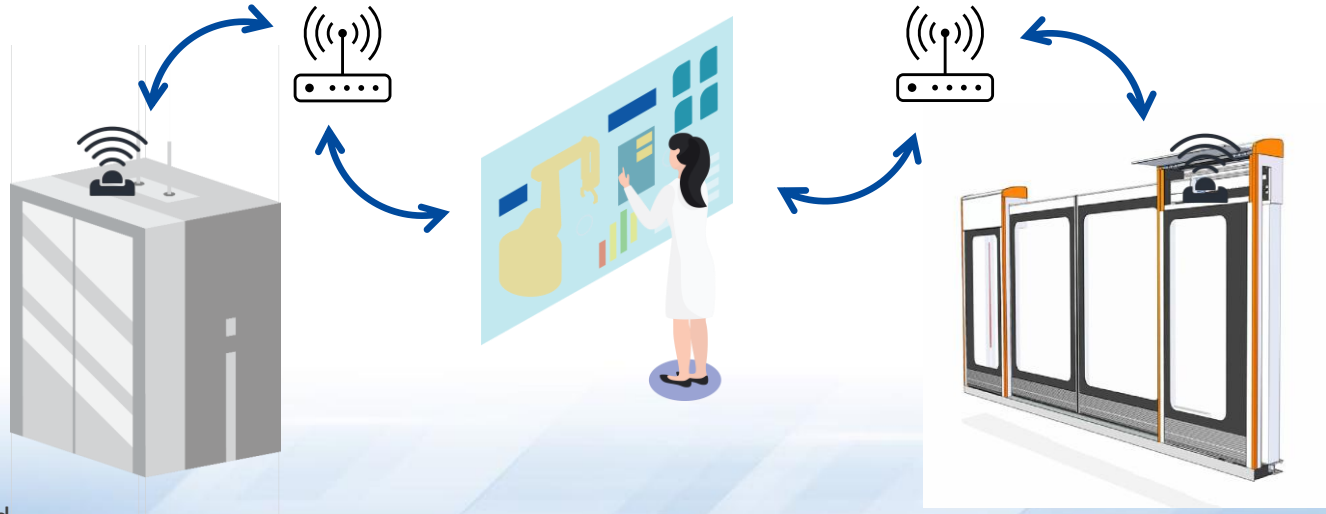
Prognostics & Health Management System for Mass Transportation

PHM Project Overview

Combine the IIoT, 5G, deep learning algorithm and edge computing to develop a Prognosis and Health Management (PHM) system for various equipment. Besides functions of real-time monitoring, the PHM system can detect potential trends of anomalies and deviations from normal operating conditions and predict when a fault will occur.



Our solution – Intelligent Fault Catcher (IFC)

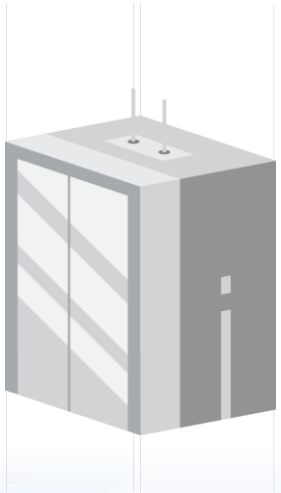
AI Powered PHM solution with IoT edge computing for APG & elevator

a) Health Monitoring
b) Anomaly/Fault detection
c) RUL prediction

Interactive Dashboard for Monitoring & PHM for APG and elevator

Elevator

- PHM System
  - Data acquisition
  - Data management
  - Data analysis
  - Dashboard



Automatic Platform Gate (APG)

- PHM System
  - Data acquisition*
  - Data management
  - Data analysis
  - Dashboard

*mainly train log data, FLAIR's sensor data are supplementary

Software Architecture

Elevator site

BeanAir sensors
(raw data)

BeanAir
gateway

Edge device

APG site

Monnit sensors
(preprocessed data)

