岩手県立大学
ソフトウェア情報学部
Faculty of Software and Information Science
Iwate Prefectural University

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Egg Surface Inspection Using Infrared Transmitted Light Images

Hisayoshi Ito and Oky Dicky Ardiansyah Prima

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hito@iwate-pu.ac.jp

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Contact

Assist. Prof. Hisayoshi Ito

Iwate Prefectural University, Department of Software and Information Science, Japan.
hito@iwate-pu.ac.jp

Research Interests

- Human-Computer Interaction
- Behavior Analysis
- Eye Tracking
- Virtual Reality

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Background :: Boiled Egg Production

Boiled Egg is one of the mass-produced daily food products in Japan.

- 😟 To avoid damages during transportation and to keep a good appearance as a product, **the surface of eggshells must be smooth**.
- 😟 The food processing industry **manually removes out-of-spec eggs** before boiling.

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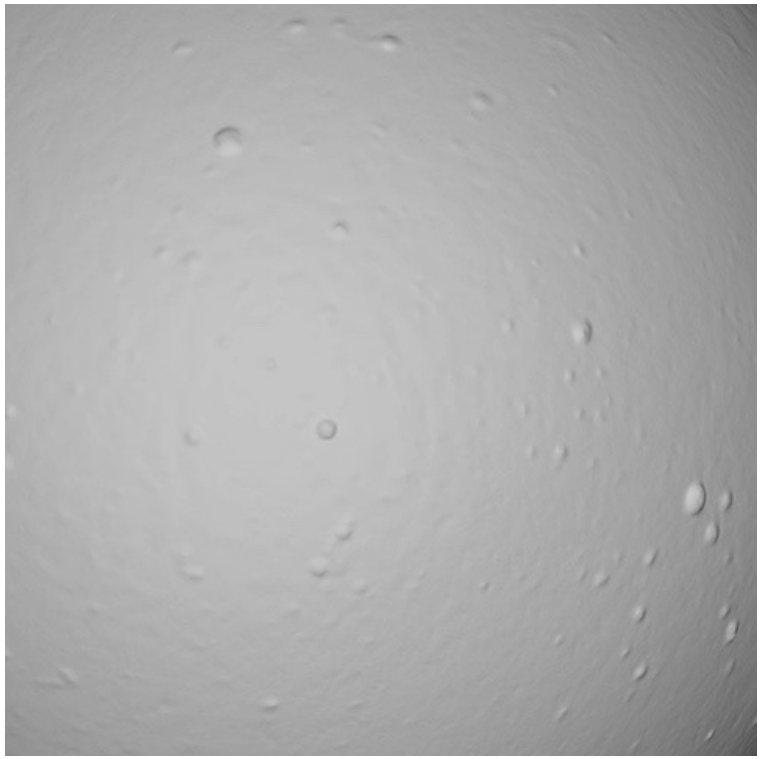
Background :: Out-of-spec eggs

As shown in the figure, there are many **protrusions** on the surface of the out-of-spec egg's shell.
These protrusions can trigger cracks due to vibration during transportation, **causing them to be unsalable**.
Surface unevenness that exceeds the standard is called "Zara", and eggs with Zara must be removed before being boiled.



