Lateral impact sensor for measuring firmness of fruits in an experimental packing line

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Purpose

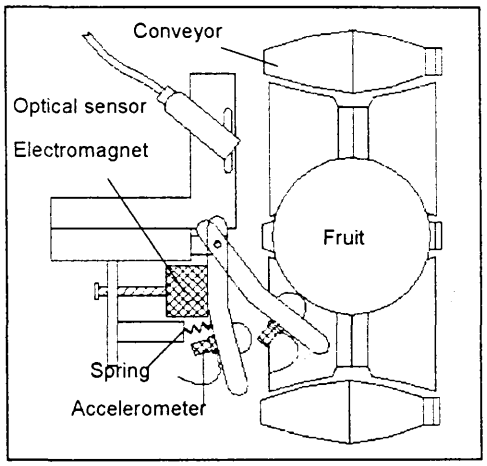
Different parameters are used to quantify the maturity of fruits at or near harvest (shape, color, flesh texture and internal composition). Flesh firmness is a critical handling parametef for fruits such as peach, pear and apple. Results of previous studies conducted by different researchers have shown that impact techniques can be used to evaluate firmness of fruits.

A prototype impact system for firmness sorting of fruits was developed by Chen and Ruiz-Altisent (Chen et al., 1996). This sensor was mounted and tested successfully on a 3 m section of a commercial conveyor belt (Chen et al., 1998).

This is a further development of the on-line impact system for firmness sorting of fruits. The design of the sensor has been improved and it has been mounted on a experimental fruit packing line (Ortiz-Cañavate et al., 1999).

Characteristics

The prototype impact system for firmness sorting of fruits (TOUCHLINE) consists of an optical sensor for sensing the position of the fruit, a low-mass impact sensor for sensing the firmness of the fruit, a control electronic circuit, a microcontroller and a fruit ejecting system.



The impact sensor consists of: a low mass impactor, a small accelerometer, a pre-load spring, and an electromagnetic holder. In this new design the optical sensor is placed on the impact sensor structure and the old reset solenoid which recovered the small mass impactor has been removed. The electromagnet holder extends and retracts the mass impactor.

The operating cycle is as follows: a) when the optical sensor detects a fruit the electromagnet is de-energized, and the spring accelerates the impactor until the impactor leaves the spring and moves at a constant speed until it strikes the fruit; b) the accelerometer sends the acceleration signal to a computer where the signal is processed to determine the firmness of the fruit; c) according to the firmness index the ejecting system classifies the fruit as hard, medium or soft. The optical sensor and the lateral impact sensor operate simultaneously, e.g. when the fruit is detected the impact sensor is released.

Results and conclusions

The sensing system has been mounted on an experimental fruit packing line (Ortiz-Cañavate et al., 1999). The impact sensor schematic is shown in the figure.

A new electronic control system has been designed and developed to control the impact sensor system and a specific software has been developed to process the accelerometer signal and classify fruit according to the firmness index.

Initial tests to calibrate the system were carried out with cork, tennis and rubber balls.

Further tests will be carried out with different fruits to establish the correlation between impact response parameters recorded by impact sensor and traditional firmness indexes.

References

Chen, P. and Ruiz-Altisent, M., 1996. A low-mass impact sensor for high-speed firmness sensing of fruits. Paper 96-F-003 presented at AgEng 96, Madrid.

Chen, P. and Tjan Y., 1998. A Real-time impact sensing system for on-line firmness sensing of fruits. Paper 98-F-006 presented at AgEng 98, Oslo.

Ortiz-Cañavate, J.; García Ramos, J., and Ruiz Altisent, M. Testing equipment for the improvement of mechanical devices to minimize damage to fruit in commercial packing lines. Symposium: Actual Tasks on Agricultural Engineering; 1999; Opatija, Croatia; 223-229. ISBN: 953-6135-26-4.