Enhancing Precision Agriculture through Logic Based Crop Maturity detection of apples

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Abstract

This current research aims to develop an algorithm utilizing fuzzy logic approach to detect the apple maturity (**Malus Domestica**), which is an important aspect of the agriculture and food industry. By accurately assessing apple maturity, yield and product quality will be assured and post-harvest losses can be reduced.
This study explored different detection methods, such as **color, texture, shape** and **sweetness**.
Predictive models developed using artificial intelligence techniques, especially the fuzzy approach, can quickly and reliably estimate apple maturity levels, that can be categorized into **three** primary stages**: green G, blushed Bl and red R.** This research will help farmers to optimize apple harvesting, storage and marketing practices, improve product quality and meet growing consumer demands for sustainability and freshness.

Why GALA Variety?

Variety	Color	Size	Specifications	Shape
GALA	Red	Medium	Diameter: 7.6 cm Weight: 140 g	Round

Most farmers choose the GALA variety because of its special and great taste, sweetness, faster growing up, huge production, and large shelf life. With all these advantages and features, we preferred to make our study on this type of apple.
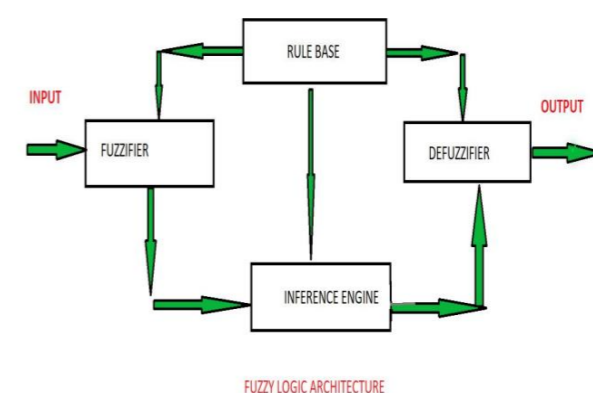

FUZZY LOGIC ARCHITECTURE

Application

The three parameters chosen are the inputs in the fuzzifier. After the fuzzy step, we get the rules for noticing the ripeness of inspected fruit. The following table determines if an apple is ripe, half-ripe, or unripe. S means small, M means medium, and L means large. For the texture and as mentioned above, Rd means round, O means oblong and C means conical.

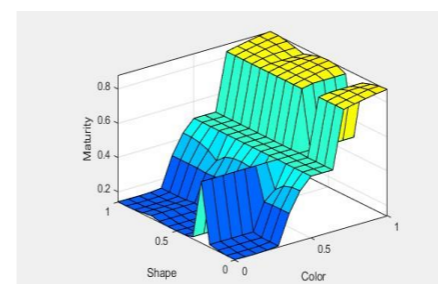| INPUTS			OUTPUT
COLOR	SIZE	Texture	Maturity
Red	Medium	Round	Mature
Red	Medium	Oblong	Mature
Red	Medium	Conical	Mature
Red	Large	Round	Mature
Red	Large	Oblong	Mature
Red	Large	Conical	Mature

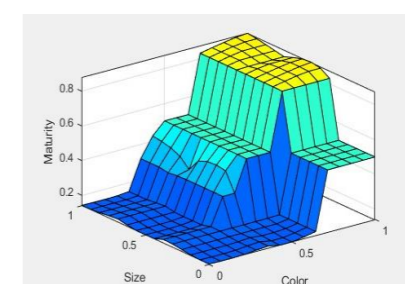## Results

Figure 1 Color and Size Maturity
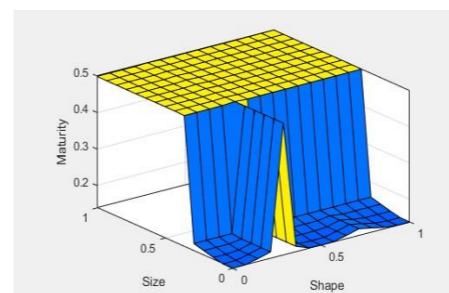

Figure 2 Color and Shape Maturity

Figure 3 Size and Shape Maturity

The curves represent the surface view of the maturity level of the fruit based on the inputs mentioned before. As shown, the curves represent two inputs and one output. Figure 1 shows that both inputs affect maturity significantly. Figure 2 with its inputs impacts the maturity too. And the last figure (figure 3) has a small impact on the maturity.

Conclusion and perspectives

This study introduces a fuzzy logic-based approach for detecting the maturity level of apples, focusing especially on Royal Gala. This approach examines select inputs and their influence on the apple's size, and subsequently incorporates additional inputs. It is worth noting that other factors may play a significant role in determining the maturity rate of apples that we will integrate in the next studies. As a future direction, it is suggested to extend this work to analyze different fruit varieties and integrate more parameters to detect the maturity of the fruit. Moreover, a potential shift in focus could involve investigating consumer satisfaction through the application of the same logical approach.

References

A. Soulhi et S. Guedira, « DECISION-MAKING AUTOMATION FUZZY DECISION-MAKING IN INDUSTRY ».

« Aziz et al. - BASED ON THE FUZZY INFERENCES IN THE TRAFFIC REGUL.pdf ».

A. K. Daniel, P. Sharma, et R. Srivastava, « Fuzzy Based Prediction Model Using Rainfall Parameter for North eat India Maize production », in *2018 5th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)*, Gorakhpur: IEEE, Nov. 2018, p. 1-6. doi: 10.1109/UPCON.2018.8597129.