Study Aim

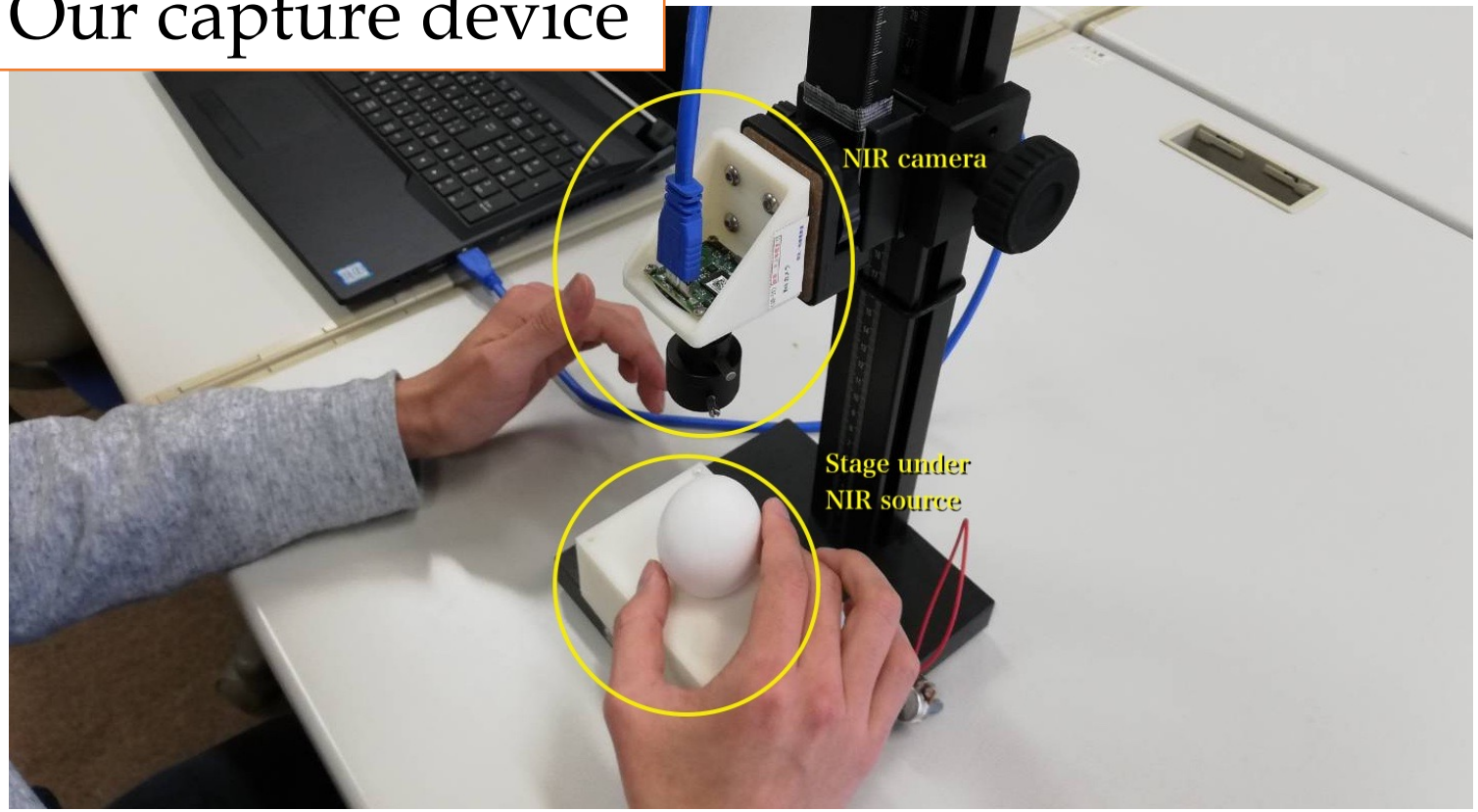
This study aims **to develop an inspection system that detects out-of-spec eggs with "Zara"** to produce boiled eggs.

- To detect the protrusion on the surface from images of the eggshell taken by a camera that can capture images near-infrared light.
- To identify a good or not good state of surface shape using features of the NIR image of the egg.

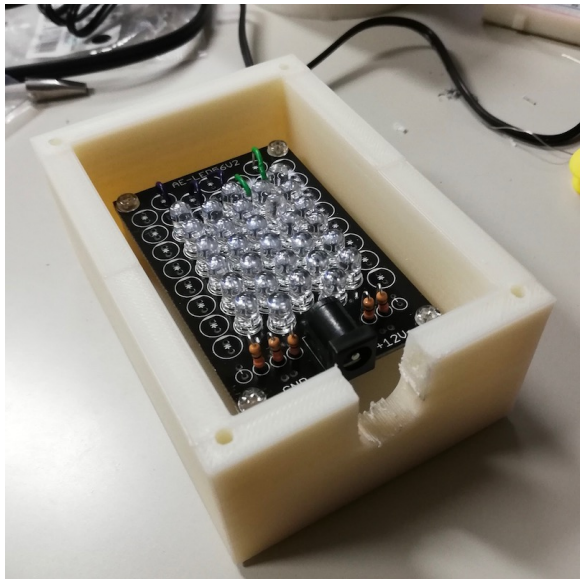
Methodology::Image Acquisition

We attempt to inspect the shape of the egg's surface with **a camera that can capture near-infrared images** and **near-infrared LED as a light source**.

