Intelligent Image Analysis Solution for Preventing Overcrowding

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01. Introduction

Introduction

Crowd Crush Accident

An accident in which people crush and kill or injure people
as they put pressure against each other
such as multiple crowds falling down

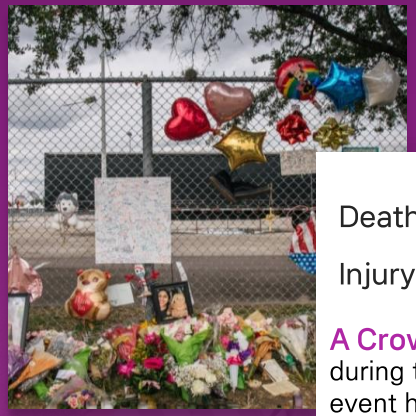
2015 Hajj Tragedy (Sept. 24, 2015)

Death : **2,177 persons**

Injury : **934 persons**

A Crowd Crush Accident that occurred in Mecca, Saudi Arabia while Hajj[1] was in progress

1) Hajj : Participating in religious rituals while visiting the Holy Land



Astroworld Festival Tragedy (Nov. 5, 2021)

Death : **8 persons**

Injury : **300 persons**

A Crowd Crush Accident that occurred during the Astroworld Festival, a music event hosted by NRG Park at Houston, Texas (US)

Introduction

Crowd Crush Accident

An accident in which people crush and kill or injure people
as they put pressure against each other
such as multiple crowds falling down

Kanjuruhan Stadium disaster (Oct. 1, 2022)

Death : 133 persons

Injury : 583 persons

A Crowd Crush Accident due to a r iot that broke out during a soccer match in Kanjuruhan Stadium at East Java, Indonesia

Itaewon Tragedy (Oct. 29, 2022)

Death : 156 persons

Injury : 152 persons

A Crowd Crush Accident that occurred in Itaewon-dong, Yongsan district, Seoul, South Korea

02. Necessity

Necessity

① Cause of crowd crush accidents

Because a great number of people gather at a certain area for a religious event, political event, and other events.

② Countermeasure

If a large number of people flock together, evacuate the site immediately, or if unable to evacuate, respond to crowd crush accident based on emergency instructions.

③ Problem

People cannot identify overcrowded areas in real-time or are unable to know all the information about areas expected to be crowded.

④ Solution

The local government or state institution must manage overcrowded areas in real-time and prevent an accident beforehand by providing information about overcrowding to the general public.

CROWDWATCHER

Capable of **preventing casualty accidents** through **management of overcrowded areas in real-time** and **taking preventive measures**

- Manages overcrowded areas in real-time
- Provides alarm in real-time when overcrowding occurs
- Provides alarm on direction of crowd movement in real-time
- Provides information on areas expected to be crowded.
- Manages image data of overcrowded situation
- Manages potentially overcrowded areas


Intelligent image analysis solution for preventing overcrowding
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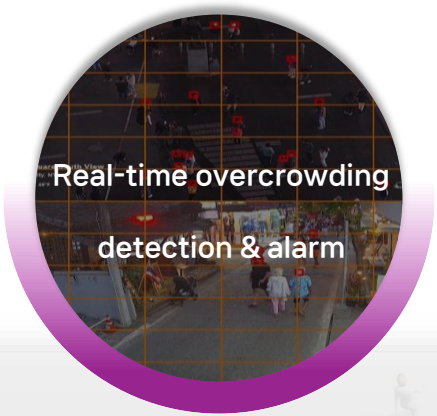
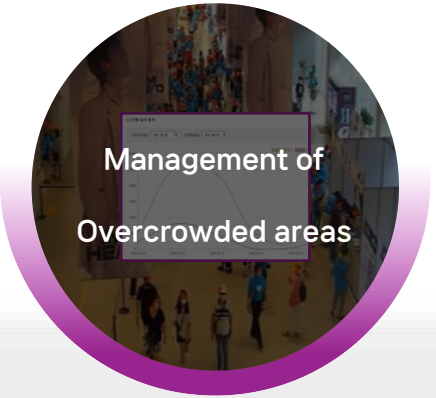
03. Overview

Overview

AI-based counting solution with enhanced convenience and efficiency of overcrowding detection using intelligent image analysis technology based on CCTV images