Monnit
gateway

Server

docker

MongoDB
Database

MySQL
Database

APG Log File

iMonnit

Health Index Models

Database API

Fault Prediction
Models

Dashboard

Webhook

RESTful API

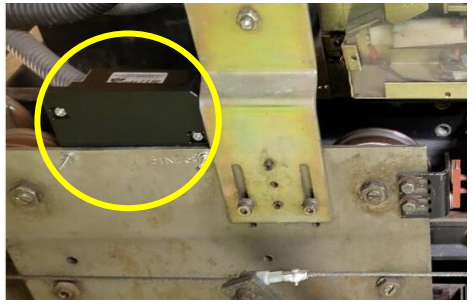
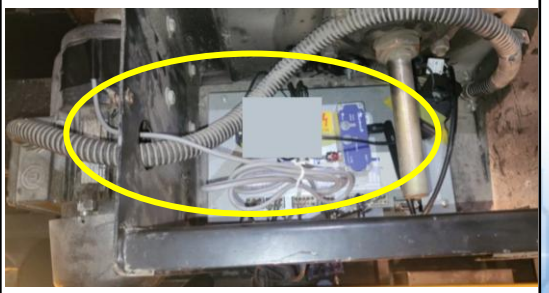
RESTful API

RESTful API

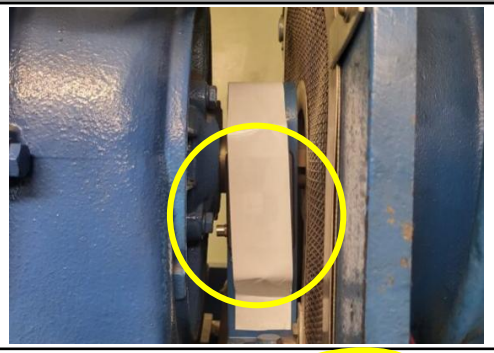
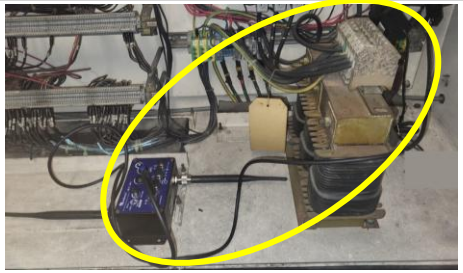
RESTful API

PHM: Elevator

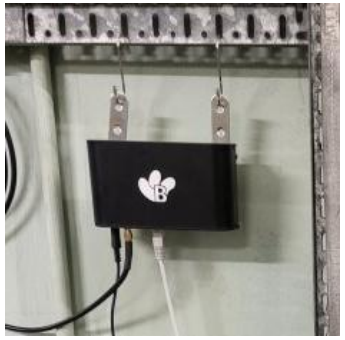
Recap of Sensor Installation

Monitored Component	Installation Location	Sensor/Hardware	Photo
Cabin door	Left cabin door	Inclinometer + Integrated temperature sensor	
	Right cabin door	Accelerometer	
	Cabin roof and door motor box	Current sensor + DAQ	
	Door motor box	Temperature sensor	

Recap of Sensor Installation

Monitored Component	Installation Location	Sensor/Hardware	Photo
Cabin	Cabin roof	Accelerometer	
Traction motor	Traction motor	Accelerometer	
	Control cabinet	Current sensor + DAQ	

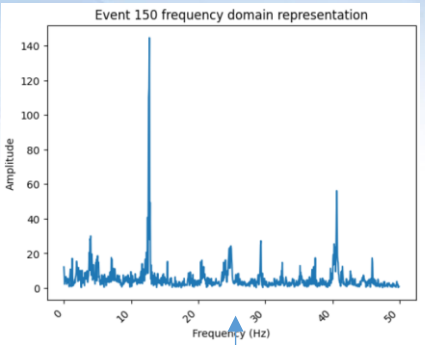
Recap of Supplementary Hardware Installation

Purpose	Installation Location	Sensor/Hardware	Photo
Gateway (Sensor data aggregation and transmission)	Control room	Collects the sensor data, and transmits the data to the edge device via the router. The gateway also manages the wireless sensor network and controls external access to it to enhance security.	
Router	Control room	Used to establish connection between the gateway and the edge device. Connects the local network to the internet via a SIM card providing cellular data.	
Edge device (Database, data analysis, web server)	Control room	Runs BeanScape (sensor supervision software) to monitor and operate the sensors in real time, and stores the sensor data locally.	

