

AN AI BASED HYBRID TECHNIQUE FOR ONLINE TEA COLOUR SEPARATION

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Introduction

Tea colour separation is a course of action that takes place at the end of the tea manufacturing process. Unsuitable tea particles (large red particles) are removed during this process in order to obtain clean tea (pure black tea and the tips) (Bhuyan and Borah, 2002).

At present tea colour separation is carried out using a tea cleaning machine which works on the colour mismatch technique. The most obvious difference between stalk particles and clean tea particles is their colour. Stalk particles are amber to brown colour whereas clean tea particles are black. The tea cleaning machines of colour sorter type exploit this difference for separation of stalk from black tea. The presence of stalk is detected by photocells which in turn activate small air jets and the timing is adjusted so that the stalk particle which activated the photocell gets ejected by the force of the air jet (Samaraweera *et al.*, 1988). The colour sorter also identifies the tips/golden or silver tips as stalks as they are lighter in colour, which in turn reduce the price of tea by a huge margin. Since the price of a 1 kg of silver tea is around Rs.20000, the losses caused by these machines are considerably high. Moreover, this system applies same amount of pressure to eject all the stalk particles which in turn removes lot of good tea

particles along with the stalks and causes a reduction in output.

The main aim of this research was to detect stalk particles as part of broader tea manufacturing process. In order to achieve this, this paper proposes a tea colour separation system, based on image processing and artificial intelligence techniques.

Methodology

An experimental set up was devised for capturing images of tea particles within tea manufacturing process. An image database of 100 captured images was used to develop the methodology introduced in this paper. The image database contained images of several possible combinations of black tea, stalks and tippy tea. Images that were captured using a 6.0 mega pixel digital camera were analyzed to detect the stalk particles.

Prior to the analysis, the images were partitioned into three parts/segments so that it makes easier for ejecting the detected stalks. Each part of the image was analyzed to identify the stalk particles. Initially, K means clustering and fuzzy C means clustering were used to identify the stalk positions. The procedures followed for K means clustering and fuzzy C means clustering is same. The RGB images were converted in to 'L*a*b' colour

space and the colours in the 'a*b*' space were clustered using K means clustering and fuzzy C means clustering (Horváth, 2006), (Lindbald, 2005). It has been observed that the outputs given by both the methods weren't useful to detect the stalk particles.

A thresholding method devised based on three different cut-off values for RGB components of the particles was therefore, tried out as an alternative strategy. The conditions considered in this system were that the intensity of the red component of a pixel should be greater than 90, the difference between the intensities of the red and green components of the pixel should be greater than 30 and the difference between the intensities of the red and blue components of the pixel should be greater than 35. It has been observed that the thresholding method was capable of providing promising results along with an excellent processing time. However, this method had some drawbacks such as identifying end of some good tea particles as stalks. Due to this fact thresholding method had a lower accuracy rate.

To increase the accuracy of the thresholding method a fuzzy system was introduced. A fuzzy rule base of eight rules was used to select the criteria that indicate whether a particular pixel belongs to a stalk particle or not. Since a digital camera was used to capture the images, the RGB colour model pixel classification was used. The intensity of the red component, intensity value of (red - green) and value of (red - blue) were provided to the system as input values. These inputs could vary between 0 and 255. The output of this system varied between 0 and 1. Whether a pixel

belongs to a stalk particle or not was decided by a threshold value of 0.5. The fuzzy rule base was designed so that the output would be greater than 0.5 only if the intensity of the red component of a pixel is greater than 90, the difference between the intensities of the red and green components of the pixel is greater than 30 and the difference between the intensities of the red and blue components of the pixel is greater than 35. Moreover, the centroid defuzzification method was used since all the membership functions carried area of equal density. If stalk particles were detected in an image they were labelled and the coordinates of the centre point was found using the labelled components. Apart from identifying the stalk particles, the system could also identify area of each stalk as an additional outcome.

Results and Discussion

The accuracy of the systems was measured by comparing the original number of stalks in an image against the number of stalks identified by the system. The thresholding method showed an accuracy rate of only 93%, due to incorrectly identifying some good particles as stalks. But this system had a very low processing time that ranged between 0.1015 s – 0.2250 s which in turn accomplished a challenging requirement in real-time operations.

On the other hand, the fuzzy system which was introduced in order to increase the accuracy provided with a better result by increasing its accuracy to 99%. Even though this system also identified some edges of the good particles as red stalks, the error rate of the fuzzy system was less than that of

the thresholding method. Other than the number of stalk particles, this system also provided with the coordinates of the centre point and the area of each stalk particle in different text files. The only drawback of the fuzzy system compared to the thresholding method was that the

processing time (1.0050 s – 8.8525 s) was high. This becomes a critical issue when it come to real time processing since the output should be given before the tea particles reach the air jets. Table 1 shows a comparison between the success rates of the thresholding method and the fuzzy system.

Table 1. Comparison between the success of thresholding method and the fuzzy system

The System Used	Number of Stalk Particles	Detected	Error Percentage	Success Percentage	Average Processing Time
Fuzzy system	781	792	1.408%	98.592%	3.2004
Thresholding method	781	839	7.426%	92.574%	0.2030

Conclusion

The fuzzy system would be the most suitable method to achieve the highest quality output. However, its processing time is very high compared to the thresholding method. Since the time is very important aspect of tea manufacturing, businesses men might prefer the

thresholding method over the fuzzy system in order to save time and reduce cost of production. This system could be implemented instead of the traditional colour sorter and it can be developed so the outputs of this system can be given as the inputs for a system that ejects the detected stalk particles in order to obtain pure tea.

References

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