Real-time Detection of the "Three Cs" with Image Analysis "COVID-19 AI Image Analysis Solution"

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1. Introduction

Efforts to stop the spread of COVID-19 and restore stable economic and social life continue. Negative impacts on the entire market are huge, and annualized GDP is expected to drop 20% or more. However, there are also industries that have prospered during the pandemic, and solutions needed for the "New Normal" are flourishing, with demand for online meeting and SaaS business tools for remote communication and remote work, robotic technologies for remote operation and automation, and services such as online shopping and delivery for at-home consumers.

With a mission to "Solve social and customer issues and create new business and a new society using advanced technology," Ridge-i Co. Inc. has provided unique AI solutions in wide-ranging fields and has had much success* with AI image analysis, focusing particularly on deep learning.

The majority of our members are either practitioners and researchers in machine learning, or from strategic consulting firms, pursuing ideas from a broad perspective (hence "Ridge") through knowledge synergy among specialists from various fields.

* One example of success in development is a technology to automatically colorize black-and-white video, developed in collaboration with NHK Art Inc. In collaboration with Ebara Environmental Plant Co. Ltd., we also developed a deep learning system to recognize garbage features. It has been in use for over one year as part of an "Automatic garbage identifying AI crane" at a waste incinerator facility operated by Funabashi City. We also have several initiatives using AI to analyze satellite data, including a land-slide analysis AI developed under contract with JAXA, and SAR image analysis for the major oil spill that occurred near Mauritius, as reported on Yahoo! News and other major media. We have been awarded the Fourth Space Development and Utilization Grand Prize by the Minister of Economy, Trade and Industry (METI) for our utilization of advanced technology to solve societal issues.

In this article, we discuss our "COVID-19 AI Image Analysis Solution," which is able to detect the three C's: "Closed spaces," "Crowded places" and "Close-contact settings"; from camera images in real time. We developed and released it in only two weeks after the state of emergency was declared in April 2020. We discuss its features and future prospects, as well as future requirements for AI technology and organizations.

2. Background to "COVID-19 AI Image Analysis Solution"

On April 7, 2020, when many countries were just beginning to implement measures such as social distancing to prevent the spread of novel coronavirus infection, seven prefectures, including Tokyo, declared a state of emergency. On April 16, our Chief Research Officer (CRO), Yoshitaka Ushiku and I met to discuss for the first time whether there was anything we could do. That was when the concept for "COVID-19 AI Image Analysis Solution" took shape. The next day, we met with our research engineers and decided on an architecture, and our engineers volunteered to take on parts to be worked on in their spare time. Development was completed on May 1st, and the whole solution was released on that day. All work from conception to release was done in approximately two weeks.

3. Measuring closeness, crowdedness and crowd size from camera video

The "Video Analysis AI Solution for COVID-19," released in May 2020, is an AI solution that accurately detects the number and location of people in network cameras in almost real-time, and analyzes the distance between people, the degree of crowding, and the flow of people in crowds. It consists of the following three elements.

In addition, we offered a course on AI fundamentals (4) to help participants make effective use of their home time during the major holidays under the emergency declaration and to deepen their knowledge of AI and machine learning.

(1) Crowd counting, density estimation, and time-series measurement of passers-by (for street cameras, commercial facilities, and tourist facilities)
(2) Close-contact alerts (for offices, hospitals, shops, etc.)
(3) Person tracking and Re-ID
(4) AI fundamentals lecture, free-of-charge on YouTube

(1) is a system that analyze video from cameras in the street or commercial areas, displaying congestion conditions as a heat map and counting passers-by and the size of groups in the video in near-real-time. It can also show a graph of the results, which shows the number of passers-by over time. Currently, a demo of the crowd-size counting module is available on YouTube, used to analyze real-time video from areas of Hamamatsu City in Shizuoka Prefecture (see link at the end of the article). This has

been operating continuously since May, using AI functions that analyze images from cameras installed at fixed locations in the city. It locates passers-by and areas with congestion in the video, displaying data on the web page as a heat map or as a graph of daily and hourly traffic.

The camera stream is processed by an AI installed on the cloud, and the analysis is achieved with almost no delay from the live video.

