Scientia Horticulturae 228 (2018) 49–55

Contents lists available at ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

Research Paper

Harvest glove and LabView based mechanical damage determination on apples

Abdullah Beyaz

Dr. Ankara University, Faculty of Agriculture, Department of Agricultural Machinery and Technologies Engineering, 06130 Aydınlıkevler, Ankara, Turkey

ARTICLE INFO

Keyword:
Apple varieties
Image analysis
Arduino
FRS
LabView

ABSTRACT

The purpose of the survey was to determine oxidation area and skin color change at the damaged apples by using Arduino based Force Resistive Sensor (FRS) and image analysis techniques. Mondial Gala, Mitch Gala, Jonagold local apple varieties were tested with FRS supported harvest glove which was prepared for the impact measurement. FRS glove used for determination of impact force while harvesting of apples. After the impact test, oxidation areas of each sample was evaluated by using a webcam and Labview platform. The oxidation areas were precisely measured by using LabView software after all these procedures. The effects of the impact tests indicated that response to impact bruising is dependent on flesh firmness and the impact force as well as apple variety.

1. Introduction

An important fruit quality loss is caused by bruise damage due to dynamic and static impact loads. The factors causing damage on fruits are the size of fruits, the full height of fruit, the kind of contact surface, the number of contacts, contact energy and ripeness stage of fruit (Zarifneshat et al., 2010). The fresh fruit market relies on the external quality of products (Unay and Gosselin, 2006). A high-quality fruit sample cannot include fruits affected by negative textural attributes (Arana et al., 2007). The quality of apple fruit depends on size, color, shape, and type of skin defects, according to the international marketing standards. The first quality parameter important for consumers is the vividness of the food surface. This is critical for acceptance of the product in the marketplace. The semblance of the fruit surface is the first decision tool for consumers' acceptance or rejection of food products (Leon et al., 2006). The second quality parameter is bruised. Bruising has been defined as harm to plant tissue causing physical changes in grain and color. It is well-defined from the literature that bruising is an important problem affecting the character. Income from fruit and vegetables are affected by the quality of produce.

Thus, it is important to pick out the bruised apples from the nonbruised ones (Xing et al., 2006). First damage at apple harvests processes is done at grasping apples. So finger force measurement our first damage reason at the apple harvest process. Finger force measurement is a process of determination finger's ability to grasp objects (Anonymous, 2015). This ability is critical for harvesting process while grasping objects and power requirements of the crop. Furthermore, this ability also critical for touch based grasping while human, machine and environment interaction. Finger touch forces are necessary for understanding and simulating human grasping (Nakazawa et al., 1996; Peine and Howe, 1997). In the literature, we can see several researchers about the force response of human touch (Pawluk and Howe, 1999; Gulati and Srinivasan, 1995). Likewise, we necessitate to see the human touch force and touch characterizations for ergonomic applications and feedback on product design (Pawluk and Howe, 1999; Singh and Fearing, 1998). Measurement of finger touch forces is also needed for transferring this ability to the robot applications (Kim and Inooka, 1994). Moreover, regular touch forces not enough for understanding the grasping process at contact surfaces because, other forces also affect this process (Howe and Cutkosky, 1989; Han et al., 1996). Forces acting at the finger touch measurement are done using FRS placed on the fingertip (Massaro and Asada, 2002). Also, computer vision has been successfully adopted for the quality analysis of food (Brosnan and Wen Sun, 2004).

Many surveys were conducted for detection of defects and finger touch forces in different areas. However, detection of defects is still a problem due to the high variance of defect types. Chen et al. (2002) reviewed machine vision applications in farming fields. They have given examples in using image analysis techniques for detection of disease, defects, and contamination for recent food inspection. Mendoza et al. (2006) worked on a computer imaging system which measured and captured standard sRGB color, HSV, and L*a*b* color space of vegetable and fruit images. Ratule et al. (2006) have studied to characterize chilling injury development of Berangan banana (Musa CV. Berangan (AAA)) during storage at low temperature. Berangan bananas were stored at 5, 10 and 15 °C for 16 days to evaluate the

E-mail addresses: abeyaz@ankara.edu.tr, abdullahbeyaz@gmail.com.

http://dx.doi.org/10.1016/j.scienta.2017.09.049
Received 19 February 2017; Received in revised form 25 September 2017; Accepted 27 September 2017
Available online 16 October 2017

