Poster Abstract: Itocon - A System for Visualizing the Congestion of Bus Stops around Ito Campus in Real-time

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ABSTRACT

Due to the spread of COVID-19, we are desired to avoid crowded places including public transportation. Kyushu University has the largest campus in Japan, called "Ito campus", and the population there is about 20,000 in which 23% of students and 46% of staff use a bus for reaching the campus. The lectures in the first half of 2020 have been conducted online, but we plan to resume face-to-face lectures gradually. At that time, we expect the bus stops and buses to be crowded, especially during rush hour. In this paper, we introduce a system, called Itocon, to visualize the human congestion of bus stops around the campus.

Itocon aggregates the sensing data from various sensors deployed around the target bus stops, and calculate and visualize the congestion degrees in real-time. Itocon is developed as a web application to avoid requesting the application install. We hope all the people who use a bus change their moving time based on the congestion information for avoiding human crowds. We explain the details and the future prospects of Itocon.

CCS CONCEPTS

• **Information systems** → **Information systems applications**;
• **Social and professional topics** → *Surveillance.*

KEYWORDS

congestion sensing, visualization, social distancing, COVID-19

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1 INTRODUCTION

Due to the spread of COVID-19, the behavior to avoid crowded places such as shopping malls, restaurants are recommended.

"Ito campus" of Kyushu University is the largest campus in Japan, where more than 20,000 people are studying or working. Since the distance from the nearest rail station is bit far, 23% of students and 46% of staffs take buses to visit the campus. Therefore, the buses are always crowded during rush hours.

The lectures in the first half of 2020 have been conducted online, but we plan to resume face-to-face lectures gradually. At that time, we expect the bus stops and buses to be crowded as same as before COVID-19 era.

Google has implemented crowdedness predictions for public transits in Google Maps [3]. It predicts the crowdedness by using the contributed feedback from past riders. However, it doesn't deal the crowdedness of the bus stops.

In this paper, we propose "Itocon", a system for visualizing the human congestion at some bus stops around the campus. Itocon aggregates various data from several types of sensors deployed around the bus stops. And it calculates and visualizes the congestion degrees in real-time. Itocon is developed as a web application to avoid requesting the application install. We hope all the people who use a bus change their moving time based on the congestion information for avoiding human crowds. We explain the details and the future prospects of Itocon.

2 ITOCON

2.1 Overview

Figure 1 shows the screenshots of Itocon with functional explanation. We defined four levels of congestion degree empirically and

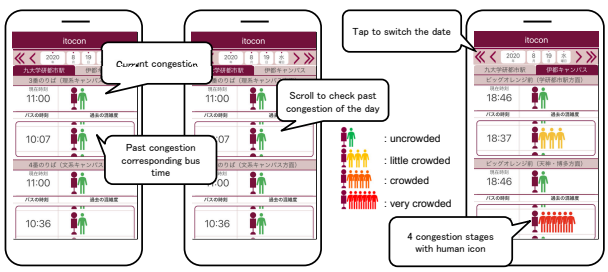

Figure 1: Screenshots with functional explanation of Itocon

designed icons that directly shows the degree of congestion. Itocon displays the current congestion degree every minute by icons. Additionally, a user can check the past congestion degree at every bus leaving time. The congestion data of past days are also available, which will help people who want to estimate the congestion for changing their future behavior.

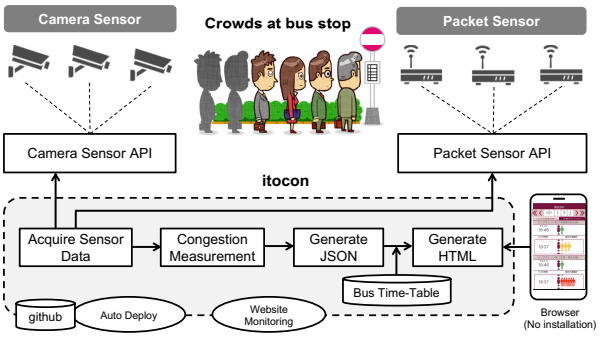

Figure 2: System architecture

Figure 2 describes the system architecture of Itocon. Itocon integrated the two types of congestion estimation system based on camera and WiFi probe packet. Since those have been deployed near the bus stops by past other projects respectively and independently, we needed to aggregate different data and show the congestion on the same scale.

