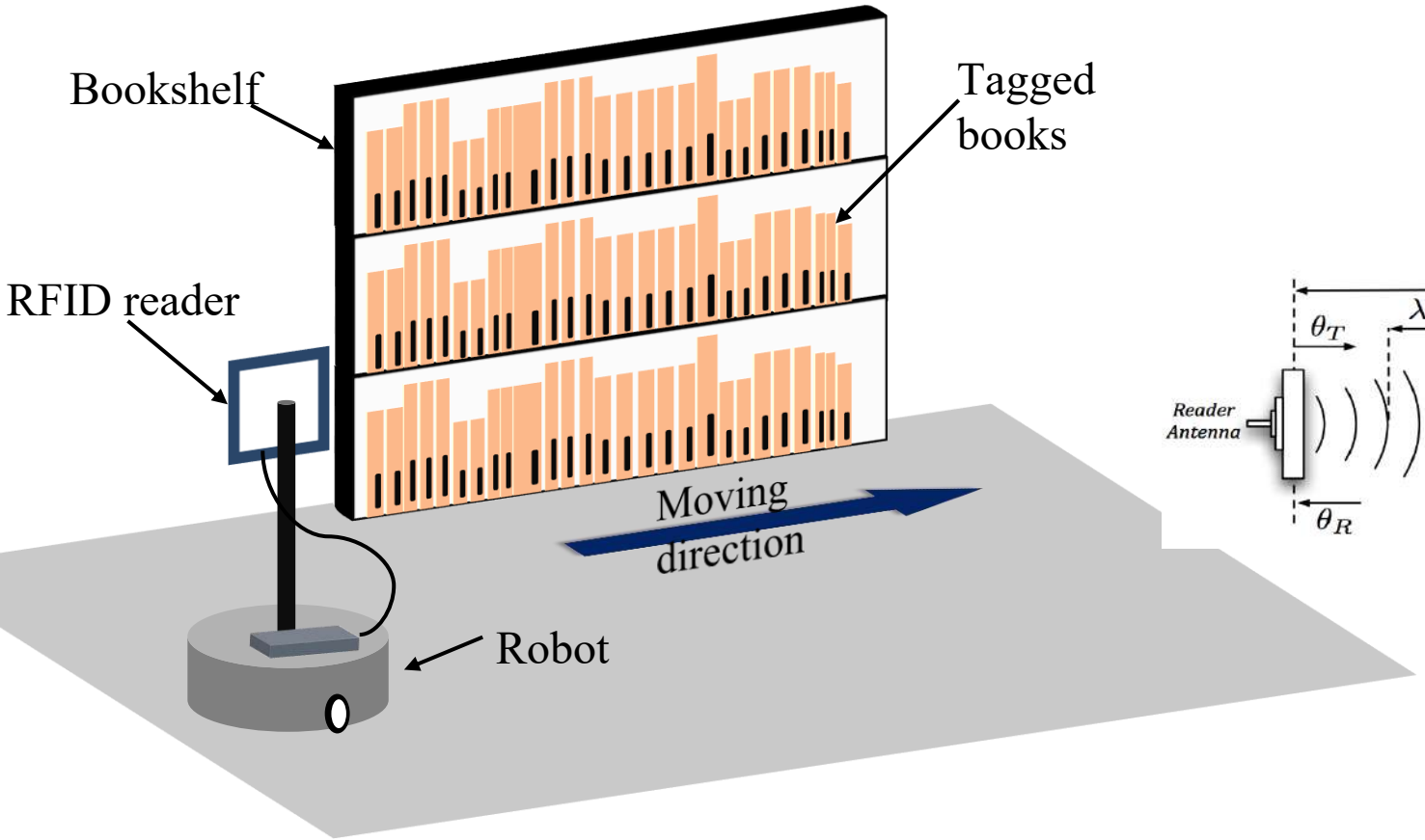
Navigation combined with RFID and LiDAR

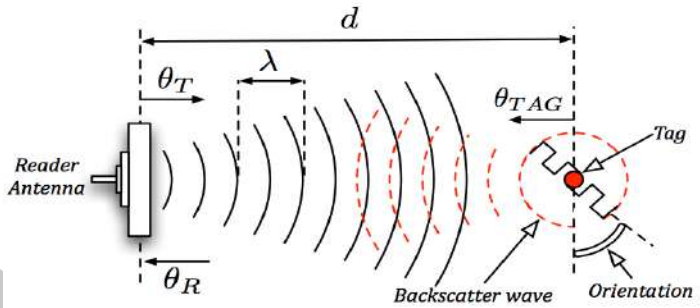
Obstacle Avoidance

Multi-modal Obstacle Avoidance

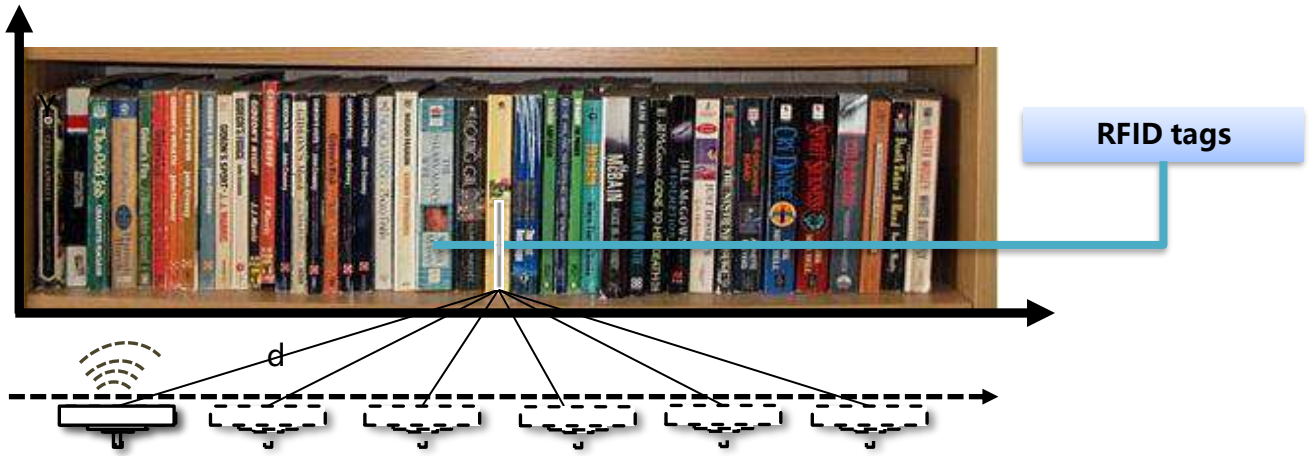
Core Advantage 1: Accurate UHF RFID Localization

Core Advantage 1: Accurate UHF RFID Localization





Core Advantage 1: Accurate UHF RFID Localization



"Phase + Hyperbola" Mode

$$d = \sqrt{(a - vt)^2 + b^2}.$$

$$\theta = \frac{4\pi}{\lambda}\sqrt{(a - vt)^2 + b^2} + \mu.$$

$$\frac{(\theta - \mu)^2}{(\frac{4\pi}{\lambda})^2 b^2} - \frac{(t - \frac{a}{v})^2}{\frac{b^2}{v^2}} = 1$$

International top-tier conference paper : IEEE INFOCOM

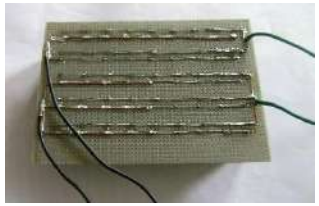
Core Advantage 2 : HF RFID (High detection rate)

(General Market Problem)

