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An Image Processing Approach of Multiple Eggs' Quality Inspection

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ABSTRACT

The current system of checking and grading egg quality in the Philippines was done manually one by one using the traditional way where graders exert great effort that resulted in graders' visual stress. To address the problem identified the researchers proposed a scientific way of checking and grading the egg quality by using image processing based non-destructive and cost- effective technique to detect various cracks, dirt, and defect in eggs. Upon testing, the system obtained a total of 91.33% as high-quality eggs and the presence of either crack or dirt while 8.66% were inspected as low quality. For the internal part of each egg, the system achieved 100% detection of the yolk. The main results achieved have been quite promising; the researchers are encouraged to continue the labor of improving the generation of internal and external egg detection.

Key words Blurring Algorithm, Canny edge algorithm, Egg classification, Egg inspection, Image processing, RGB, HSV.

1. INTRODUCTION

The back bone of the world Economy is in the field of agriculture, 75% of countries depend on agriculture [1]. One of the sections in agriculture is poultry farming or raising eggs for the purpose of commercial egg production. In the study conducted by Abdullah & Nashat, they accentuate that eggs become an economical source of nutrients for a healthy diet and life now a days. Increased egg production and consumption in the developed and developing world would significantly improve food and nutrition security [2]. Quality of eggs plays a very important role in the production of the poultry industry. This refers to its several standards which define the internal and external quality of an egg. The internal quality refers to egg white (albumen) cleanliness and viscosity, size of the air cell, yolk shape and yolk strength while the external quality focused on shell cleanliness, texture, and shape [3].

Eggs are fragile and easy to be damaged in the processes of production, transportation, and other operations. Even if they are not broken, eggs with cracks are susceptible to bacterial invasion. Therefore, the cracked egg detection is an important part of the egg processing before eggs enter the market for consumption.

Traditionally, skilled workers manually distinguished cracked egg one by one, which was a heavy, boring and unsanitary work [4]. Shell quality is also one of the most important factors that influence hatch ability as the reduction in eggshell quality results in the weakening of embryos. Therefore, identifying broken eggs automatically has been the long outstanding goal in the poultry farming industry. Overall between 8 and 10% of eggs suffer shell damage due to mechanical impacts at the moment of laying or during processing and handling [5]. The shell thickness is also characteristic of external quality which is important for shell strength [6].

Egg candling is a process that consists in applying a strong light against an egg in order to detect abnormalities such as fertilized eggs, blood stains, spots, cracks, dirt. According to Chambers & Zaheer (2017) this process classifies the eggs in different grades [7]. This process involves a person looking at eggs on top of bright light shining through each egg on a conveyor belt. It is a tiring process and can lead to many mistakes [8].

The development of different method with the advancement of technology can ensure the good and high quality of any product [9]. The advantages of an automated quality evaluation over a human one are higher reliability, higher productivity and the ability to perceive more than human beings [10]. It is a necessity to have an excellent method to distinguish the quality of any food. This influences how the consumer will accept or reject the product. It also affects the demands in the market [11]. Food inspection is intended to prevent additional cost in the operation in any food industry.

In production processes the use of image processing system is widespread. Hardware solutions and cameras respectively are available for nearly every application. One important challenge of image processing is development and selection [12].

This paper is divided into the following sections. The second section presents the details on the methods used to develop the system from external detection using HSV and normalization algorithm to internal detection that will generate a clear view of the presence and shape of the egg yolk. The third section summarizes the result obtained from the series of testing conducted where more work is required. The fourth section discusses the conclusion of the researcher after conducting the series of testing to validate the effectiveness of the system upon using the algorithms for internal and external detection of the egg.

2. METHODOLOGY AND EXPERIMENTAL SET-UP

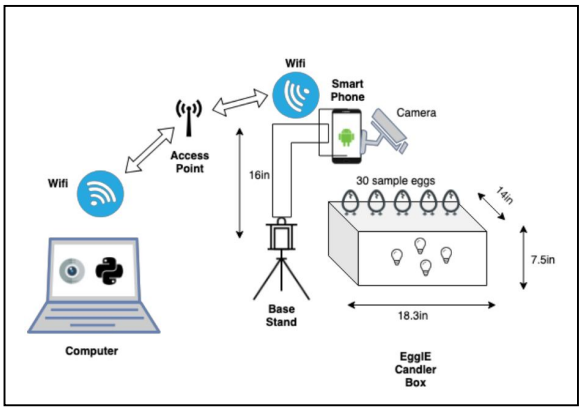

Figure 1: Conceptual Framework

Fig. 1 shows the conceptual framework of the system where samples were placed on top of the Candler box in a dark room that makes the internal quality visible. Images were taken using a smart phone with 16-Mega (f/1.9, 1.12-micron) rare camera. Digital images can be easily captured and stored everywhere [13] the light inside the box should be at least 3300 lumens for better visualization of the internal quality of the eggs. It consists of four warm white bulbs and surrounded by an aluminum foil for proper light distribution. Wireless communication was used to transmit the acquired images for inspection using image processing. The PC used as an image