Our capture device

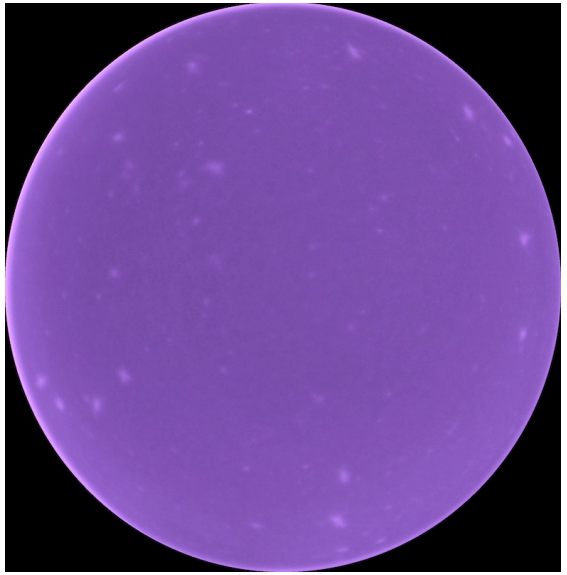


Stage with NIR light

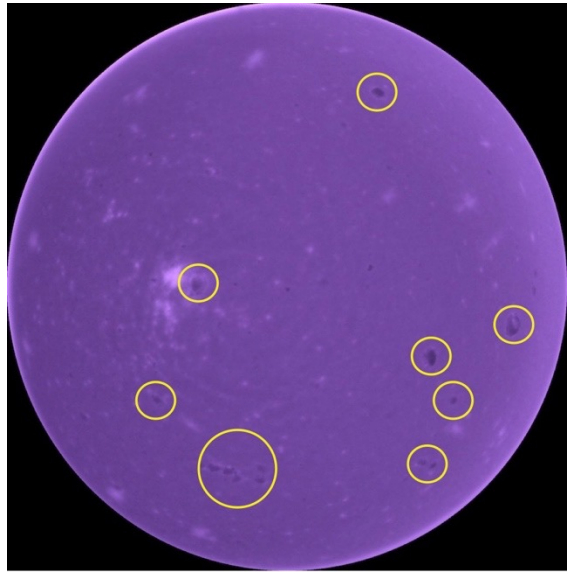


Methodology::Image Acquisition

Images captured by our device represent **the thickness of the eggshell**, not the egg's internal structure. High brightness areas indicate that the shell is relatively thin, and low brightness areas show that the thicker areas. Hence, the image of the substandard egg has **darker local regions that represent protrusions of the surface**.