Low detection rate: Low transmit power & impedance mismatch

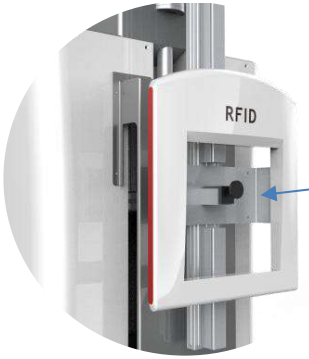
Tooker's HF RFID Technology

→ Self-designed HF RFID **readers**

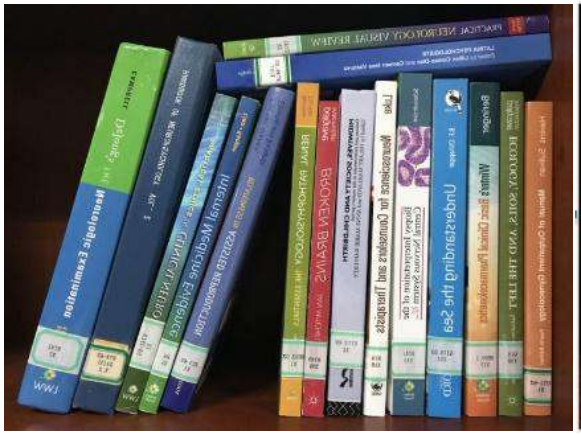


→ Self-designed HF RFID **antennas**

Core Advantage 3 : Computer Vision



Camera

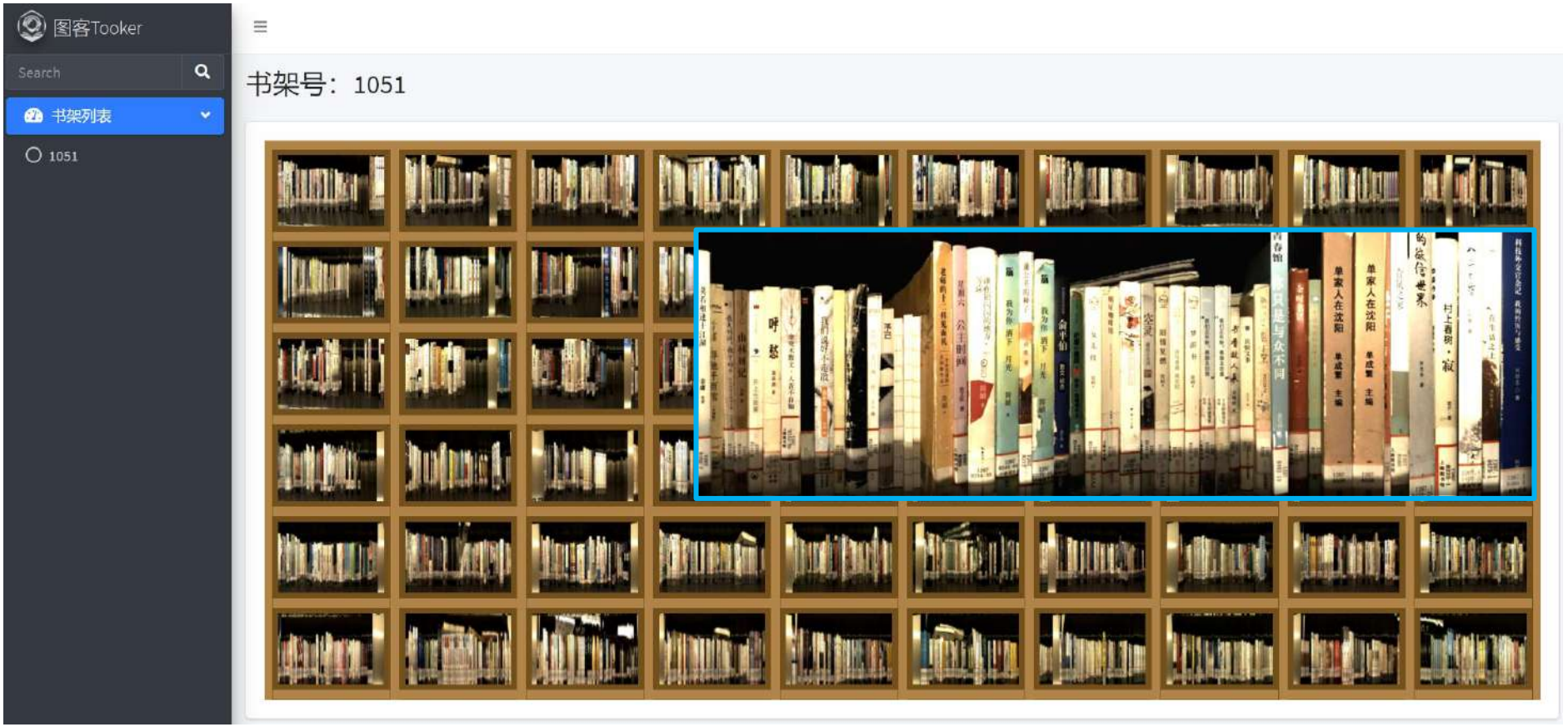


Scan and input Image

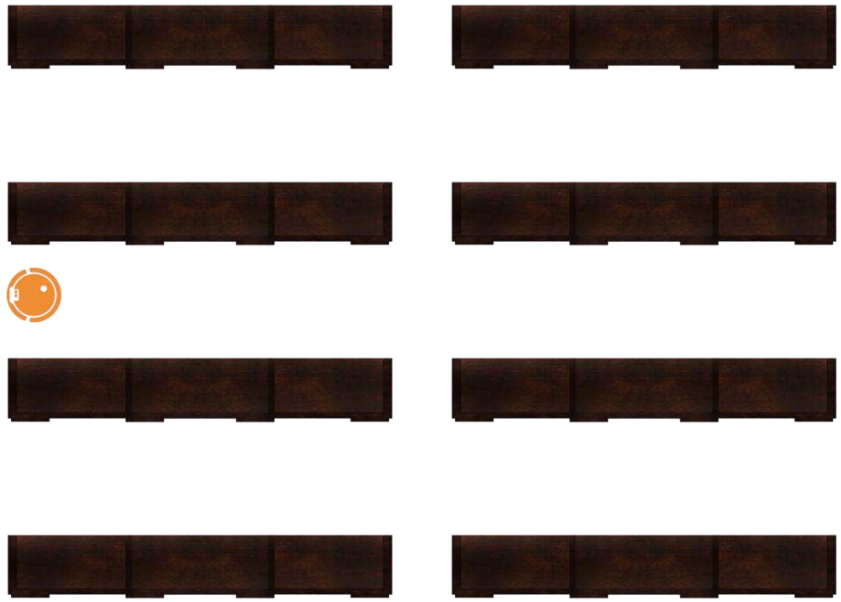
Book Spine Segmentation

Book title and call number recognition algorithm

Augmented Reality Bookshelf



Core Advantage 4 : Two Lidars



Help the robot better navigate and detect obstacles

Core Advantage 5 : Two Independent Lifting Systems

证书号第5503667号

实用新型专利证书

实用新型名称：一种可控式升降扫描设备

发明人：刘壮；陈力军；黄嘉棋；严颖超；张晓昭；李珍珠；陈星宇；郁裕杰；施庆钟；李猛

专利号：ZL 2017 2 0382815.0

专利申请日：2017年04月13日

专利权人：南京大学

授权公告日：2017年11月07日

本实用新型经过本局依照中华人民共和国专利法进行初步审查，决定授予专利权，颁发本证书并在专利登记簿上予以登记。专利权自授权公告之日起生效。

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局长
申长雨

中华人民共和国国家知识产权局

2017年11月07日

第1页(共1页)

Chinese Patent

Suitable for different shelf sizes, automatically adjusting according to shelf height

Core Advantage 6 : Quiet Book Inventory

→ Brushless Motor

→ Quiet drive wheel

People can hardly hear any noise when Tooker runs.

Robot Technical Architecture Diagram

1. Navigate → **Robot Navigation**
Let the robot move along the bookshelf instead of labour.

2. Collect → **RFID Data Collection**
Utilize RFID Robot to capture data information during mobile scanning.

3. Big Data → **Big Data Processing**
Big data processing for collecting massive data

4. Position → **High-precision Book Positioning**
Using the international advanced synthetic radar aperture algorithm for book positioning.