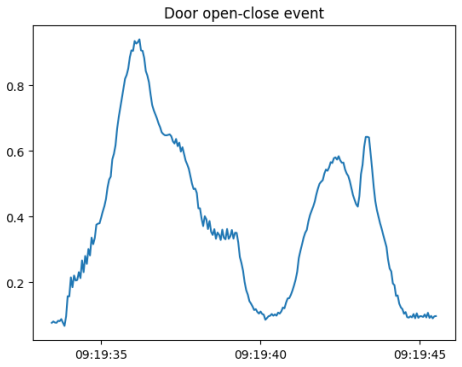
FLAIR Elevator Dataset

Sensor Data

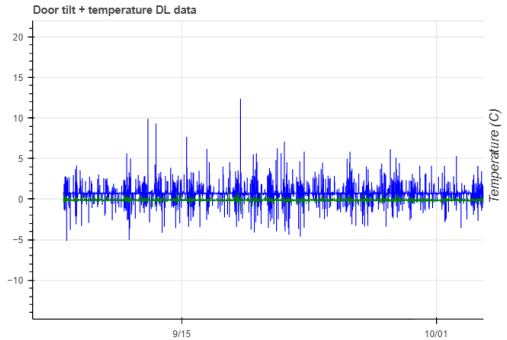
FFT



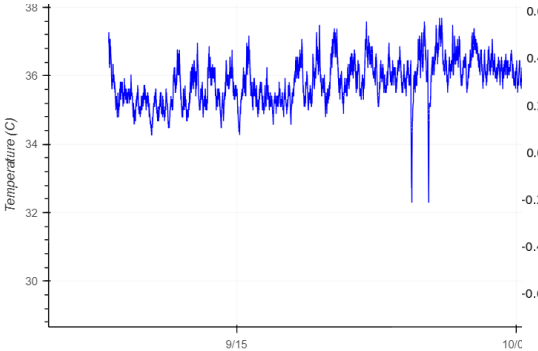
Door current



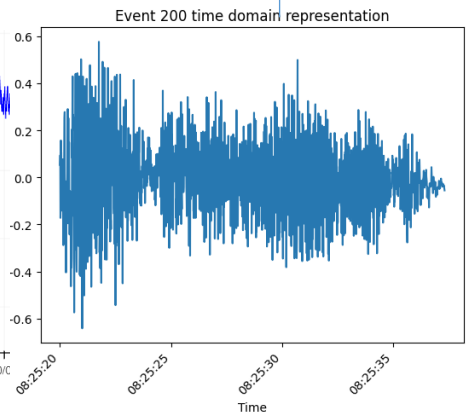
Door tilt



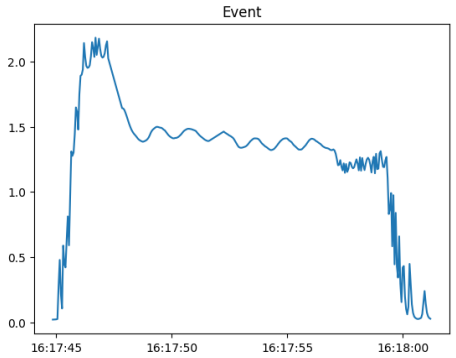
Door motor temperature



Traction motor vibration



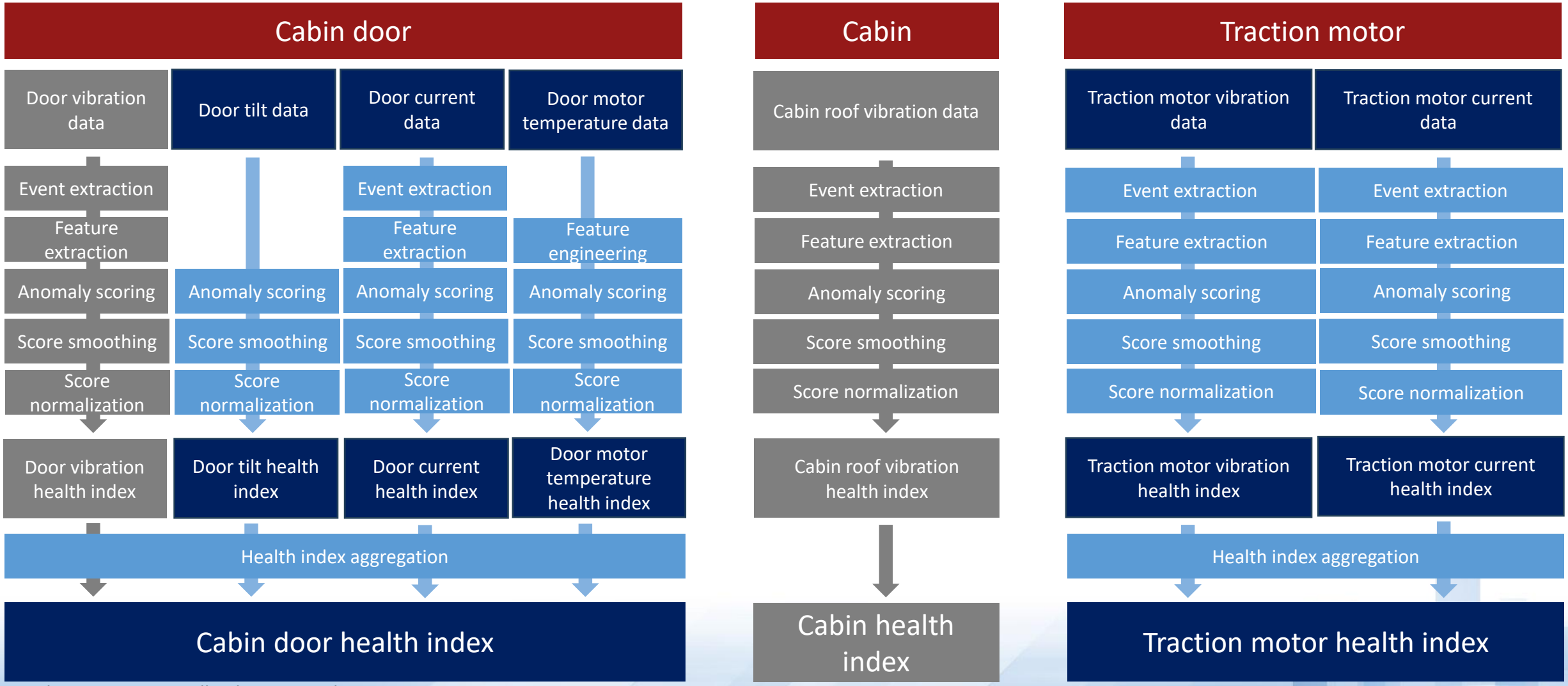
Traction motor current



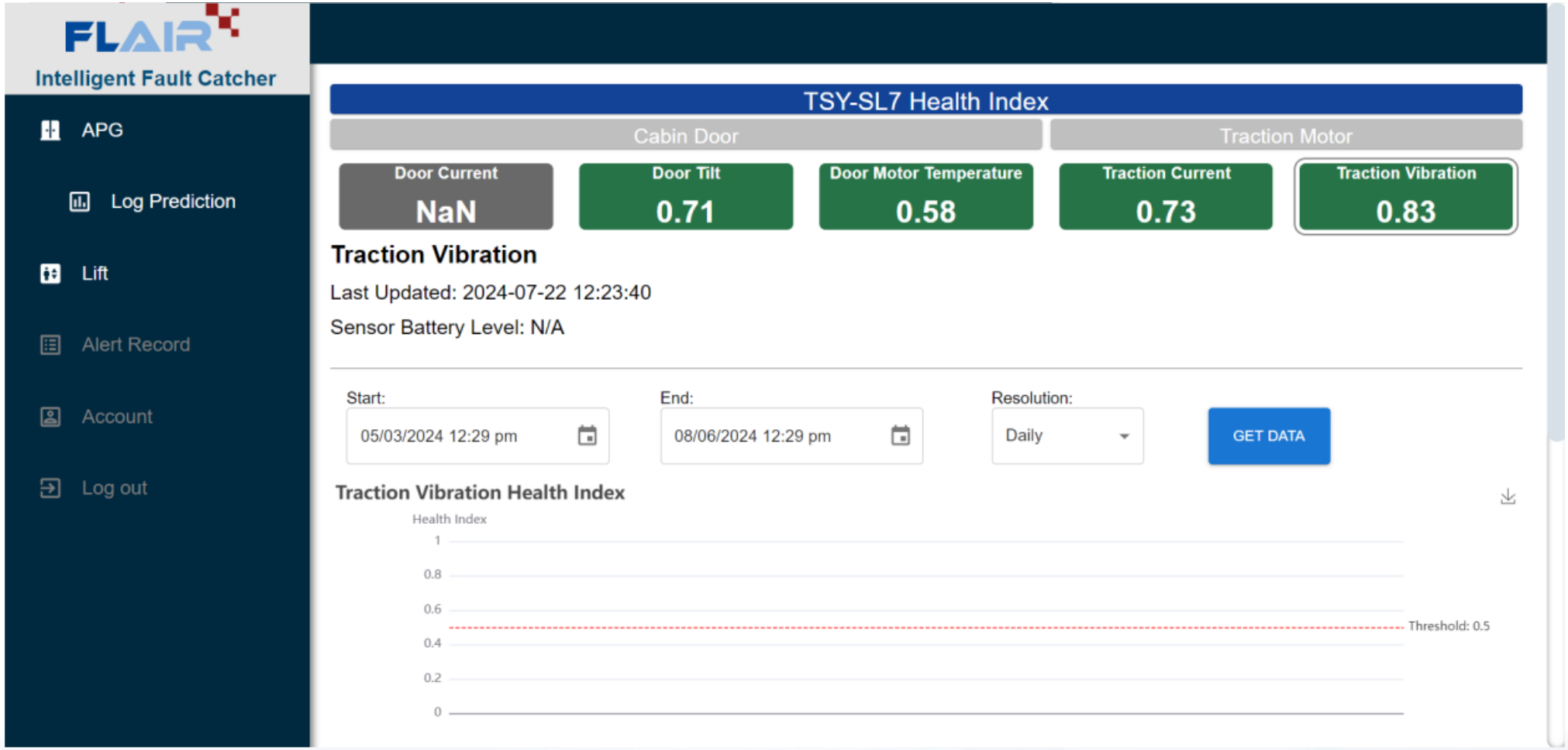
Fault/Maintenance Data

No fault/maintenance data available.

Data Analysis on FLAIR Elevator Dataset Health Index Generation



Elevator PHM System Dashboard



Health Index Monitoring Functionalities:

- Door current
- Door Tilt
- Door motor temperature
- Traction current
- Traction vibration

APG Dataset

Event Log Data

```
:Name:Plaform:Door:DCU:Value
 EVENT:MMS VERSION:::V 0.36-Dec 22 2021 - 11_19_54 VER#370-1640171994
TFORM EVENT:ALL DOORS CLOSED AND LOCKED:2:::FALSE
 ALARM:EED/TAD NOT CLOSED:2:41:81:ACTIVE
 EVENT:EED / TAD NOT LOCKED:2:41:81:TRUE
TFORM ALARM:TAD 1 OPENED:2:::ACTIVE
TFORM ALARM:LCP LOCAL COMMAND:2:::ACTIVE
TFORM ALARM:LOCAL CONTROL ACTIVATED:2:::ACTIVE
TFORM EVENT:LCP DOOR OPEN COMMAND:2:::TRUE
TFORM ALARM:UNEXPECTED UNLOCKING:2:::ACTIVE
TFORM EVENT:APG CLOSED AND LOCKED LOOP:2:::FALSE
 EVENT:OPEN ENABLE:2:40:1:TRUE
 EVENT:OPEN COMMAND:2:40:1:TRUE
 EVENT:LEAF LOCKED SWITCH:2:40:1:TRUE
 EVENT:REMOTE OPEN COMMAND:2:40:1:TRUE
 EVENT:DOOR OPENING CHIME:2:40:1:TRUE
 EVENT:LEAF LOCKED:2:40:1:FALSE
 EVENT:LEAF FREE:2:40:1:FALSE
 EVENT:OPEN ENABLE:2:40:2:TRUE
 EVENT:OPEN COMMAND:2:40:2:TRUE
 EVENT:LEAF LOCKED SWITCH:2:40:2:TRUE
 EVENT:REMOTE OPEN COMMAND:2:40:2:TRUE
 EVENT:LEAF LOCKED:2:40:2:FALSE
 EVENT:LEAF FREE:2:40:2:FALSE
 EVENT:OPEN ENABLE:2:39:3:TRUE
 EVENT:OPEN COMMAND:2:39:3:TRUE
 EVENT:LEAF LOCKED SWITCH:2:39:3:TRUE
 EVENT:REMOTE OPEN COMMAND:2:39:3:TRUE
 EVENT:DOOR OPENING CHIME:2:39:3:TRUE
```