- Event alarm is set off for control officer when overcrowding event occurs
- Concentrated management of potentially overcrowded areas based on HeatMap
- Provides direction of crowd movement
- Systematic management of overcrowded areas based on statistical data

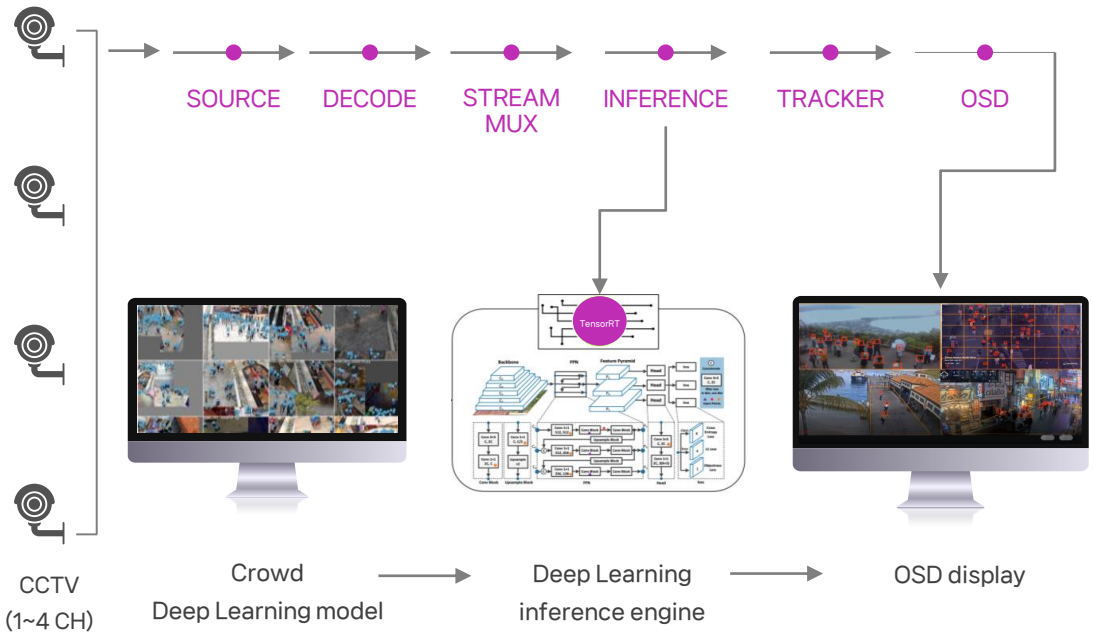
04. Main Technologies

Main Technologies

01 - Overcrowding detection technology

Overcrowding detection technology

- Deep Learning-based **Crowd data learning**
  - Data learning based on crowd deep-learning mode for enhancing crowd density detection rate
- **Crowd detection** within CCTV image
  - Detects crowd within current CCTV image using Deep Learning engine executed based on learned Deep Learning model to detect overcrowding within real-time video images