5. Report → **Automatically Generate Reports**
Wrong rack report, lost book report, automatically sent to the mailbox.

6. Display → **Data Display**
Historical inventory records, robot status, data display, etc.

Tooker's Robot Specification Parameters

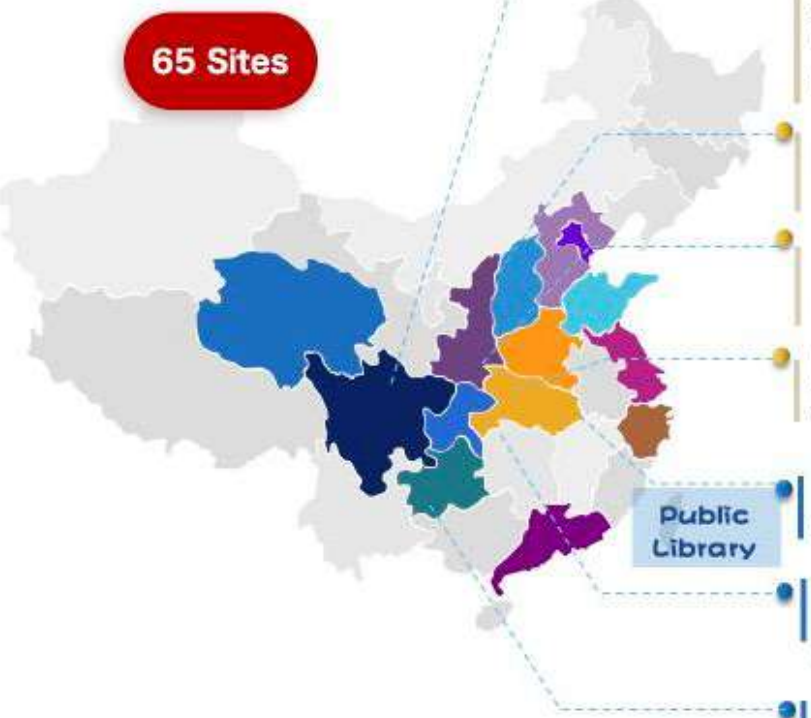
Tooker Shelf-reading Robot Hardware Parameters and Performance		
1	External Dimensions	L580m * W490mm * H1680mm
2	Upper Computer Configuration	Intel Core i5 Dual Core CPU + 8G memory, 256G or above solid-state hard drive
3	Lower Computer Configuration	Intel NUC6i5SYH
4	Traction Motors	2 Brushless DC motors
5	Display Screen Size	15.6-inch touch LCD
6	RFID Working Frequency	860Mhz-960MHz: Ultra-high frequency. 13.56MHz: High Frequency. Comply with ISO18000-6C, ISO15963 standard Equipped with dual camera module for visual assistance in inventory management.
7	Dual Lift Rod Module	• 2 independent lift systems (suitable for different shelf sizes, automatically adjusting according to shelf height). • Lower lift rod stroke: 180-990mm. • Upper lift rod stroke: 1170-2250mm
8	Dual Laser Radar Module	Equipped with at least two laser radars in the forward and backward directions, for bidirectional navigation between shelves.

Tooker Shelf-reading Robot Hardware Parameters and Performance		
9	Wheel System Characteristics	Mobile chassis with differential wheel structure, ensuring quietness during inventory management: active wheels with suspension shock absorption structure, ensuring smooth mobility.
10	Maximum Speed of Book Inventory Robot	0.5m/s
11	Speed Resolution	0.01m/s
12	Battery Working Time	Continuous running time of not less than 9 hours
13	Charging Time	6 hours
14	Operating Noise	Less than 40 decibels (1 meter from inventory machine)
15	International Standards	Conform to ISO18000-6C, ISO15963 standards
16	Self-Charging	When the battery is low, it should automatically return to the charging station for self-charging.
17	Two-Way Communication	Book inventory robot has two-way data communication with the backend server.
18	Manual Emergency Stop	In case of malfunction, there is a manual emergency stop function.

Main Functions

1. Accuracy of Book Level Positioning
2. Book Sorting Accuracy
3. Book Inventory Efficiency
4. Report Data
5. Auto-charging
6. Night stocktake
7. Protruding Book Obstacle Avoidance
8. Stocktake Mode
9. Robot Operation Sound
10. System Docking
11. Support Zero Cost Shelf Function
12. Alarm Function

Project Experiences



University & College /24 Sites

The Chinese University of Hong Kong (Shenzhen) | Wuhan University | Nanjing University | Sun Yat-sen University | Tongji University | Guangzhou International Campus of South China University of Technology | Nanjing University of Aeronautics and Astronautics | China Agricultural University | East China Normal University | Shenzhen University | Hunan University of Science and Technology | Wuhan Polytechnic University | Zhejiang International Studies University | Xi'an Jiaotong-Liverpool University | Chengdu University | Shandong First Medical University | Huaibei Normal University | Sichuan Conservatory of Music | University of South China | Tongling University | Xiamen University | Beijing Normal University | Hebei Normal University |Chengdu University of Technology.

High School /4 Sites

Shanghai Luwan Senior High School | Shanghai Shibei Junior Middle School | Nanjing No.1 High School | Taiyuan Second Foreign Language School

Vocational College /3 Sites

Shanghai News and Press College | Chongqing Engineering Vocational and Technical College | Anyang Preschool Teacher's College

Military academies /3 Sites

Army Engineering University | Rocket Force Engineering University | Xi'an Armed Police Engineering University

Provincial /3 Sites

Shanghai Library | Nanjing Library | Hainan Provincial Library.

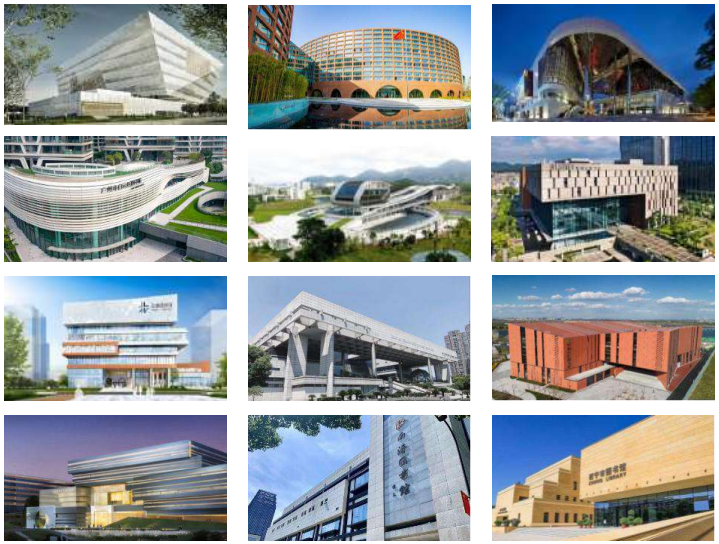
City /11 Sites

Nantong City Library | Hefei Central Library | Huzhou Library | Bengbu Library | Yuyao City Library | Tangshan City Library | Shijiazhuang City Library | Xining City Library | Guiyang Children's Library | Liaocheng City Library | Jinan City Library

District /17 Sites

Shanghai Huangpu District Library | Suzhou Wuzhong District Library | Guangzhou Baiyun District Library | Guangzhou Yuexiu District Library | Kunshan City Library Guangzhou Huadu District Library | Guangzhou Huangpu District Library | Shenzhen Bao'an District Library | Shenzhen University City Library | Yixing City Library Wuhan Dongxihu Cultural Center Library | Tianjin China-Singapore Friendship Library | Huzhou Nanxun Library | Ningbo University Campus Library Shanghai Xuhui District Library | Guangzhou Panyu District Library | Ningbo Beilun District Library

References Site



The Tooker smart book inventory robot is being applied in public libraries across the country, including libraries in major cities such as Beijing, Shanghai, Guangzhou and Shenzhen, as well as libraries in various provinces, cities, districts and counties.

This includes major universities, public libraries, military academies, K12 schools and other users across the country.














