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Survey on Identification of Gender of Silkworm Using Image Processing

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ABSTRACT

Deep learning constitutes a recent, modern technique for image processing and data analysis, with promising results and large potential. This allows larger learning capabilities and thus higher performance and precision. As deep learning has been successfully applied in various domains, it has recently entered also the domain of agriculture. This paper proposes and in this experimentally demonstrates fault tolerant optical penetration-based silkworm gender identification. The key idea lies in the exploitation of the inherent dual wavelength of white and red light illumination. In particular, the image of the posterior area of the silkworm pupa created under white light is not only transformed into an optical region-of-interest but also is used for pinpointing the female silkworm pupa, thus speeding up the identification time twice. For the male and unidentified female silkworm pupae, their images are later on analyzed under red light illumination, implying fault-tolerant operation of the system.

I. INTRODUCTION

Gender discrimination is a common experience even among cultured populations and species. Gender discrimination refers to the sorting of individuals in terms of gender differences and variations. When discussing gender discrimination, it is important to consider both the favored and the gender which receives discrimination.

In the silk industry, the production process of silk from silk worms is one unique model of industrial production. It follows for careful consideration of the cultures and gender separation of the worms. This level of care results to increased yields recorded from the culturing of these worms. However, the industry is faced with several difficulties which result to reduced productivity. One of the most common type of problem facing these industries include gender discrimination. In the case of silk worm culturing, gender discrimination affects the quality produced and gotten from the cultured worms in the production cycle. Therefore, this paper seeks to provide a literature review and analysis of written information concerning the issue of gender discrimination in the silk industry. The following section provides the literature review for this mentioned problem.

[4] There are several ways in which gender separation in silk worm classification can be achieved particularly the physical separation method which involves human labor in the separation of these two distinct cocoons. Raj et al. (2019) argue that the processes undertaken when separating silk worm cocoons result to some form of discrimination. For instance, the male cocoon is placed under less suitable conditions compared to the female cocoon which is known to provide more silk when the two production levels of the two sexes are compared (Raj et al., 2019).

Furthermore, the initial stage of enabling reproduction in the separation stage of these cocoons provide further evidence of gender discrimination. It is well known that cultured organisms have different levels of productivity even when it comes to their reproduction. However, in the article by Raj et al. (2019), reproduction is preserved for the best males and females. This is a representation of unfavorable discrimination since the other males are not allowed to reproduce. The argument presented by Raj et al. (2019) suggests that manual separation of these cocoons into the circular cylinders does not necessarily assure of the best offspring. Instead, it suggests that since human is prone to errors, there are instances when not the best silk worms are allowed to mate and reproduce.

Advanced research by the authors indicated that the conditions these cultured organisms are exposed to help in determining the gender of the silkworm. Therefore, since females are celebrated more for the amount of silk they produce, they are placed under specially treated cultures to maximize on silk harvest (Raj et al., 2019). As a result of this, males mature and their undesirable conditions resulting to less yields in terms of silk. Therefore, the article proposes that all silk worms should be cultured under the same positive cultures and environments to maximize on the harvest gotten from the silkworms (Raj et al., 2019).

[2] Silk worm gender separation process can be achieved with precise distinction when checking their physical characteristics. Gender separation is achieved through various characteristic identification. Aspects such as the shape, weight and volume are the most common measures of separable applied commonly in the gender distinctions of cocoon (Raj et al., 2019; Mahesh et al., 2017). However, these characteristics could be observed from the use of technology, Initially, manual separation resulted to lower yields in egg collection compared to electronic separation techniques (Mahesh et al., 2017). From the arguments presented, it is highly likely for gender discrimination to be recorded when classifying these silk worms. For instance, not all breeds of silk worms exhibit the same characteristics. For a cultured population consisting of two breeds of the same organism, some silk worms are characterized differently in terms of weight, shape, length, and volume. For instance, the Pure Mysore is known to weigh slightly lower than the CSR2 species (Mahesh et al., 2017; Raj et al., 2019). For mixed cultures, gender bias or gender discrimination would occur in the separation stages of these organisms as in the research conducted by Mahesh et al. (2019).

To avoid gender discrimination in silk worm gender separation, Mahesh et al. (2019) have suggested the incorporation of electronic identification media and systems in most silk culturing laboratories. They suggest the use of the ToF camera which is useful in identifying and classifying the silk worms according to the gender they pose in terms of weight, length, shape and volume. They identify it as the most particularistic solution ever invented with the purpose of making the entire process easier (Mahesh et al., 2019).