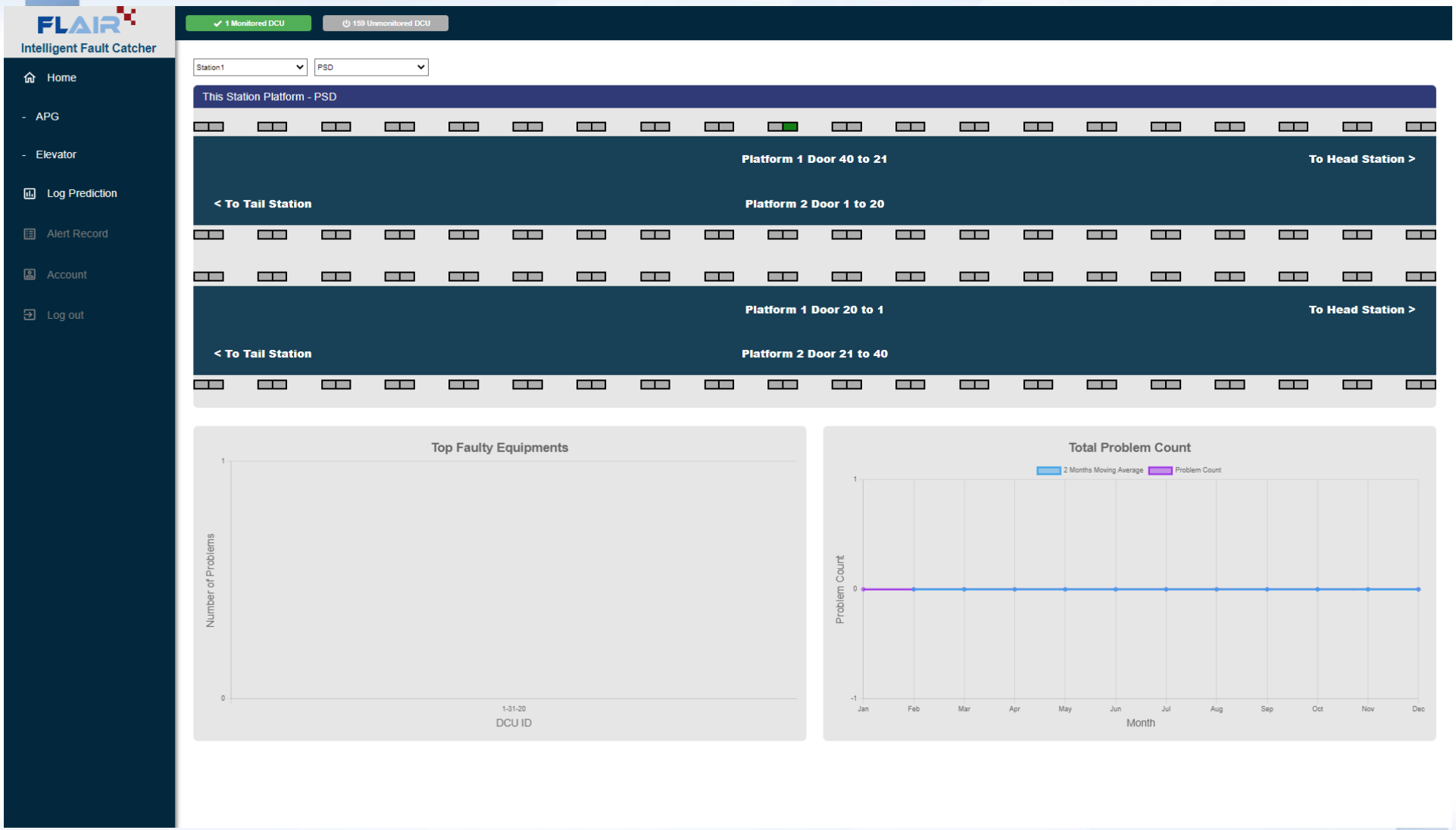
```
 ANALOG VALUE:Closing Time:1:4:73:3.40
 ANALOG VALUE:Opening Current Average:1:4:73:0.61
 ANALOG VALUE:Closing Current Average:1:4:73:0.54
 ANALOG VALUE:DCU Voltage:1:4:73:92.00
 ANALOG VALUE:Opening Time:2:16:50:3.00
 ANALOG VALUE:Closing Time:2:16:50:3.40
 ANALOG VALUE:Opening Current Average:2:16:50:0.53
 ANALOG VALUE:Closing Current Average:2:16:50:0.50
 ANALOG VALUE:DCU Voltage:2:16:50:92.00
 ANALOG VALUE:Opening Time:1:4:74:3.10
 ANALOG VALUE:Closing Time:1:4:74:3.50
 ANALOG VALUE:Opening Current Average:1:4:74:0.74
 ANALOG VALUE:Closing Current Average:1:4:74:0.78
 ANALOG VALUE:DCU Voltage:1:4:74:91.00
 ANALOG VALUE:Opening Time:2:15:51:3.00
 ANALOG VALUE:Closing Time:2:15:51:3.50
 ANALOG VALUE:Opening Current Average:2:15:51:0.62
 ANALOG VALUE:Closing Current Average:2:15:51:0.58
 ANALOG VALUE:DCU Voltage:2:15:51:92.00
 ANALOG VALUE:Opening Time:1:3:75:3.00
 ANALOG VALUE:Closing Time:1:3:75:3.70
 ANALOG VALUE:Opening Current Average:1:3:75:0.59
 ANALOG VALUE:Closing Current Average:1:3:75:0.50
 ANALOG VALUE:DCU Voltage:1:3:75:91.00
 ANALOG VALUE:Opening Time:2:15:52:3.10
 ANALOG VALUE:Closing Time:2:15:52:3.50
 ANALOG VALUE:Opening Current Average:2:15:52:0.55
 ANALOG VALUE:Closing Current Average:2:15:52:0.55
```