2.2 Congestion data aggregation

Camera-based congestion estimation system counts the number of people by analyzing the image data [1] taken by multiple cameras. It is used for two bus stops at the nearest rail station.

WiFi-based congestion estimation system counts the number of mobile devices near a bus stop by monitoring the probe packets sent from those devices [4]. It is used for two bus stops in our campus.

The main server requests data periodically to those APIs and classifies the obtained value into four levels of the congestion degree based on the thresholds shown in Table 1.

2.3 Visualization of the congestion

Itocon generates a static HTML file every minute to avoid heavy load on the sensor APIs and the main server because our potential user is around 20,000 persons.

The bottom of Figure 2 shows the processing flow of Itocon.

First, the aggregated data is converted to JSON data, which includes the timestamp and the congestion degree. The HTML file of the day is regenerated periodically by combining this JSON data and the time table of the bus. By generating pages independently of user access, it is possible to reduce the load on the server when a large number of people access at the same time.

Table 1: Thresholds to convert to congestion degrees

sensor API	Threshold	Congestion degree
Camera	$value < 10$	1
	$value < 20$	2
	$value < 30$	3
	$value >= 30$	4
Packet	$value < 20$	1
	$value < 50$	2
	$value < 70$	3
	$value >= 70$	4

2.4 Expandability and maintainability

Itocon is designed for expandability and maintainability.

The Itocon backend system is implemented with object-oriented programming to make it easy to add other congestion sensor APIs. The interface with the sensor APIs is created as a base class with common functions and is inherited to each kind of sensor to express the differences between various sensor APIs. We can easily support new types of sensor APIs thanks to this implementation. We are planning to employ WiFi-based sensing technologies [2],[5] for congestion sensing while preserving users' privacy in the future.

To maintain Itocon effectively and sustainable, we employ an alive monitoring system and automatic deployment system. The alive monitoring system notifies a manager when the server is not available or when the sensor API returns an abnormal value. The automatic deployment system monitors the remote repository of Itocon by using the Webhook function, and it pulls the files when new changes are committed to the main branch.

3 CONCLUSION

In this paper, we presented Itocon, a system for visualizing the human congestion of four bus stops around our "Ito campus". According to Google Analytics, for three months from June 12 to September 11, 1392 people have accessed Itocon, and the total number of access is 2560. The maximum daily active users (DAU) is 298. 347 users have accessed Itocon multiple times and 37 of them have accessed Itocon more than or equal to 10 times. The most active user has accessed Itocon 77 times. Itocon was often accessed in rush hours, such as around 8am, 9am, 3pm, and 6pm. The number of users is slightly smaller than we expected, but we expect that it will increase if the face-to-face lecture starts. We plan to advertise Itocon more to acquire users, installing more sensors to other bus stops and other crowded places such as cafeterias and in buses.

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REFERENCES

[1] Alexey Bochkovskiy, Chien-Yao Wang, and Hong-Yuan Mark Liao. 2020. YOLOv4: Optimal Speed and Accuracy of Object Detection. *arXiv preprint arXiv:2004.10934* (2020).

[2] Masahiko Miyazaki, Shigemi Ishida, Akira Fukuda, Tomoki Murakami, and Shinya Otsuki. 2019. Initial Attempt on Outdoor Human Detection using IEEE 802.11ac WLAN Signal. In *Proc. IEEE Sensors and Applications Symposium (SAS 2019)*. 1–6.

[3] Ramesh Nagarajan. [n.d.]. Get Around Safely with These New Google Maps Features. https://www.blog.google/products/maps/get-around-safely-these-new-google-maps-features

[4] Atsushi Shimada, Kaito Oka, Masaki Igarashi, and Rin-ichiro Taniguchi. 2017. Congestion Analysis Across Locations Based on Wi-Fi Signal Sensing. In *Proc. Int. Conf. Pattern Recognition Applications and Methods*. Springer, 204–221.

[5] Ryo Takahashi, Shigemi Ishida, Akira Fukuda, Tomoki Murakami, and Shinya Otsuki. 2019. DNN-Based Outdoor NLOS Human Detection Using IEEE 802.11ac WLAN Signal. In *Proc. IEEE SENSORS 2019*. 1–4.