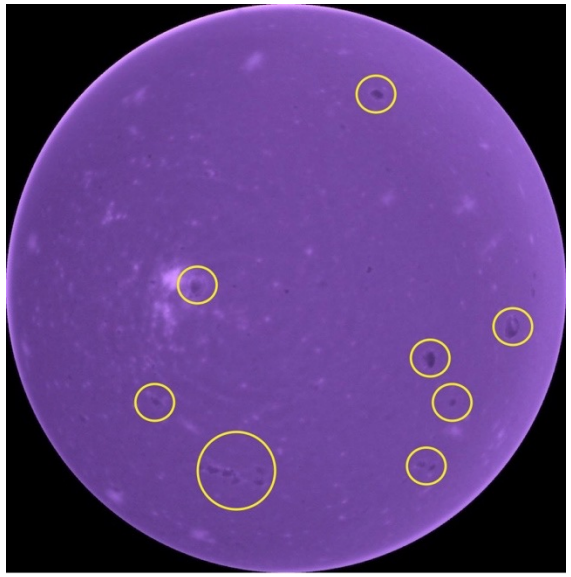
NIR image of a good egg



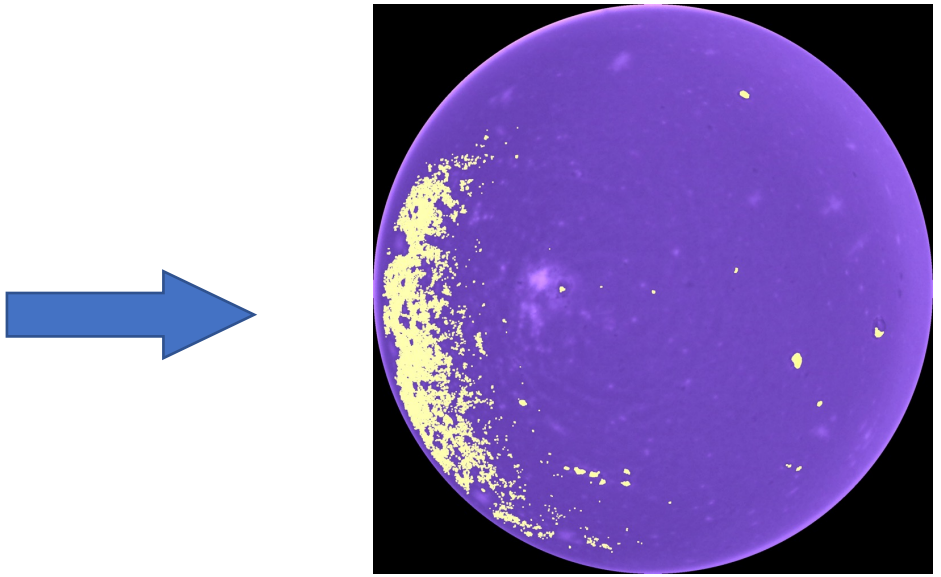
NIR image of a out-of-spec egg

Methodology::Thresholding

To extract regions of low brightness, the captured images **were binarized with predefined threshold** *L*. Regions drawn by yellow are blobs as a result of thresholding. These blobs contain **narrow areas due to local protrusions** and **large areas due to shadows** because of low transmitted near-infrared light.



NIR image



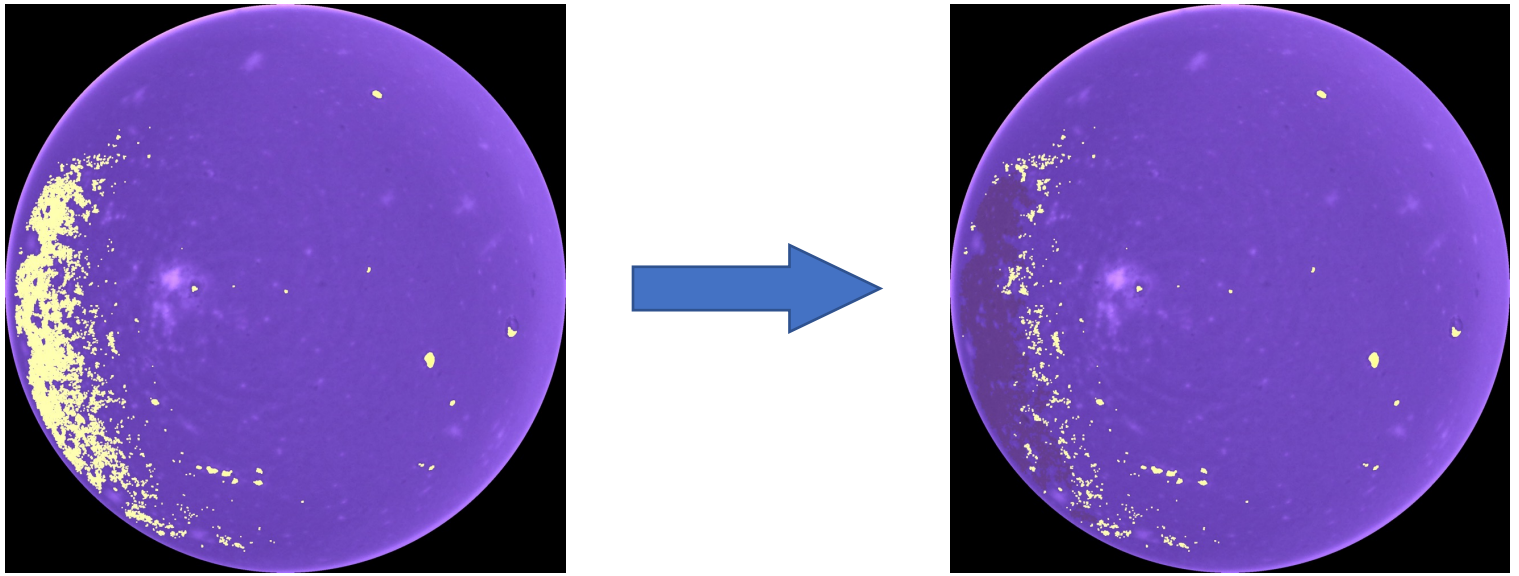
Binarized image imposed over NIR image

Methodology::Unevenness Identification

Blobs were distinguished between surface protrusions and shadows by comparing that area with a predefined upper limit and lower limit. The number and distribution of protruding masses could be a criterion for determining the presence of “Zara” on the eggs, and good or not good to produce boiled eggs.