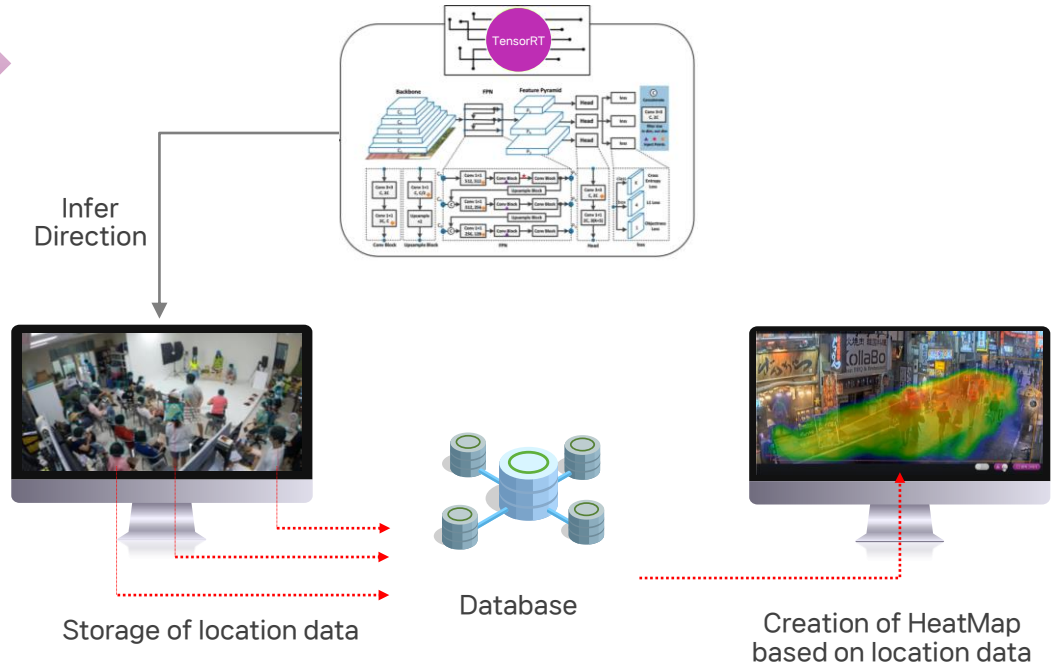
Main Technologies

02 - Technology for creating HeatMap based on data from crowd location inference results

Technology for **generating HeatMap based on data** on crowd location inference results

- Location **inference & storage**
  - Inference and storage of location of objects within CCTV video image using engine based on learned Deep Learning model.

- **Provides HeatMap information** based on location data
  - Creates and displays HeatMap based on stored location data

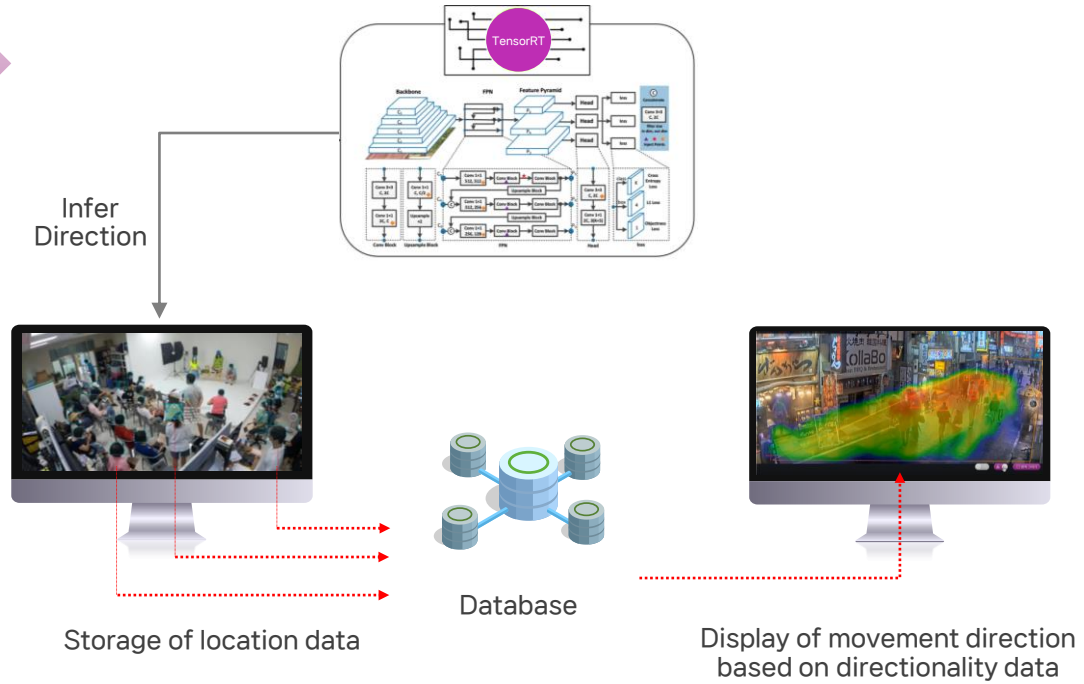


Main Technologies

03 - Technology for displaying crowd direction based on crowd direction inference result data

Technology for displaying crowd direction based on crowd direction inference result

- Direction **inference & storage**
  - Inference and storage of location of individuals within CCTV images using engine based on learned Deep Learning model
- **Display of** direction **data**
  - Displays individual's movement direction based on stored directionality data

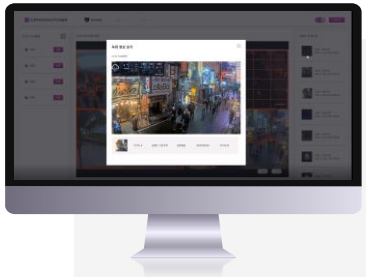


05. Major Functions

Major Functions

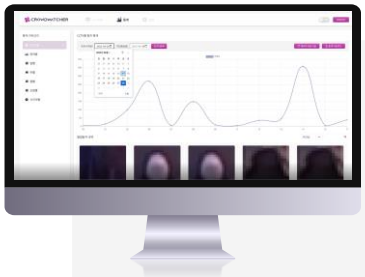
Real-time **alarm function for overcrowding**