1
12
3
4
5
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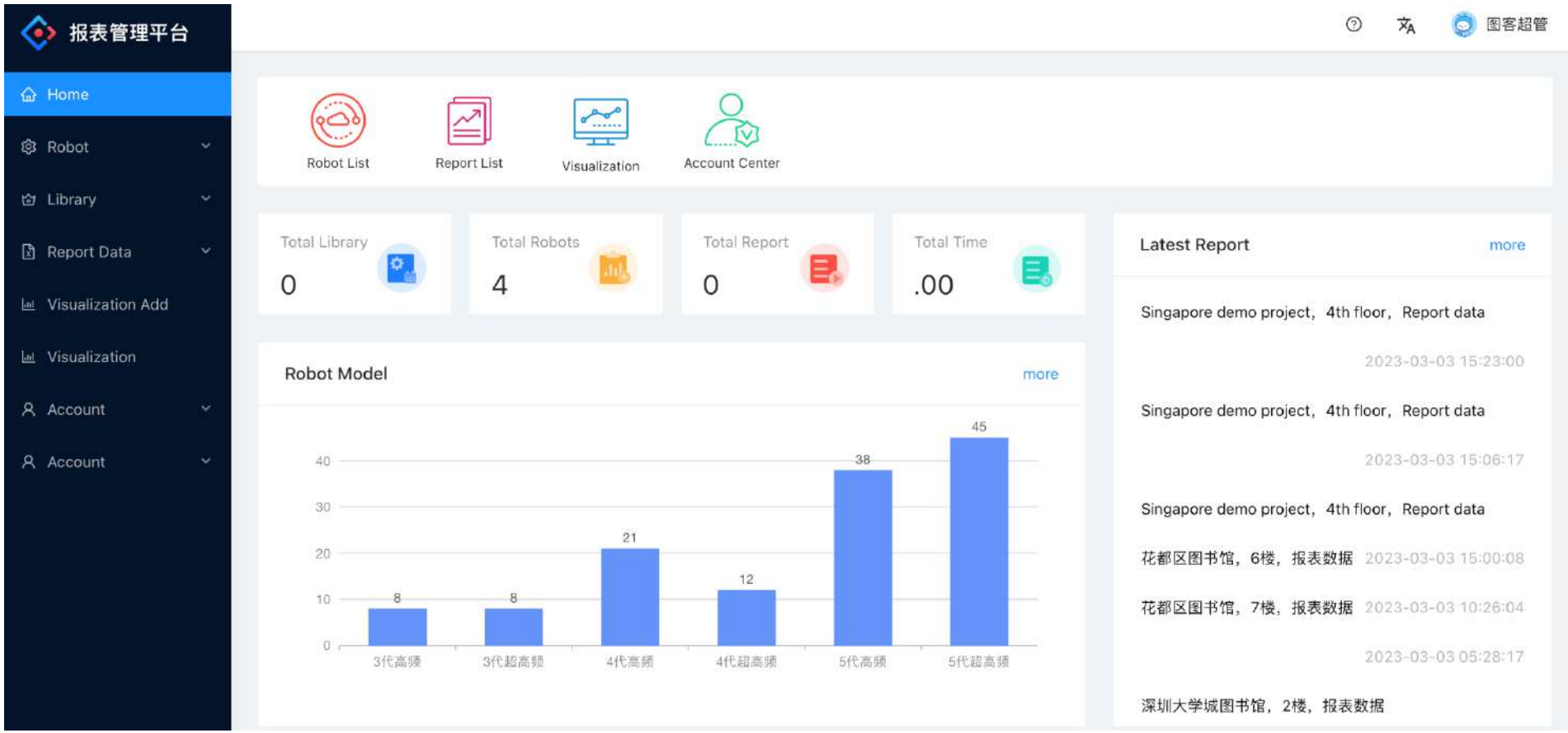
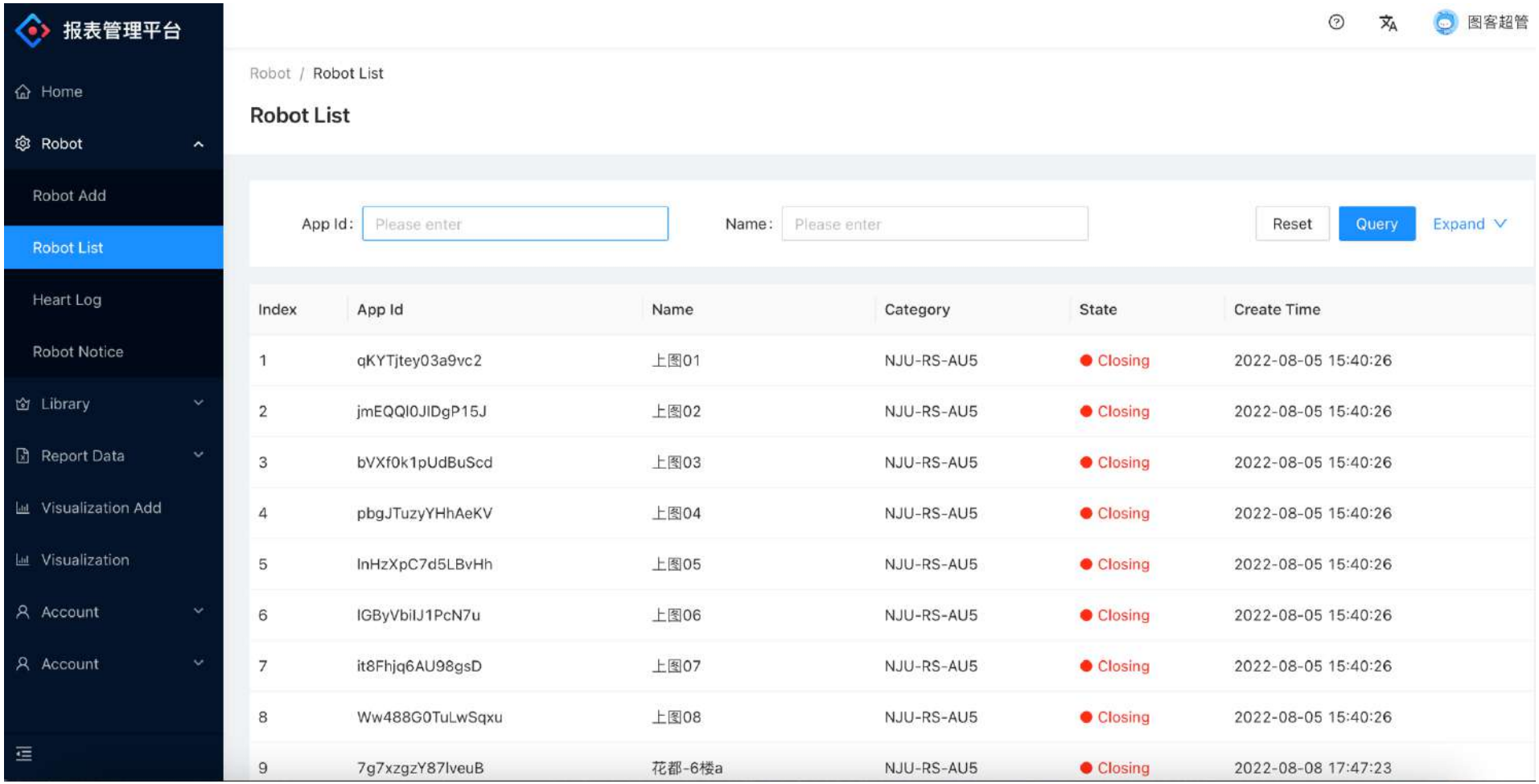
7
8