2.1 Compilation of Sample Eggs

The eggs were came from the local poultry farm in the Batangas, Philippines. There are 30 eggs used as a sample for testing. These eggs were directly gathered fresh within the day of laying. Damaged eggs were removed, and sizes of eggs were not considered in order to inspect the internal quality of the egg regardless of the size. Five number of trials were made to determine the effectiveness of the proposed algorithm.

2.2 External Dirt Detection Algorithm

Detection of a n egg's stain is important as it affects the market value to consumers. Egg shell may get different amount of stain in the process of production, it may be caused by various substances like smears of blood which are more common on eggs from pullets in initial lay. This stains maybe in all or partial part of an eggshell. To identify a n egg stain, it is important to accurately display regions of potential stains. The severity of stains will be determined using the process below as shown in Fig 2.

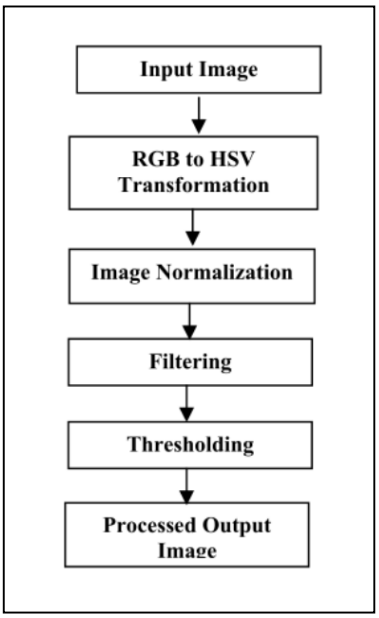

Figure 2: External Dirt Detection Algorithm

The process started from the captured raw image of an egg where this raw image is converted into HSV color space. This H denotes hue, S denotes saturation and V denotes values. This process of extraction with HSV color space is done by the computer vision method. In other words, computer vision is used to get a deeper understanding of digital data. After the extraction of features of images, the collected n number of data which is imported in the get data to make the images into vectors which make the process of identification easy [14]. This is used to distinguish the color, saturation and hue image. HSV provides the capability to separate color components from intensity which allows to optimize the algorithm from lighting changes and removing shadows. Given that human is much more sensitive to brightness than saturation and hue, saturation and value components of HSV color space have been adopted to define color saliency[15] In this way, the dirt or stains can be easily highlighted and identified. Modifying the algorithm's threshold were made so that only the dirt will become apparent to the whole image with the use of Gaussian value (225) and a binary threshold value (115,1). This result in an output of dirt image of an egg was detected.

2.3 External Crack Detection Algorithm

Egg cracks result in similar consequences to market value to consumers. Cracks happen when struck by other eggs or on a hard surface at the moment of laying during the process of checking and handling. An almost similar approach was implemented to detect cracks present on the surface of an

egg. Only a different algorithm was used to acquire the desired result. The system accepts a live feed of the eggs which was then processed by the algorithm frame by frame. The intensity of cracks will be determined using the process below.

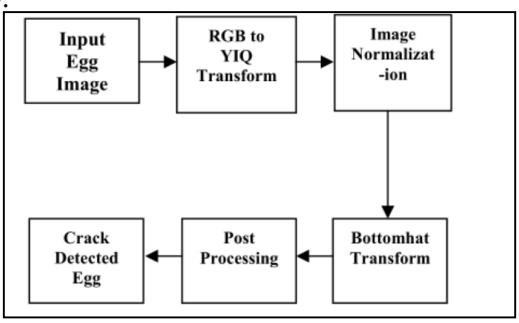

Figure 3: External Crack Detection Algorithm

Converting the image from RGB to YIQ were made for the optimal for the system. Using the YIQ color space; which was intended to take advantage of human color- response characteristics. This has shown that when implementing it to the functionalities of the system will highlight and reveal even the smallest shadows present on the surface of the eggs caused by the tiny cracks, breaks or damages. The rest of the process as part of the algorithm are included to further highlight and assist the user in observing the eggs.