Fault Log Data

ID	DeviceID	Status	Message	DateTime
1	1	OK	Some text	2018-1-1 20:23:10
2	1	Fault	Something gone wrong	2018-1-1 18:22:10
3	1	Fault	Something gone wrong	2018-1-1 18:20:10
4	1	OK	Some Text	2018-1-1 17:00:00
5	1	OK	Some text	2018-1-1 10:23:00
6	1	Fault	Something wrong	2018-1-1 10:21:00
7	1	OK	Some text	2018-1-1 10:20:00

PHM: Automatic Platform Gate (APG)

APG PHM System Dashboard - Home Page



APG Health Index Page

FLAIR
Intelligent Fault Catcher

- Home
- APG
- Elevator
- Log Prediction
- Alert Record
- Account
- Log out

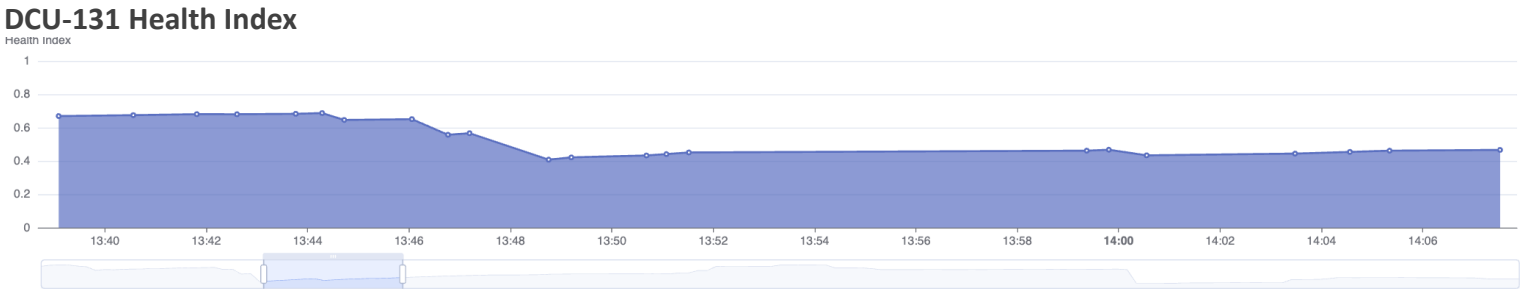
1 Monitored DCU | 159 Unmonitored DCU

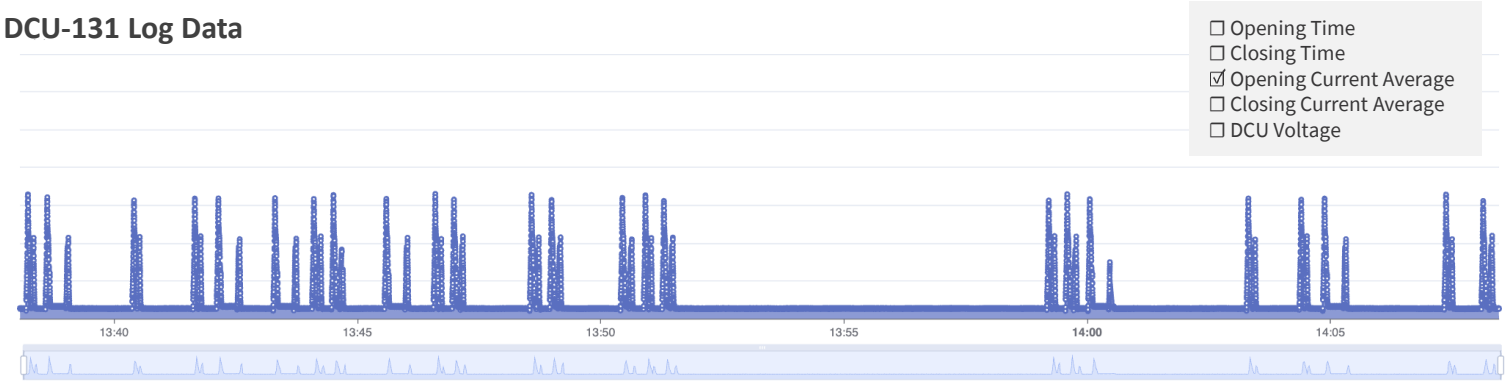
DCU-131 Health Index

DCU-131
0.63

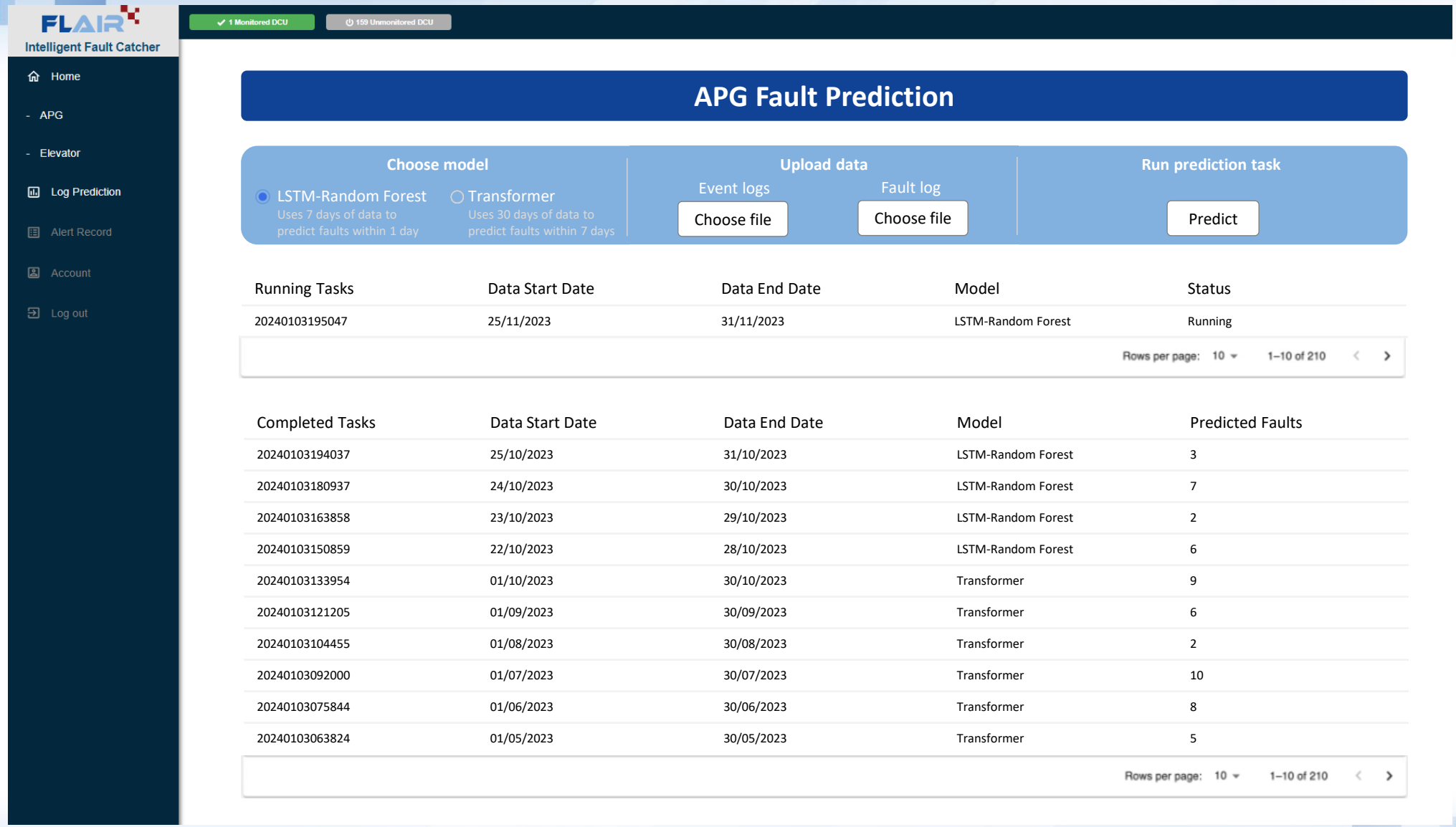
DCU-131

Last updated: 30/10/2023 4:55PM





APG Fault Prediction Home Page



APG Fault Prediction Results Page

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