degree of browning (DOB) and peel color (L*, C* and h°). Li et al. (2002) examined the damaged apple surfaces by applying image analysis techniques. They took an image of apples from four directions simultaneously and developed a technology based on their experiments. They stressed that the developed hardware and algorithm were useful in seeing the damaged surfaces. Işık and Güler (2003) identified the open fields of Golden Delicious apples in their subject area. They compared the measurement accuracy of their data which were obtained from image analysis technique and planimeter measurements. Yurtlu and Erdoğan (2003) evaluated the bruise susceptibility of Williams pear and Golden Delicious and Starking apples by using compression and shock tests. Radwin et al. (1992) in their research stressed that they used small conductive polymer force sensors for measuring individual finger forces exerted during grasping. Also, they used a linear force summing strain gauge dynamometer for measuring resultant five-finger grasping posture force. They individually measured finger forces at 10%, 20%, and 30% perceiving force levels and also 1*0 kg, 1*5 kg, and 2*0 kg loads. They were observed no significant individual finger force differences at the 3 N, 10% maximum voluntary exertion level, but at the ring, small fingers and middle fingers they observed something different at more than 5 N force, 30% voluntary level. The average results of middle, ring, little fingers and other fingers were evaluated 33%, 33%, 17% (16). Lee et al. (2009) in their study worked on muscle activity while the finger is tapping along a computer keyboard. In repeated laboratory experiments, they collaborated with six participants at 0.31 N vs. 0.59 N; 0.55 N vs. 0.93 N force levels. They employed a load cell for measuring fingertip at key switch. They emphasize that their findings suggest a central switch convert the dynamic loading of the muscles, peculiarly in the intrinsic muscles, during keyboard work (9).

In the brightness of this literature, in this research, according to the color change of damaged regions, oxidation areas of each apple variety was evaluated by using a webcam and Labview platform.

2. Materials and method

First of all, a harvest glove was constructed for determination of impact forces. The glove was designed for different impact forces (Max 20 N for each finger). Mechanical forces exerted on apples evaluated by using designed sensor glove during the harvest period, as considerably as the harm done by these forces (Fig. 1).

At harvest glove, the Arduino UNO R3 was used as an evaluation board. Arduino UNO R3 is an ATmega328 microcontroller based board. It delivers 14 digital input and output pins 6 of them can be used for PWM outputs. It too has six analog inputs, a USB connection for PC, a power jack for external power, an ICSP header, and a reset button. It holds whatever we asked to a microcontroller; it is plainly connected to a data processor by using a USB cable. At the same time, it is possible to power it with an AC to DC adapter or battery (Fig. 2).

Fig. 2. Arduino UNO R3 and FRS base glove sensor.

Along with Arduino UNO R3, five force resistive sensors were used for valuations. FSR402-long by Interlink Electronics were used to set the finger touch forces damage. These sensors have 13 mm diameter evaluation area which is constructed from the thick polymer film. When the force increases as the electrical behavior of the detectors, resistance decreases. Although resistive force sensor can measure between 0 and 20 N. FSR402-long sensors are low-cost sensors. Also, each of them costs 30. Each of FRS was stuck with using a double-sided sticker to the fingertips of harvest glow.

Determination of accuracy all the sensors had been done calibration process. Each FSR calibrated with strain-gauge measurement. The fingertip force was repeatedly applied on the FSR with a single finger with different velocities and powers.

Hc05 Bluetooth module with 10 m data transfer distance was used for wireless data transmission for optimum harvest glow usage.

After development, a harvest glove, Mondial Gala, Mitch Gala, Jonagold apple varieties was selected for experiments. These samples were taken randomly from newly harvested apples (Fig. 3).

Fifty apples were used for evaluations from each apple varieties. Apple varieties as experimental materials have been harvested from Haymana Research and Application Station Orchard of Ankara University, Faculty of Agriculture (39.61N°, 32.69E°) (Figs. 4 and 5).

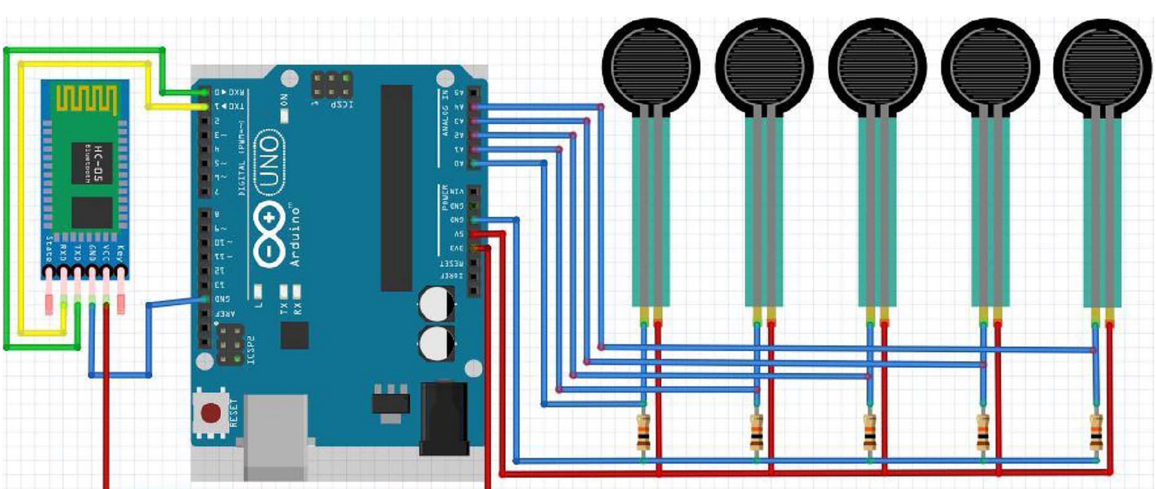

Fig. 1. Harvest glove wiring schematics.