2.4 External Dirt and Crack Detection of Multiple Eggs

Images of samples were gathered then pre-processed for dirt and crack detection. Canny edge algorithm was used with a threshold value (30,110) which was suitable to enhance the visibility of the dirt and crack. The classical approach to get an edge image is to threshold the gradient image. The main objective of third stage in the pre-processing is to reduce the over-segmentation as much as possible [16]. This embodies the contours of the eggs that are useful to determine its edges. The final step to recognize eggs with minimal dirt and crack labeled as good condition.

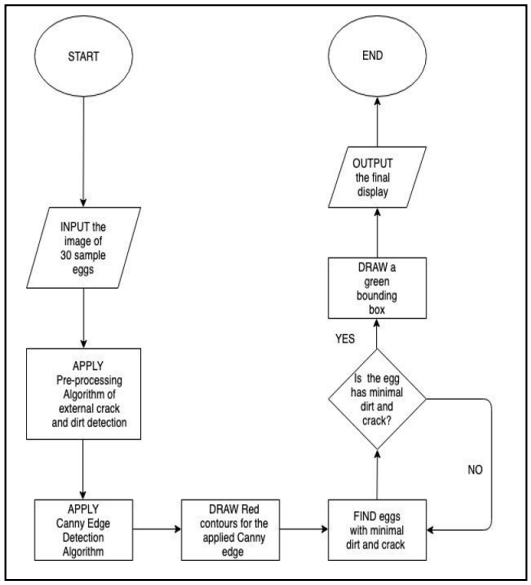

Figure 4: External Dirt and Crack Detection of Multiple Eggs

2.5 Internal Egg Detection Algorithm

The internal quality of the egg is considered a difficult aspect of the inspection without breaking the shell. This general relates to the quality of albumen. To detect and assess the internal egg quality, eggs frames were processed by the strong illuminating light arranged from underneath.

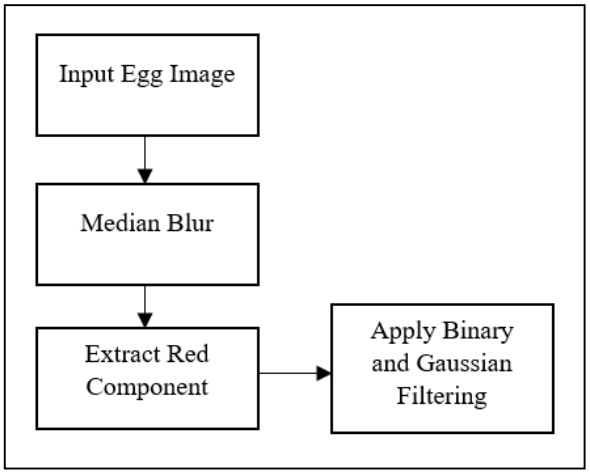

Figure 5: Internal Egg Detection Algorithm

Figure 5 shows the internal egg detection algorithm where acquired image was subject for blurring as pre-processing technique. This is to achieve the smoothness image needed to improve the results of the later processing. To enhance the image the blurring in the background used was median blur value 19 combined with a gray scale.

2.6 Internal Detection of Multiple Eggs Algorithm

The same egg condition was used as a sample to determine the external egg quality. All eggs are positioned on each hole in the box.

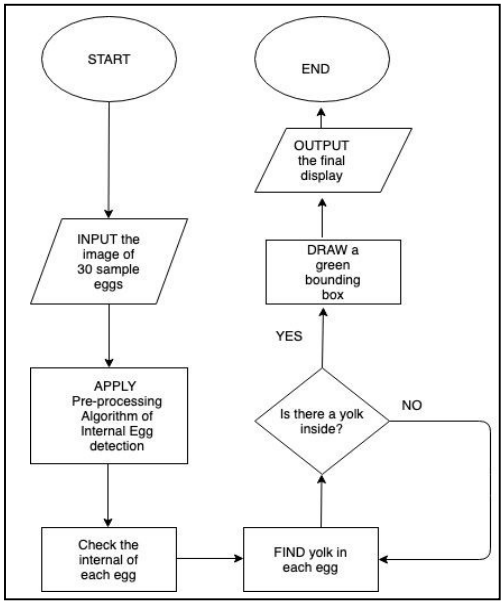

Figure 6: Internal Egg Detection of Multiple Eggs

3. EXPERIMENTAL RESULTS AND DISCUSSIONS

The testing used 30 egg samples. The box used a total of 4800 lumens, an average of 160 lumens for each egg with 220 volts and 52 watts light bulbs which strong enough to detect egg abnormalities. Each slot has a 23mm diameter which is enough for the eggs to be placed properly. Acquired images are communicated wirelessly, either a mobile hotspot or Wi-Fi connection to the application software using python programming. The image was converted into an array and decoded into OpenCV usable format. The sample images results are shown below.