Function for providing crowd direction information

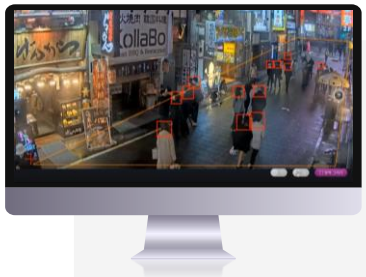


Function for **Recording and Replaying events**

Concentrated management of potentially crowded area



Statistics function



Function for setting areas

06. Detailed Functions

Detailed Functions

01 - Function for real-time alarm of overcrowding

Detailed Functions

- Support of 4 channel CCTVs
- Detects overcrowding within CCTV video images
- If the number of crowd defined by a user is concentrated, red line blinks on the relevant CCTV.
- Quickly communicates the overcrowding situation to a police station and fire department using auto alarm function.
- Warns overcrowding situation to the general public in real-time using loudspeaker and warning lamp

Expected Effect

- Capable of real-time identification of overcrowding and taking accident prevention measures.

4-Channel CCTV support

An event is indicated with red borders.

Detailed Functions

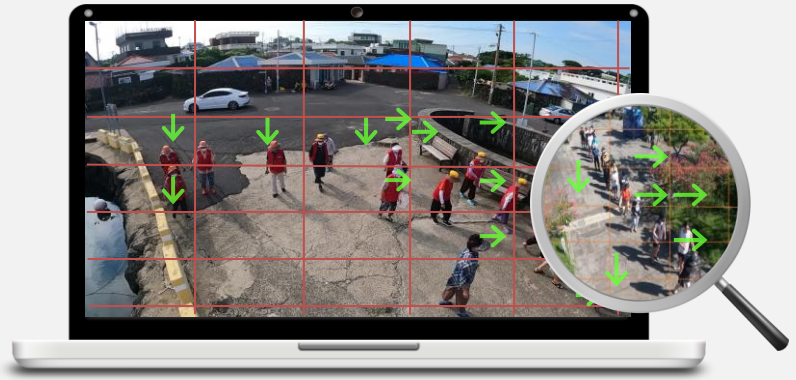
02 - Function for providing directionality information

Detailed Functions

- Detects directionality of **individuals within CCTV images**
- Provides **real-time movement direction information** of crowd within an area

Expected Effect

- Since the user can find out in which direction the crowd is currently moving, it is capable of **responding to an overcrowding situation according to the direction of crowd movement**.



Provides directionality info

Detailed Functions

03 - Timeline, Event Recording and Replay function

Detailed Functions

Timeline Function

- Events **are sorted in ascending order based on recent events**
- Provides info on CCTV where event occurred, area, time of event, **captured thumbnail.**
- Replays video images when thumbnail is clicked

Event Recording & Replay Function

- **Records video images,** including time before and after an event in case of an overcrowding event
- **Provides overcrowding situation video images** by displaying recorded images according to user's request.

Expected Effect

- Capable of **systematic analysis of overcrowding situation** based on provided images.

Provides **Timeline**

Recording & replay of event

Detailed Functions

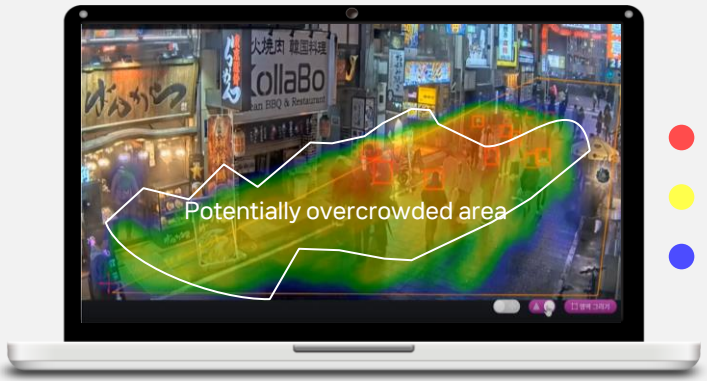
04 - Function for concentrated management of potentially crowded areas

Detailed Functions

- **Indicates** area with high crowd density **in Heatmap.**
- Classifies the stage of crowd density **into red, yellow, and blue.**

Expected Effect

- Capable of **concentrated management of potentially overcrowded areas by providing intuitive Heatmap of crowd density information within images** based on Deep Learning-based location information data.