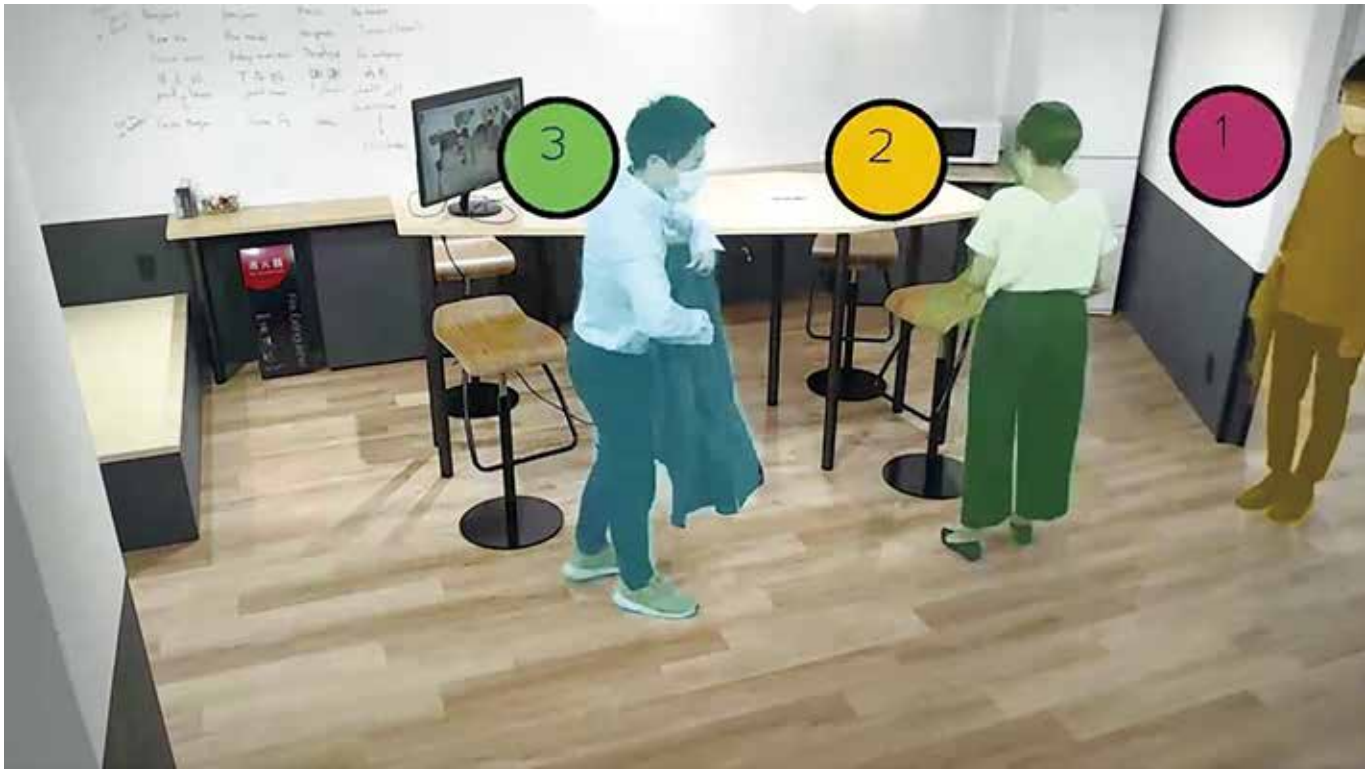
Currently, the system is accurate enough for practical applications in large facilities such as stadiums, commercial facilities, or public offices with many people coming and going. In the future, we intend to also support night-time operation, and we are also already preparing to provide versions that run well on Android and edge devices.

(2) assesses the separation of people in more closed environments such as offices, hospitals, or shops; in order to detect and alert the user when people get too close, or when congestion occurs as the density of people exceeds a certain level. For example, in an office with a large number of staff moving around, if the distance between them becomes less than 1.5 meters (the distance can be set freely), an alert is issued in real time. It is also possible to notify by sound or vibration. In particular, the distance between people is measured with high accuracy by capturing the position of each foot using AI for posture estimation and person detection.

(3) performs person tracking and re-identification, identifying each person by analyzing their face, bone structure, clothing, walking style, etc. without a need for prior registration of users. The mechanism assigns a unique ID to each person when they first appear on the camera image. Once this ID has been assigned, it will be applied to that person even if they leave the image and reappear later. As such, the technology can be used to authenticate that it is the same person (Figure 1). This person tracking function could be used to check a person's past movements from camera video if, for example, they are diagnosed with COVID-19, to identify who they were most in contact with or locations requiring careful disinfection. This could also prove itself useful in order to perform procedures more efficiently after an infection is detected.

By using the kind of solutions that we provide, it is possible to detect and avoid "dense" situations in various environments in real time. In particular, since they are based on camera image analysis technology, they have advantages over mobile base station data (Mobile Spatial Statistics), which operates on a coarse mesh, and can cover indoor environments where GPS is weak. They can also

Figure 1: Person tracking and Re-Identification AI. Assigns IDs without prior registration. Assigns ID by making use of features such as posture, body type, etc. so that the same ID is assigned even after the subject puts on a jacket.



determine whether masks are being worn through image analysis. We have already had inquiries from public offices, retail chains and automobile dealerships and we are conducting trials with some of them.

Our fourth initiative (4) is unique as a solution. On the assumption that the number of on-line students will increase because they are spending more time at home, we have been offering basic AI training lectures free-of-charge on our YouTube channel since May. The lectures cover a curriculum conceived by our CRO, Yoshitaka Ushiku, to provide an overall grasp of AI. They include ten basic-lecture videos following the history of machine-learning development, from the birth of AI to the present. This course is also used as a tool to build a correct common understanding of AI with our customers.

4. AI technologies used in the solution

Our COVID-19 AI Image Analysis solution's strengths are its exceptional accuracy and inference speed in each of the technical elements, as well as how they are integrated. The main technical elements used in the solution are described below. While each of them alone could be considered AI, we refer to combinations of multiple elements as a single solution.