3.1 External Dirt Detection

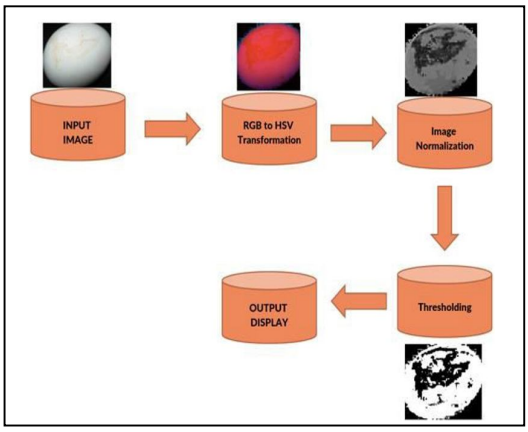

Figure 7: Eternal Dirt Detection

As seen in the Fig.7, the egg was tested to determine the external dirt using the algorithm, where RGB is converted to HSV in order for the dirt or unwanted materials to be easily highlighted and identified. Then, the image normalization algorithm was done. As a result of the algorithm applied, the dirt is detected after applying all the processes.

3.2 External Crack Detection Image

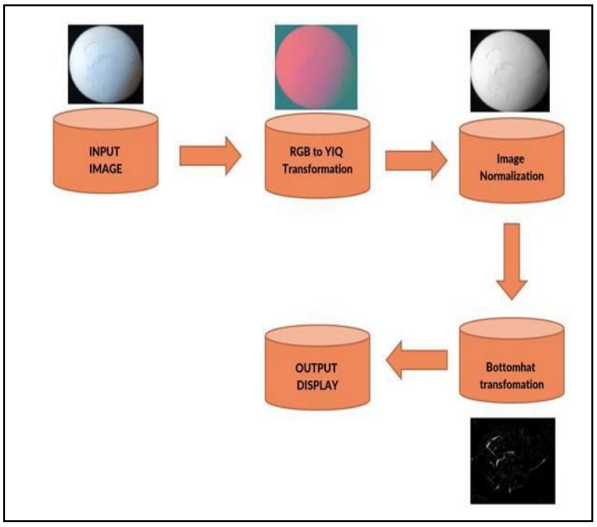

Figure 8: External Dirt Detection

Fig. 8 shows the result of the single egg was tested to determine the external crack. The RGB image was converted to YIQ color space and its corresponding luminance image was generated. The normalization took place to brighten the pixels of the image intensity value. This resulted in an image as brightest as possible without altering any content of its information. The bottom hat filter was used to highlight the structure of the egg with defects and finally separate it from the background.

3.3 External Dirt and Crack Detection of Multiple Eggs

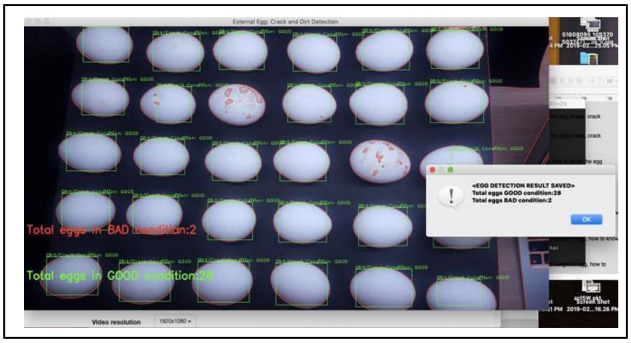

Figure 9: Dirt and Crack Detection Result of Multiple Eggs

Figure 9 shows Dirt and Crack Detection Result of Multiple Eggs. The same algorithm was used for the detection of dirt and crack to multiple eggs. The red contour represents that dirt and crack are presents in an egg. Eggs with dirt and crack are marks in bad condition which resulted in a low quality of eggs while the once with no remarks are considered as good condition. All eggs with bad and good conditions were counted and saved for reference.