Function **for concentrated management of potentially overcrowded area**

Detailed Functions

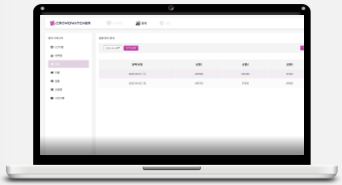
05 – Statistics Function

Detailed Functions

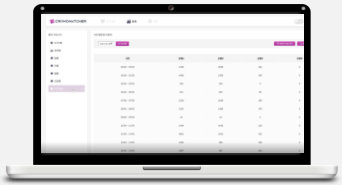
- **Provides statistics on areas and CCTVs** displaying virtual thumbnails and videos.
- Provides statistics by day, week, month, weekday, and time slot **based on the data of the number of crowds within an area.**
- Visual statistics : Displays thumbnail list of individuals detected within statistics by CCTV and area, and provides video images of an event **when a thumbnail is clicked.**
- Numerical statistics : **Provides numeric statistics** by period that calculated the crowded mass of people.
- **Data export** function by statistics

Expected Effect

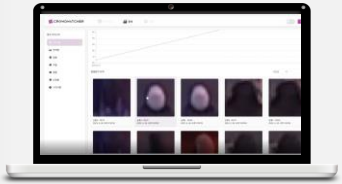
- **Capable of inducing installation of CCTVs and loudspeakers on areas where overcrowding is expected** based on statistical data.
- **Capable of identifying the situation before and after overcrowding** based on **visual statistics.**
- Capable of **efficient crowd dispersion management** by checking date and time of overcrowding by period based on numerical statistics.



Statistics by date



Statistics by time slot



Statistics by CCTV

Result of statistics export

Detailed Functions

06 – Area setting function

Detailed Functions

- CCTV monitoring screen
- If 'Draw area' is clicked on the monitoring screen, **Area Setting function can be used**.
- Area setting function
- Whole area : Sets **the area where overcrowding is detected on the entire screen.**
- Guide : **Sets area where overcrowding is detected by automatically dividing from 2×2 to 6×6 to fit the screen.**
- Custom : Function in which **the user directly divides and arranges** the areas where overcrowding are to be detected.

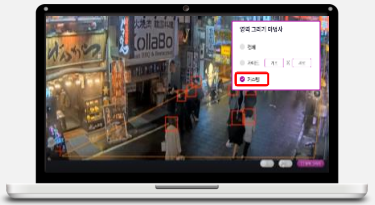
Expected Effect

- Improved user satisfaction anticipated based on **various detection area setting.**