- Pose estimation Deep Learning
- Human Detection Deep Learning
- Human attribute classifier Deep Learning
- Human and Object Tracking Technology
- High-speed, stable video stream processing
- Crowd Counting Deep Learning

Our AI development for posture estimation and person identification is at the top level in the world in academic benchmarks, and in particular, our proprietary deep learning method for posture estimation has achieved SOTA (State of the Art) in public benchmarks (as of June 2020).

A single deep learning is rarely enough to solve a real-world problem, but by combining multiple deep learning models, users can experience an end-to-end AI solution.

5. New social challenges from the COVID-19 pandemic

One thing we felt keenly in creating this "COVID-19 AI Image Analysis Solution" was the importance of preparing systems such that technologies can be provided immediately when needed. To solve immediate needs, quality is of course necessary, but speed is required above all else.

As mentioned in the introduction, our mission is to "Solve social and customer issues using advanced technology and create new business and a new society," but practically speaking, given limited resources and unexpected troubles, it has been more difficult to work concretely based on this mission than we imagined. There are other companies with similar missions, but it seems that most of them were not able to maneuver under the declaration of emergency and its effects, or to adjust for remote work and other measures. We also had planned projects just before the declaration of emergency, which changed drastically because of it, and we were forced to respond quickly. However, taking action under such conditions is the hallmark and raison d'etre of a venture company, and we managed to overcome these problems by a good margin.

In addition, in order to respond quickly to unpredictable situations, it is important to create robust elemental modules and technologies such as the ones mentioned earlier, so that we can combine them flexibly to provide an AI that can answer specific problems. Beyond just advanced development skills, the ability to understand real-world problems, divide them in elemental components and translate them into technical requirements is also crucial.

Even if we see what needs to be done technically to solve the problem, it can be difficult to reach the decisions necessary to execute it. In this case, our CRO, Yoshitaka Ushiku, and I went ahead based on our own judgment, but we could not have succeeded without our volunteers' support. We strongly felt the importance of our mission and our organizational culture. It was important to decide roles quickly and pursue multiple tasks simultaneously without waste of time, not only by top-down decisions but also by parallel and organic decisions taken at all levels of hierarchy.

The four solutions we provided this time are not the ultimate solutions to problems, but they have provided an excellent opportunity to challenge the technologies and the organizational culture we have cultivated over four years. I think the greatest assets we have gained are a greatly increased awareness of our development processes, of what sort of AI technical elements can be modularized to provide functionality quickly and with flexibility, and the real experience of creating a solution within a period of only two weeks.

6. AI technology requirements and company qualities required in the future

After the announcement of the solution, we received not only inquiries from commercial facilities, but also requests for interviews from various media groups, including NHK. It was particularly impressive that we were asked not only about the details of the functions and technology, but also about why we decided to create such a solution.

Six years have already passed since the tertiary AI market in Japan began gaining notice in 2014. With a large amount of AI

ventures in the market, it is difficult for a company to shine based on its AI technology alone. The market also has a reputation that many projects do not go beyond the PoC stage, resulting in mixed feelings of hope and disappointment. According to material published by the Ministry of Economy, Trade and Industry (METI) in March 2020, 97% of AI related projects are abandoned before completion, which is quite surprising. We have summarized the obstacles faced by some representative projects below (Figure 2).

Considering the level of maturity of this market, companies that have been developing AI thus far will need to make drastic changes. They are already expected to provide not only promising AI prototypes, but also successful integrations that can be used in practice.

Social and business needs are also changing prompted by the COVID-19 pandemic, but the New Normal has not settled yet. Under such conditions, we must assume that there are still no precedents for some user needs or how to address them, and ventures must find agile solutions quickly, by experimenting quickly and not being afraid of failure.

In the New Normal, the need will likely increase for solutions characterized by keywords such as remote monitoring, remote operation, semi-automation, and location-free. AI technology will be a necessary element of such solutions, but many problems in robotics, communications, edge inference, sensing and other fields cannot be solved with AI alone, making it increasingly important to have partnerships with enterprises in various other fields.

The qualities that a company must have in such an environment include (1) ability to sense and adapt flexibly to new needs in society, (2) rapid development, deployment capabilities and technical assets to respond quickly to urgent issues, (3) design and technical capabilities to go beyond planning to successfully deploy their solution and produce results, and (4) ability to collaborate with partners in solving problems rather than only acting alone.

At Ridge-i, we plan to maximize the AI technology assets and personnel that we have cultivated to provide solutions that produce major benefits for our customers, replacing the negative impacts brought on by COVID-19. We encourage partner companies and individuals to contact us, to propose and implement solutions for the New Normal together.

Related Links
Ridge-i Inc. https://ridge-i.com/
Hamamatsu City, Kajicho-dori, Live demo of counting crowd numbers
(Ridge-i YouTube Channel) https://www.youtube.com/channel/UCTBaJrfibBNosxCVEjPnYWw

Figure 2: Bottlenecks to introduction of AI. 97% of AI projects are abandoned uncompleted.