Sample UI

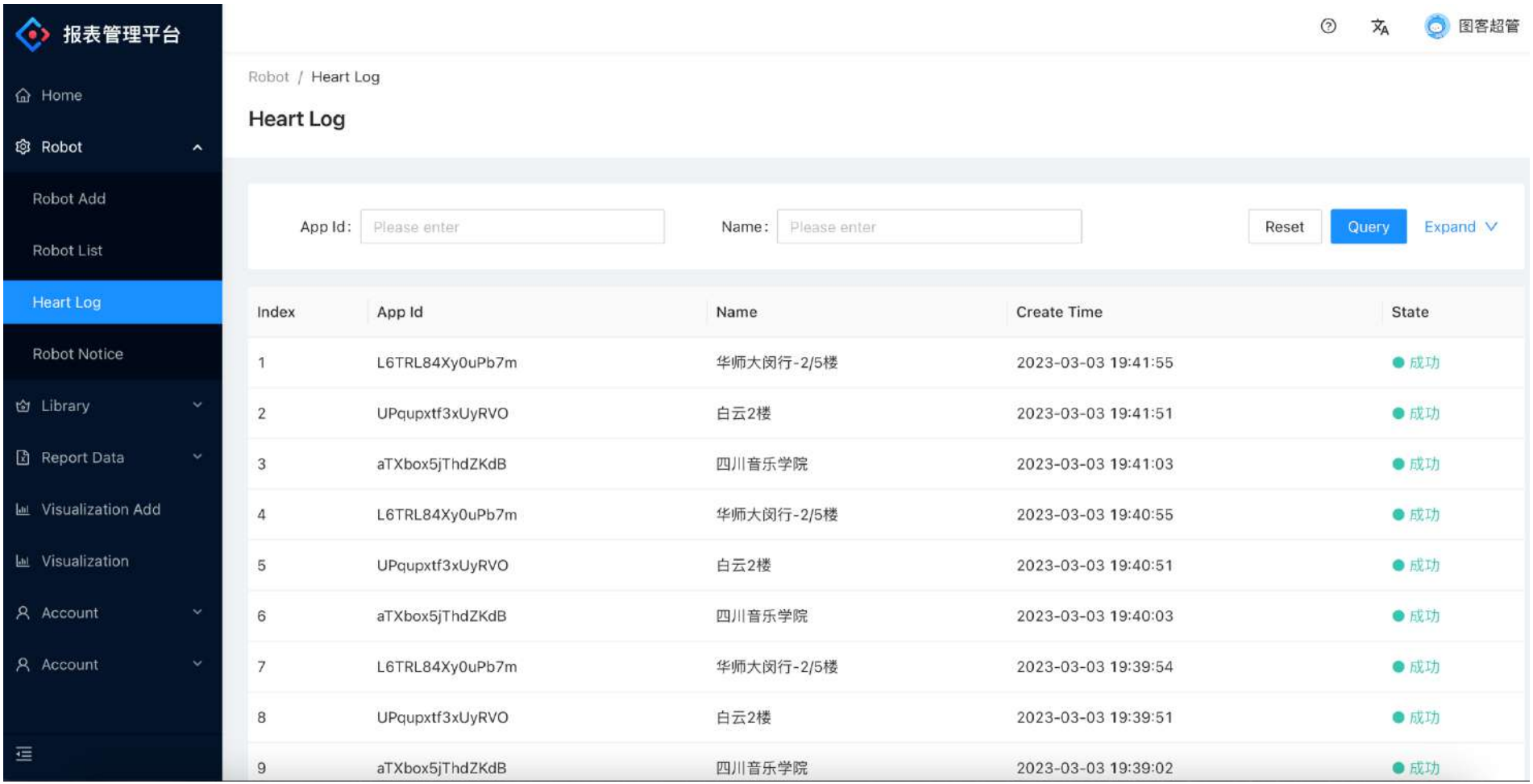
Dashboard


报表管理平台
Home
Robot
Library
Report Data
Visualization Add
Visualization
Account
Account
图客超管
Robot List
Report List
Visualization
Account Center
Total Library
0
Total Robots
4
Total Report
0
Total Time
.00
Robot Model
more
45
38
21
12
8
8
40
30
20
10
0
3代高频
3代超高频
4代高频
4代超高频
5代高频
5代超高频
Latest Report
more
Singapore demo project，4th floor，Report data
2023-03-03 15:23:00
Singapore demo project，4th floor，Report data
2023-03-03 15:06:17
Singapore demo project，4th floor，Report data
花都区图书馆，6楼，报表数据 2023-03-03 15:00:08
花都区图书馆，7楼，报表数据 2023-03-03 10:26:04
2023-03-03 05:28:17
深圳大学城图书馆，2楼，报表数据

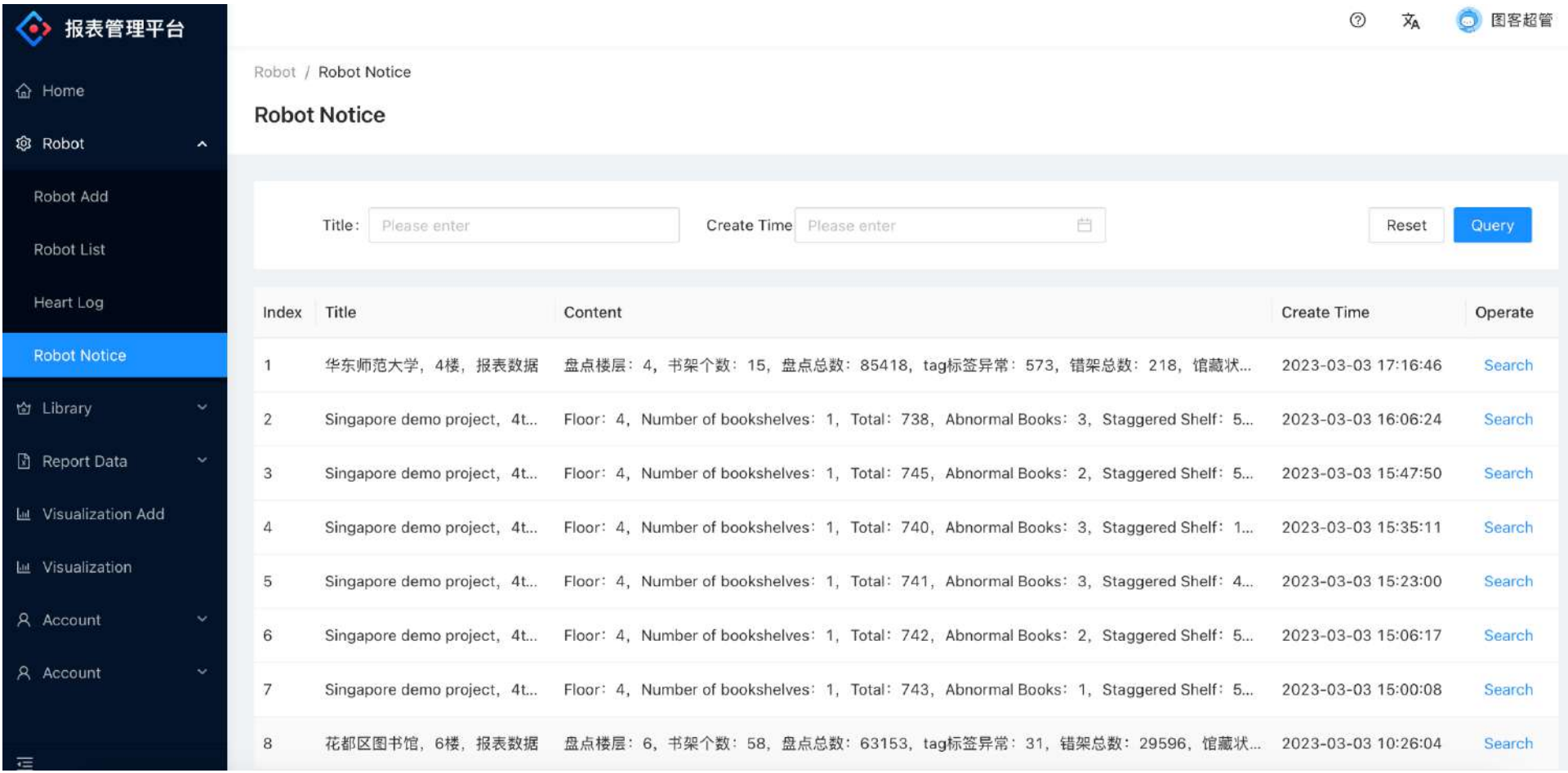
Robot List


报表管理平台
Home
Robot
Robot Add
Robot List
Heart Log
Robot Notice
Library
Report Data
Visualization Add
Visualization
Account
Account
图客超管
Robot / Robot List
Robot List
App Id: Please enter
Name: Please enter
Reset
Query
Expand
Index
App Id
Name
Category
State
Create Time
1 qKYTjtey03a9vc2 上图01 NJU-RS-AU5 Closing 2022-08-05 15:40:26
2 jmEQQl0JlDgP15J 上图02 NJU-RS-AU5 Closing 2022-08-05 15:40:26
3 bVXf0k1pUdBuScd 上图03 NJU-RS-AU5 Closing 2022-08-05 15:40:26
4 pbgJTuzyYHhAeKV 上图04 NJU-RS-AU5 Closing 2022-08-05 15:40:26
5 InHzXpC7d5LBvHh 上图05 NJU-RS-AU5 Closing 2022-08-05 15:40:26
6 lGByVbiIJ1PcN7u 上图06 NJU-RS-AU5 Closing 2022-08-05 15:40:26
7 it8Fhjq6AU98gsD 上图07 NJU-RS-AU5 Closing 2022-08-05 15:40:26
8 Ww488G0TuLwSqxu 上图08 NJU-RS-AU5 Closing 2022-08-05 15:40:26
9 7g7xzgzY87lveuB 花都-6楼a NJU-RS-AU5 Closing 2022-08-08 17:47:23