CCTV monitoring screen

Whole area setting

Guide area setting



Custom area setting

07. Operating Specification & System Configuration

Operating Specification & System Overvieew

Operating Specification

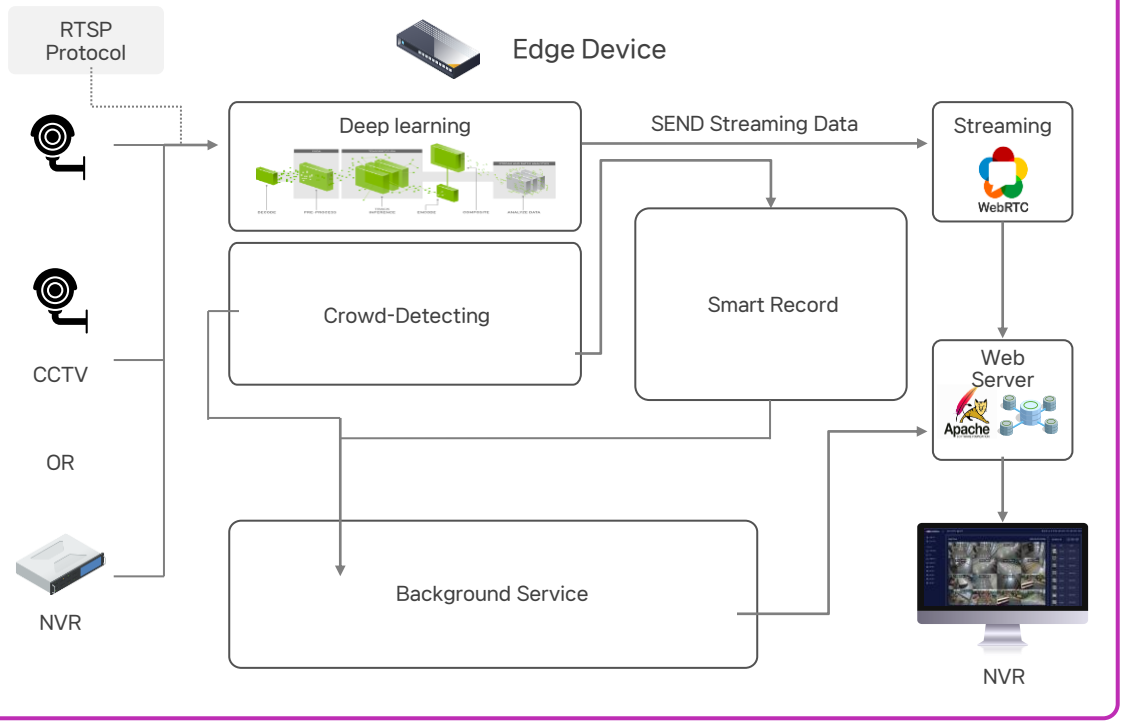
Software Specification

- Ubuntu 18.04.6
- WEB: Apache Tomcat 8.5.76
- DB : MariaDB 10.1.48

Hardware Specification

- CPU : 8-core NVIDIA Carmel Armv8.2 64-bit
- Memory : 32GB
- DISK : 256GB SSD
- POWER : 8 ~ 35V DC Input
  (Opt Acc. 160W AC-DC Adapter)
- GPU : NVIDIA Volta architecture
- NIC : 10/100/1000 BASE-T Ethernet

System Overview



08. Expected Effects

Expected Effects

Expected Effect
01

Accident Prevention & Safety

- Prevents overcrowding accidents
- Concentrated & safety management of crowded areas
- Effect of managing crowd dispersion in overcrowded areas
- Reduces accident rate
- Secures golden time and ensures safety of the general public

Expected Effect
02

Economic cost reduction through preemptive response to accidents

- Effect of saving time and human resources inputted to solve accidents
- Effect of saving economic cost that may arise due to accidents

Expected Effect
03

Enhanced Business Efficiency

- Enhances work efficiency based on video image analysis
- Reduces labor cost by improving working environment
- Quickly establishes work processing system

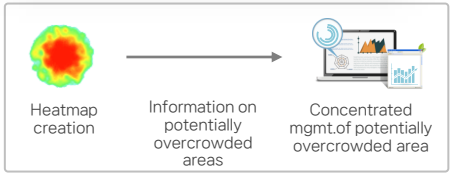
09. Service Scenarios

Service Scenario (Utilization plan 1)

"Prevention of an accident by detecting overcrowding and direction of crowd movement in real-time, and managing potentially overcrowded areas"

Management of potentially overcrowded areas

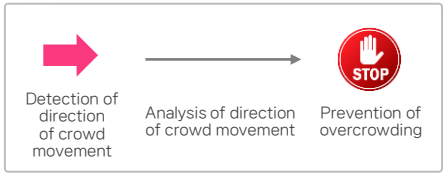
- Concentrated management of potentially overcrowded areas by providing a Heatmap of the crowd density information



"Do not approach since overcrowding is expected at Street XX"

Detection of direction of crowd movement

- Prevents overcrowding based on info on direction of crowd movement



"Overcrowding is expected at Street XX, maintain a safe distance of more than 1m with the person in front of you"

Real-time crowd management

- Prevention of incidents and accidents through crowd control

Real-time overcrowding detection & alarm

- Prevention of incidents & accidents through real-time alarm and detection of overcrowding

Service Scenario (Utilization plan 2)

"Prevention of overcrowding and accidents through management of potentially crowded areas based on statistical data"

① Provide overcrowding statistics info

Analysis & mgmt. of overcrowding statistics

② Manage potentially crowded areas based on analyzed overcrowding info

Management of potentially overcrowded area

- **Effect of managing crowd dispersion** by managing potentially crowded areas based on statistical data

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