[5] When in the process of sorting or discrimination, another particular aspect of the pupae which could help in identifying the gender is the rail gonad. According to Tao et al. (2019), the tail gonad of each pupae of the silk worms has a particular shape which helps in determining the gender; the males have a dot pattern while the females have an X pattern in the gonad. This aspect helps in easily identifying the gender of the silk worm resulting to a faster way of classifying the worms in terms of their gender. When a dot pattern is identified, the pupae is automatically considered male. On the other hand, when an X pattern is identified, the pupae is classified as female. However, this aspect is not openly realizable thus the need for the incorporation of other features of the silk worm in the classification stage (Tao et al., 2019).

Further classification can be achieved through prediction of the edges whereby the input blurred image accuracy levels could be measured and the accurate level of kernel determined with utmost precision (Tao et al., 2019). With this, achieving selection is made possible and could be made more accurately as possible. Gender discrimination does not entirely rely on the provided materials, rather, it focuses the characteristics identified by that who is carrying out the process. The quad group further identifies that the outlook of the tail gonad could at times mislead since the classification is dependent on the images obtained from the ToF camera (Tao et al., 2019). Therefore, they suggest indiscrete reliance on these models for comparison of the gender groups of these silk worms.

Further research identifies that gender discrimination could be achieved using a computer based vision method. This is according to a paper written by Liu and Wang (2019) where they suggest application of these computer systems in identifying the gender of the silk worm as early as it is in its larvae stage. This computer system uses the Automatic Gender Recognition module in its operation when identifying the gender of the silk worm (Liu & Wang, 2019). As a result, it becomes easier for the gender of any silkworm to be identified depending on the stage of growth it is in. For instance, when in the larval stages, the computerized system uses the AGR technology to identify the gender based on the characteristics and the genetic composition of the worm. When the larva turns to a cocoon, the characteristic of the cocoon highly determines the gender (Raj et al., 2019).

[3] This implies that a female silk worm will have more fiber covering on the cocoon, so, the male will have less fiber covering on the cocoon (Liu & Wang, 2019). To this extent, the computerized system identifies the gender of the silk worm with the application of too little stress on humans. Therefore, the duo suggest that this classification method should be taken up and applied mostly in large scale silk production industries such as those put up in India (Liu & Wang, 2019).

[1] Another way to possibly variate the genders of these silk worms is through the use of optical penetration without the intent of causing any harm to the individual worm. They propose the use of this system which is optically driven to study the internal composition of any pupa of the silk worm. They propose the use of this and they have supported their arguments with experimental results.

According to them, the level of precision arrived at when classifying the worms according to their genders is at 97.34% compared to the human error recorded at -17.76% (Sumriddetchkajorn et al., 2015).

They call for the development of other models which utilize the same concept in providing solutions related to problems previously experienced in the silk industry. One more positive correlation they observed in their experiment is the visual interpretation of the genetic composition of the silk worm (Sumriddetchkajorn et al., 2015). This realization when explored fully will mean that the identification

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process of any silk worm will take up to a maximum of ten seconds (10secs) (Sumriddetchkajorn et al., 2015). They suggest that each cultured worm will have to check in the computer system and its genetic composition will automatically classify it as either male or female. The final advantage of this computerized optical system is that it can check the gender of as many as 50 worms at a time (Sumriddetchkajorn et al., 2015). This implies that the time taken will relatively drop allowing for more production of silk and culturing of silk worms.

II. DATA PREPROCESSING

The large majority of related work (36 papers, 90%) involved some image pre- processing steps, before the image or particular characteristics/features/statistics of the image were fed as an input to the DL model. The most common pre-processing procedure was image resize, in most cases to a smaller size, in order to adapt to the requirements of the DL model. Image segmentation was also a popular practice

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III. CLASSIFIER

Classifiers are used to classify the images according to their features. There are various classifiers like Naive Bayes Classifier, k- Nearest Neighbours (k-NN), Support Vector Machine (SVM), Artificial Neural Network (ANN), Convolutional Neural Network (CNN) and Random Forest Tree Classifier.

IV. FEATURE EXTRACTION

When input data to an algorithm is very large and it is supposed to be a redundant, then it can be transferred into small set of features. Finding the subset of the initial features is called feature selection. It is expected that selected features contain the required information, so the preferred task can be performed with using reduce representation. Various authors have an considered combination of colour, shape and texture for feature extraction.

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V. METHODOLOGY USED

In order to accurately and efficiently perform automatic gender recognition on silkworm cocoons, We use a multi-resolution local Gabor binary pattern (MLGBP) feature extraction method based on computer vision to comprehensively describe the fine and rough local microscopic patterns of silkworm cocoons.
The weight features and shape related features of each cacoon are combined and are provided as input to Support Vector Machine Classifier for gender classification of cacoon.

VI. CONCLUSION:

In conclusion, it is evident that the silk industry has been ventured. Silk production highly relies on the ability of any industry to differentiate between male and female worms. The productivity rates are highly dependent on the ability to enhance reproduction in the worms. Classifying them into different genders could be achieved through the use of various models as outlined in the above literature review.

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