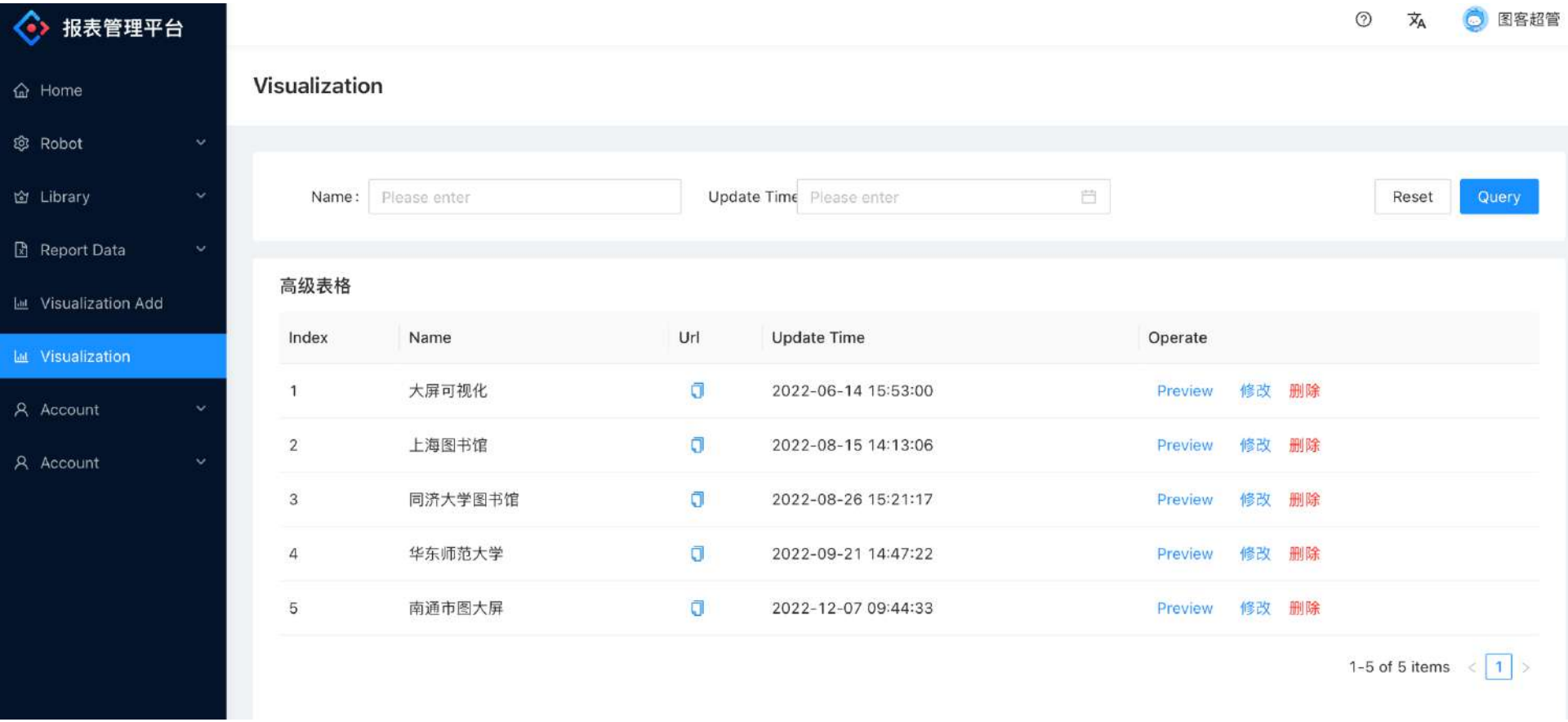
Job Completed Status



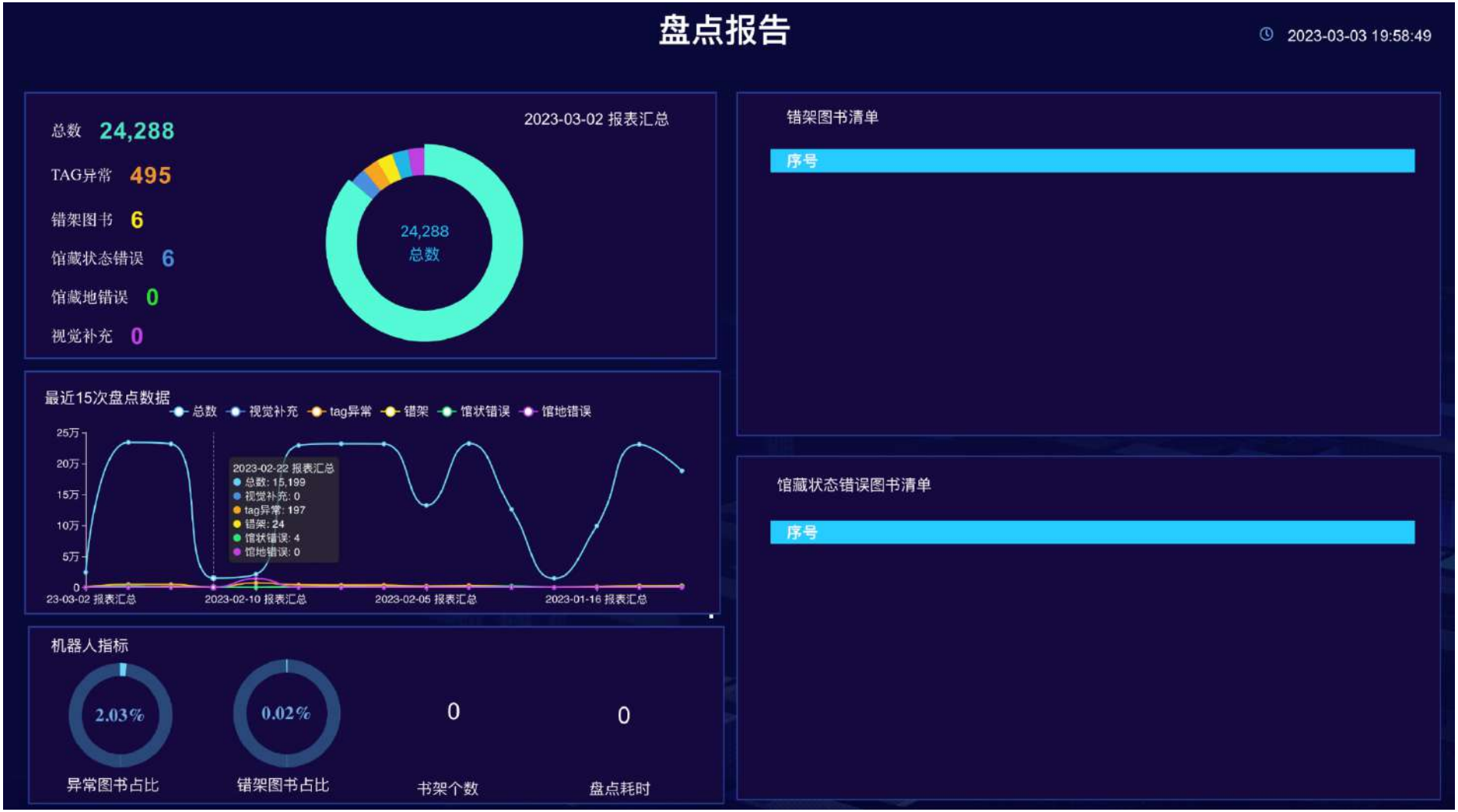
Report Generation Notice



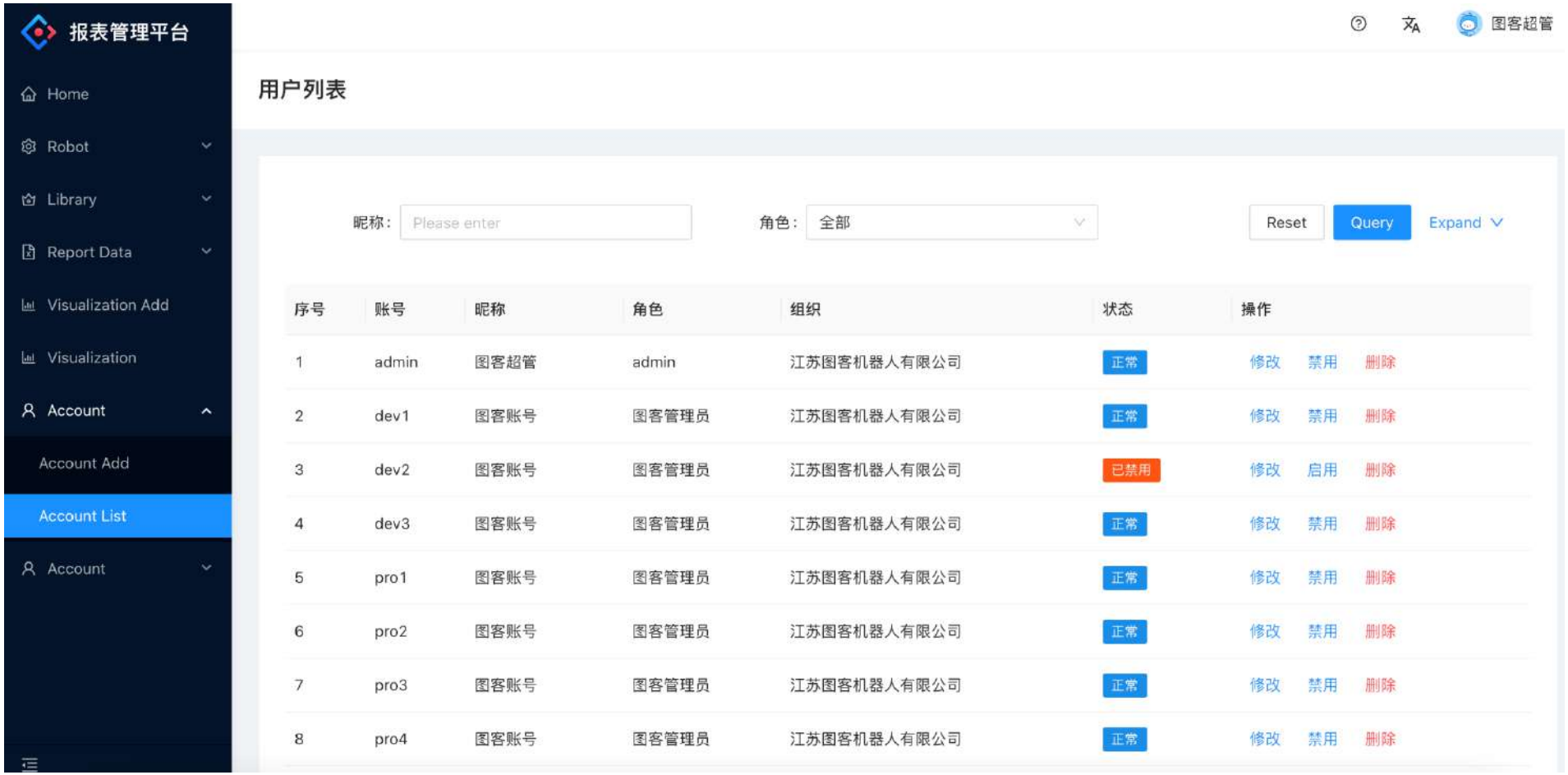
Visualization



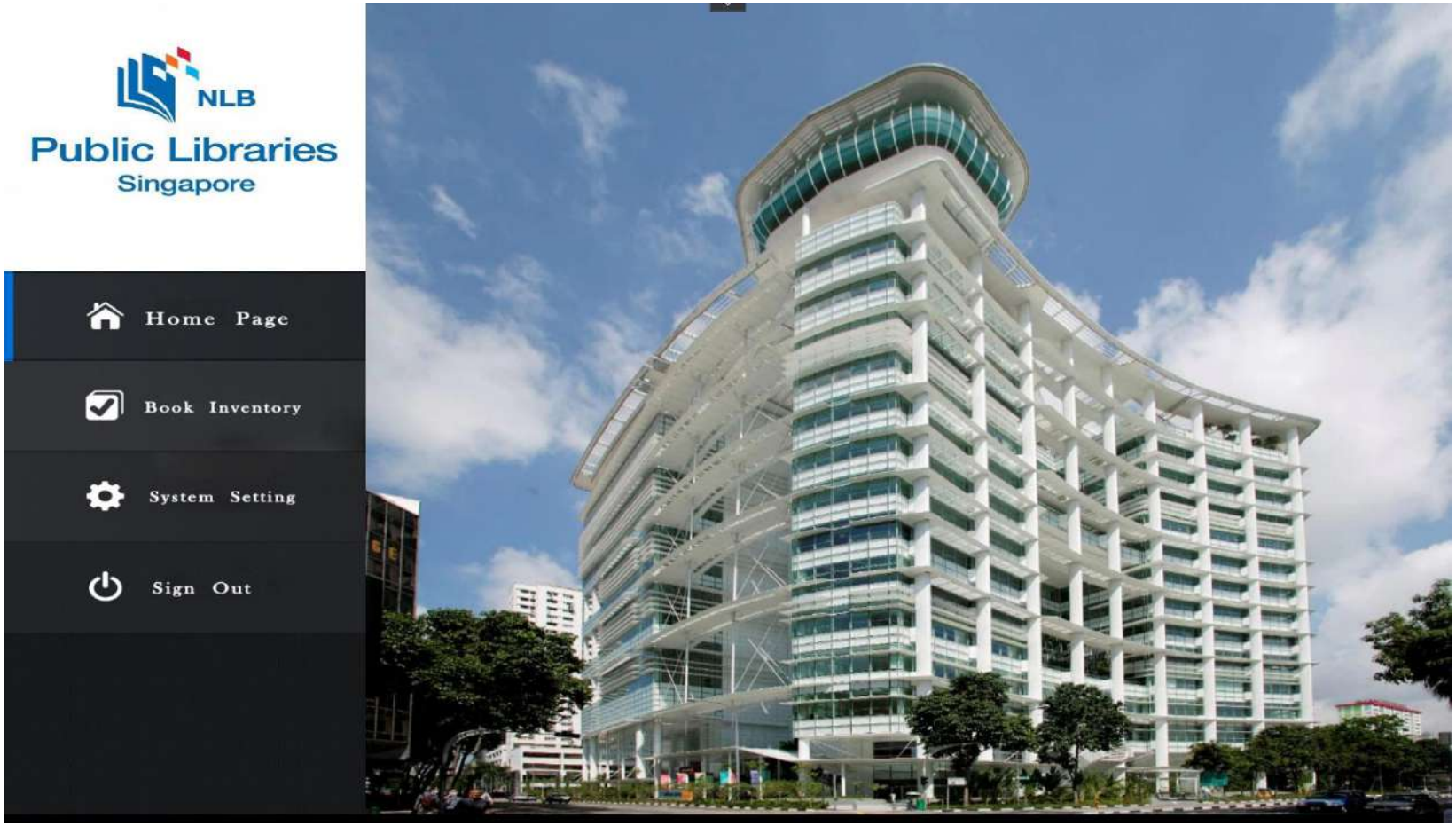
Visualization Report



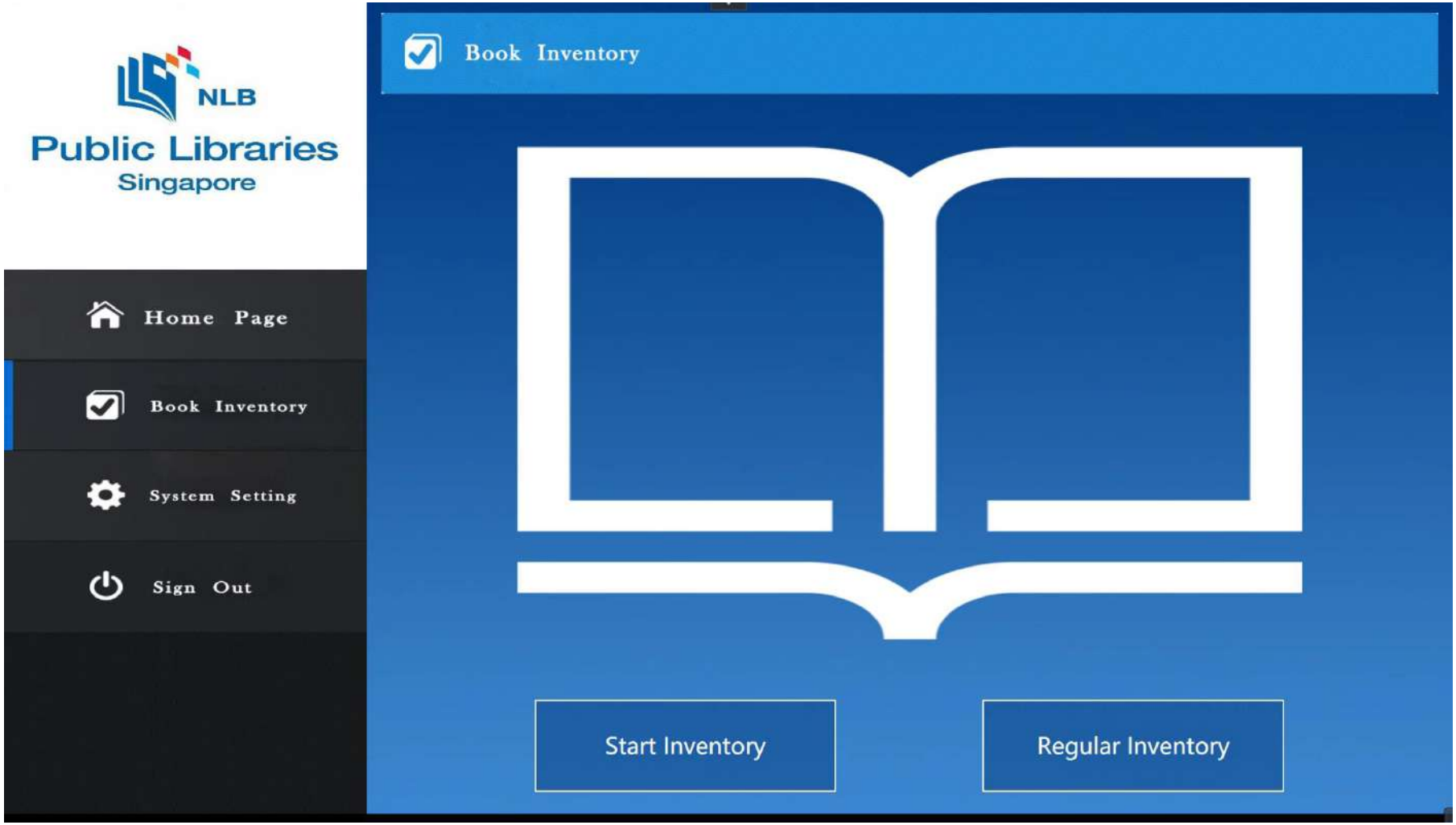
User Creation and Management



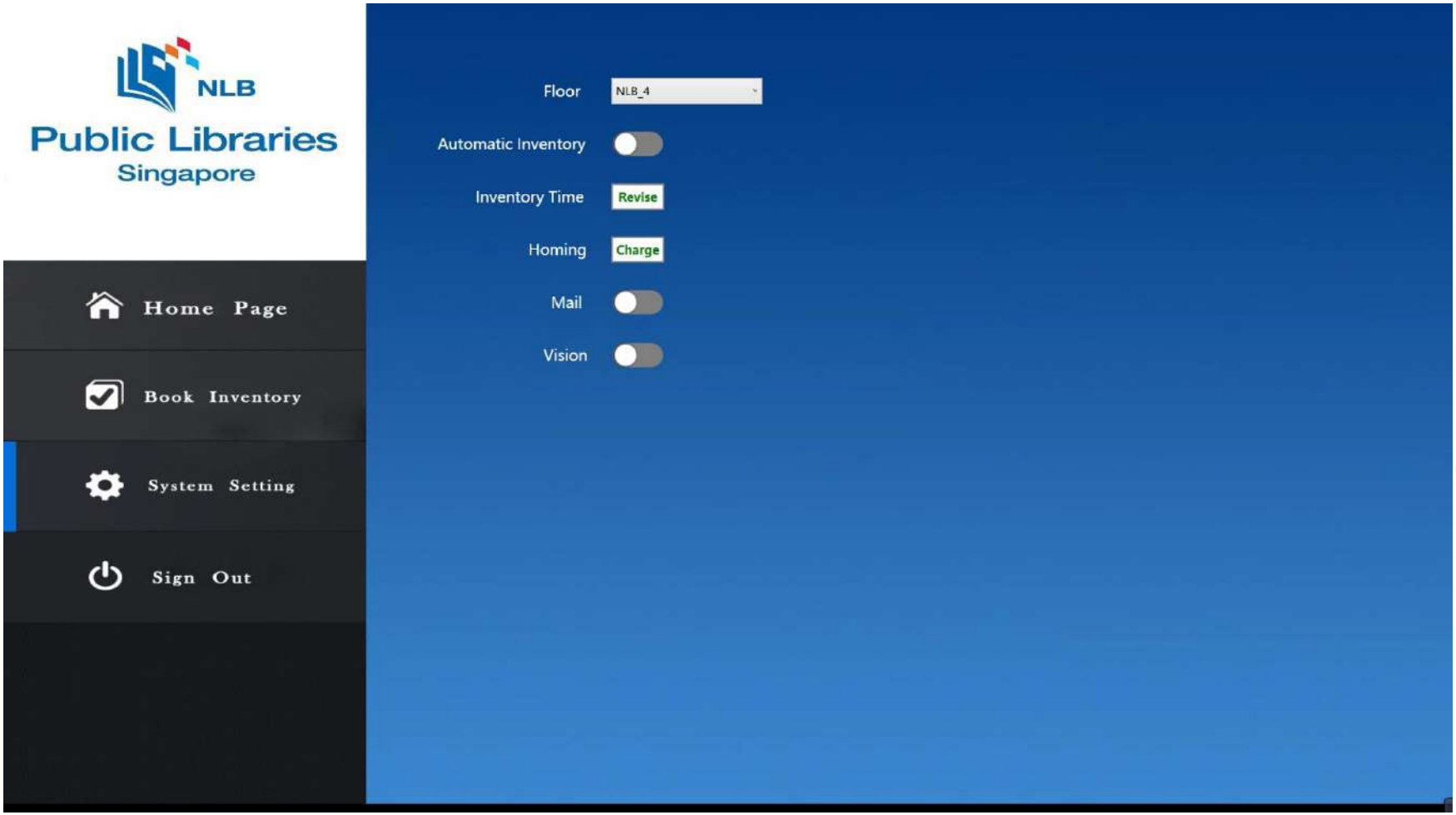
Robot Screen UI – Main Screen



Robot Screen UI – Book Inventory



Robot Screen UI – System Setting



Books Detection and Location Report - Sample

Barcode	Call number	Level	Detected location	Detected Location	Date	Remarks
B37558002H	AAA	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.677819	
B37558003I	AAB	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.648781	
B37558005K	AAC	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.425844	
B37558006A	AAD	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.735128	
B37558007B	AAE	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.672849	
B37558008C	AAF	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.640787	
B37558010G	AAG	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.642191	
B37558011H	AAH	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.639388	
B37558012I	AAI	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.174918	
B37558013J	AAJ	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.994616	