3.4 Internal Detection of Multiple Eggs

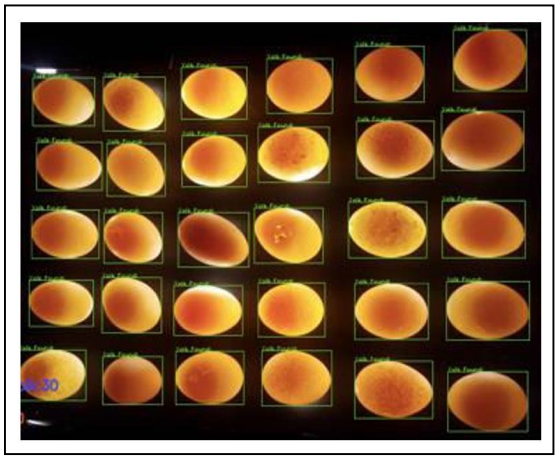

Figure 10: Internal Detection Result of Multiple Eggs

Fig. 10 shows the result of the internal detection of multiple eggs. Using the applied lumens and setup, it provided clear visibility to check egg abnormalities. The samples were found to have a good result, egg with the yolk.

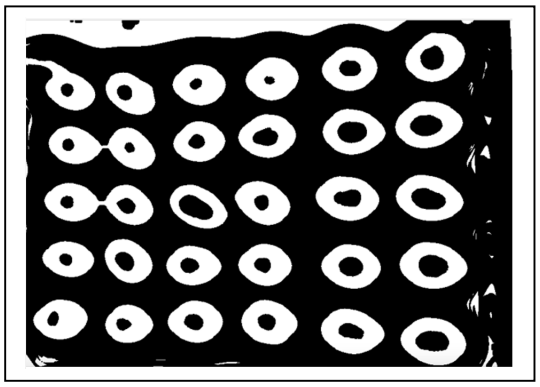

Figure 11: Internal Detection Result of Multiple Eggs

Fig. 11 shows the internal viewer result of multiple eggs to magnify and optimize the visibility of the samples. This represents a clear view of the present and shape of the yolk. No egg abnormalities were found in this result. This results in a high grading value of the eggs.

Figure 12: Detection of Egg White Yolk

Fig. 12 shows an example of an egg without yolk. Once the sample met the specified area of the threshold of the contour, the sample is considered as yolkless. This resulted in a low grading value of the egg.

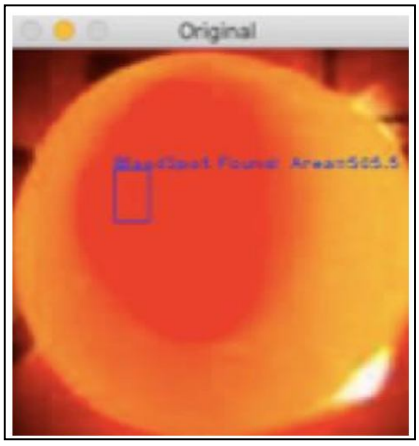

Figure 13: Detection of Egg Blood Spot

Fig.13 shows the image of an egg with a blood spot. The candled image was considered as an input for the detection of the egg blood spot. The result was used for legend marking.

Table 1: Summary of the Inspected Internal and External Quality of Multiple Eggs

# of Trials	Inspected in High Quality (External)	Inspected in Low Quality (External)	Inspected without Abnormality (Internal)	Inspected with Abnormality (Internal)
1	28	2	30	0
2	28	2	30	0
3	27	3	30	0
4	27	3	30	0
5	27	3	30	0

Table 1 shows the trials made to test the samples. A total of 91.33% of samples were inspected as a high-quality egg, no presence of either crack or dirt while 8.66% were inspected as low quality. Similarly, all samples were inspected to be in internal good condition.

4.CONCLUSION

The study presented an internal egg detection that is capable of checking multiple eggs at a time, one tray of eggs can be checked at a time and the results would be easily displayed on the screen. Upon testing the internal egg detection, the system found the yolk in each egg and labeled as yolk found. The group tested each egg and found that all of them have yolk inside using the system. Based on the result of the testing conducted, it can be concluded that using the proposed system it displayed a clear view of the presence and the shape of the yolk on the multiple eggs testing. The study also shows that using the external crack/dirt detection, the system found 28 eggs in good condition out of 30 eggs. Thus, identification of the external crack and dirt using the HSV and normalization algorithm found to be effective. As a result of testing the system obtain a total of 91.33% of samples were inspected as high- quality eggs, no presence of either crack or dirt while 8.6 were inspected as low quality. The results of the testing are quite promising and encourage the researchers to continue improving the system.

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