IHI Project:

Title: Novel framework of optical character recognition for sustainable food supply chains

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Background and objectives:

Several highly automated systems using standardized formats have been available in distribution and retail industries, but achieving sufficient reliability of necessary information remains very challenging because tremendous varieties of labeling formats are still used widely to display prices, ingredients, expiration dates, and other information, all depending on the product characteristics. This diversity is especially true for the food supply chains which connect farmers to consumers through various supply routes, even though state-of-the-art AI technologies have led to development of reliable systems in quite challenging environments. This situation creates several difficulties when trying to decrease food waste and to transform our society into a more sustainable one.

The objective of this project is construction of novel approaches to alleviate such difficulties using applications of mathematics. In recognition of partially obscured character strings printed in various formats and typefaces from different viewpoints and from different viewing angles, mathematical approaches such as geometry and topology are expected to play crucially important roles together with modern machine learning techniques.

Technical target of the project

We have set a specific system as the project's target as described below, but the framework we develop for the project is expected to be applicable to a broad range of automated systems.

When a cardboard box containing food arrives at a distribution center, the expiration date printed on the box is read immediately. After registration of this information in the center's system, it is used as a record for shipping. Additionally, shipments are arranged so that items approaching their expiration dates are prioritized. Expired items are excluded. Currently, handheld terminals are used to read expiration dates manually. To reduce costs, this repetitive task must be automated.

To automate the reading of expiration dates, we have constructed the device presented in the following diagram [1].



- (1) The first sensor counts the cardboard boxes.
- (2) A barcode printed on the cardboard is read to verify the box contents.

(3) A webcam captures an image of the side of the box to recognize the expiration date printed on the surface.

(4) After the read information is printed on a label, it is affixed to the cardboard box.

The expiration dates are printed in various locations on the boxes using different formats, fonts, printing methods, colors, and sizes. Additionally, some parts of the text might be smudged or hidden by adhesive stickers.



Expectations

Student members are expected to construct and then implement a new algorithm to read expiration dates from images on the sides of cardboard boxes printed using widely diverse methods, formats, and fonts: often they are partially obscured. As the output, the system is expected to display the following information on the screen and simultaneously record it in a file:

- The expiration date in the format of 2024-01-24 (ISO 8601 format)
- > The reading confidence level (0% 100%)

Some different ideas might be useful when defining confidence levels that affect the reliability of the automated systems immediately, which are especially important in food supply chains. The anticipated outcomes of this project extend beyond those listed above, and we also welcome stretch goals that arise from the identified challenges.

Requirements

Mandatory:

- > Programming skills (Python, or any of C++, C, or other alternatives.)
- Elementary knowledge of image processing [2]

Image preprocessing enhances the printed text contrast and removes noise, thereby improving the accuracy of optical character recognition (OCR).

Preferred

Elementary experiences in machine learning [3]

Training machine learning models to accommodate different formats, fonts, and printing methods is an important part of the project.

➢ General knowledge about OCR [4]

For accurate reading of the text of expiration dates printed on cardboard boxes, OCR technology recognizes characters in images and converts them into digital text. OCR technology must be capable of identifying characters, even if smudged or printed in different formats.

References:

- [1] Press release, "<u>IHI, group company, and U.S. startup jointly develop the world's first</u> automatic expiration date reading system for food shipping cases," 2021
- [2] <u>https://www.kaggle.com/code/zeeshanlatif/image-processing-basics-with-opencv-for-beginners</u>
- [3] https://pytorch.org/tutorials/beginner/basics/intro.html
- [4] Najib Ali Mohamed Isheawy and Habibul Hasan, Optical Character Recognition (OCR) System, IOSR Journal of Computer Engineering (IOSR-JCE), e-ISSN: 2278-0661, p-ISSN: 2278-8727, Volume 17, Issue 2, Ver. II (Mar.–Apr. 2015), pp. 22-26