B37558014K	AAK	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.982124	
B35602031I	ADI	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:55.619000	
B33346773C	AIC	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:56.770000	
B33200961B	ALE	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:56.388000	
B37557960I	ALS	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:57.528000	
B30612744E	AND	4	01架A面01列01层	S1-T1-B1	2023-03-06 09:48:55.994000	

Books Misplaced Report - Sample

Barcode	Call number	Level	Detected location	Detected Location	Date	Remarks
B37558015A	AAL	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:58.989446	Misplaced books
B37558016B	AAM	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:57.999307	Misplaced books
B37558017C	AAN	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:57.993046	Misplaced books
B37558018D	AAO	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:57.676271	Misplaced books
B37558019E	AAP	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:57.665681	Misplaced books
B37558020H	AAQ	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:57.970285	Misplaced books
B37558021I	AAR	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:58.589839	Misplaced books
B37558022J	AAS	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:57.170636	Misplaced books
B37558023K	AAT	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:57.161247	Misplaced books
B31741917K	BUR	4	01架A面01列02层	S1-T2-B1	2023-03-06 09:48:18.820000	Misplaced books
B37558031J	DDA	4	01架A面01列03层	S1-T3-B1	2023-03-06 09:49:59.264939	Misplaced books
B37558032K	DDB	4	01架A面01列03层	S1-T3-B1	2023-03-06 09:49:59.326070	Misplaced books
B37558033A	DDC	4	01架A面01列03层	S1-T3-B1	2023-03-06 09:48:29.963784	Misplaced books
B37557840F	GGA	4	01架A面02列03层	S1-T3-B2	2023-03-06 09:49:02.673883	Misplaced books

Honors and Awards

APPLIED FOR OVER 50 DOMESTIC & FOREIGN PATENTS

Possesses complete independent intellectual property rights.

THE NATIONAL STANDARD LED BY THE TEAM HAS BEEN APPROVED FOR IMPLEMENTATION

"General Technical Conditions for Library Inventory Robots."

- **The highest award in the 46th Geneva International Invention Exhibition: The Special Gold Award**
- **The highest award, for Outstanding Exhibits in the University Exhibition Area at the 22nd China International Industry Fair: The Special Prize**
- **Awarded the title of "2020 China Good Technology" by the China Productivity Promotion Center Association.**
- **Selected as one of the "Top 10 Technological Advances in World Intelligent Manufacturing in 2022" by the Intelligent Manufacturing Alliance of CAST Member Societies (IMAC)**

Thank You !