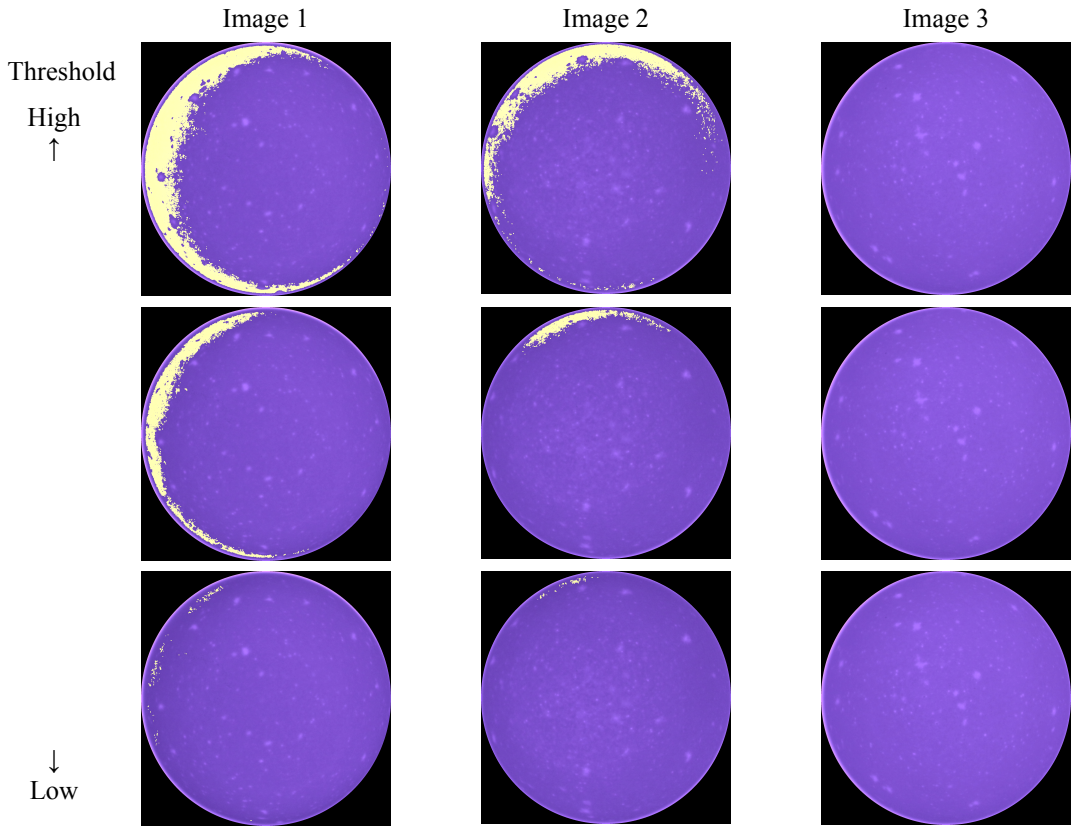
Binarized image without large blobs

Binarized image



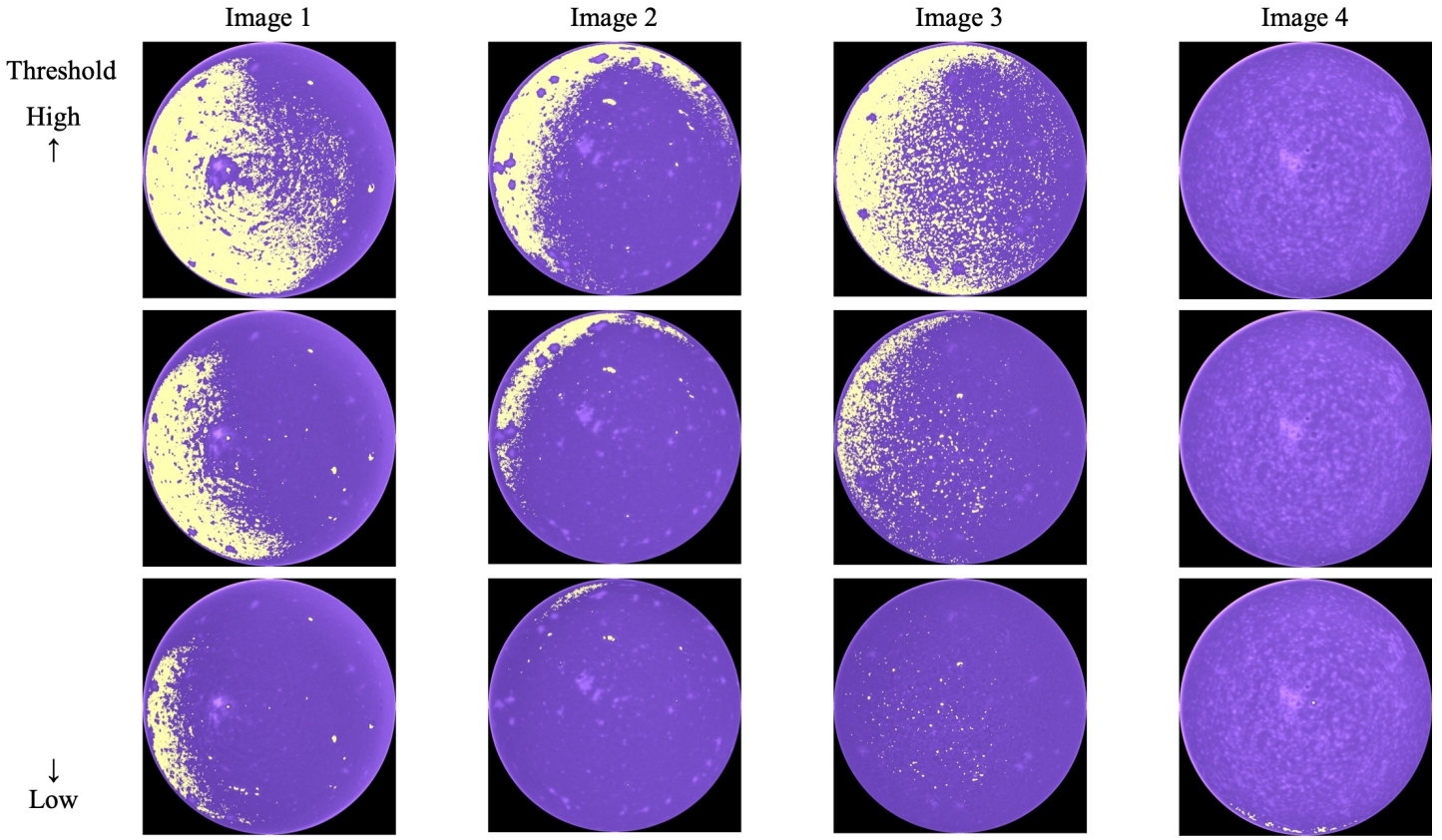
Experiments::Good eggs

The figure shows 3 NIR images of good eggs binarized with various thresholds. Images in Each row were the same threshold, respectively. Blobs identified as protrusions were rarely shown; however, on edge of the egg image, large blobs identified as shadows remained when the threshold was high.



Experiments::Threshold and blobs

The figure shows 4 NIR images of out-of-spec eggs that were binarized with various thresholds. Images in Each row were the same threshold, respectively. The result shows a common threshold cannot get extract protrusive blobs from various out-of-spec eggs.



Conclusion

- Our image sensing system was able to extract the features of irregularities on the surface of eggshells by near-infrared rays.
- Blobs identified as protrusions were rarely observed from images of good eggs; however large blobs identified as shadows were found in binarization with a high threshold.
- The constant threshold did not give good results for extracting blobs at the protrusive region from overall images of out-of-spec eggs.

Future Perspective

- The future focus will be on matching the NIR image with the three-dimensional shape of the eggshell acquired by a 3D scanner to detect protrusions near the sides of the shell.