# DETERMINATION OF FIRMNESS IN A FRUIT PACKING LINE USING A NON DESTRUCTIVE IMPACT SENSOR.

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**Introduction**

The increasing of quality fruit demanded by the consumers is originating an advance in the development and application of sensors capable of measuring parameters of quality (sugar, acids, firmness, etc) on a non destructive way. Some of these sensors are already operative for their use in laboratory and even in lines. The Physical Properties laboratory of the Polytechnic University of Madrid, is developing different sensors for their implementation in lines. One of them is a non destructive impact sensor to measure fruit firmness.

**Method**

A non destructive impact sensor to measure fruit firmness has been installed on the commercial sizer chain of an experimental fruit packing line. This sensor impacts each fruit by means of a rotating arm with a semi spherical head in the rear of which an accelerometer is located. The release of the arm is ordered by a photoelectric cell that detects the fruit presence. The accelerometer signal allows the classification of the fruit in three levels of firmness by means of a specific software. The firmness index is obtained from the curve of acceleration-time supplied by the accelerometer.

Several test have been carried out using different types of balls and fruits (apples and peaches) to determine the sources of variation that can affect the obtained signal: position of the photoelectric cell, effect of the position of the fruit, impact area, work velocity, etc, to achieve the best possible measuremend and calibration. In parallell the fruit firmness indexes have been determined in laboratory using traditional methods (Magness-Taylor, load-unload with a compression of 2,5 mm and also applying a force of 3 N) and using the impact sensor in static (without motion of the fruit).

**Results**

The use of the impact sensor in laboratory gives good results in the determination of firmness of fruits. In the packing line, the results are variable because the fruit and the prototype's arm are in movement. A little variation of the sensor regulations varies the impact moment, and therefore the observed values. For that reason the values obtained are very sensitive to variations in the fruit's form, impact angle, and curvature radius of the fruit. These variations would imply an advance or backwardness of the detection of the photoelectric cell (that it would advance or it would put back the impact) varying in that way the place where fruit is impacted. Test carried out with apples and peaches, gave good results when fruit of regular form and same size was tested. Results improved when the firmness range of the fruits was wider.

At a speed of 5 to 7 fruits per second the relationship variables: ratio A/t (maximum acceleration value divided by its corresponding time), mean and maximum slopes of the curves supplied by the accelerometer, were well correlated with the firmness data obtained in laboratory with the load-unload test.