Estimation of Papaya Fruit Volume and Surface Area Using a Dual Ellipsoid Representation and Image Analysis

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SUMMARY

Knowledge of volume (V) and surface area (A) of agricultural products can be applied in the design of machinery, in predicting amounts of pesticides, and in quantification of bruise, abrasion, and insect damage. A and V are also useful for calculating rate of post-harvest loss in horticultural produce and monitoring fruit growth

In this study, laser scanning methods and standard hydro-static techniques are in first place used to create accurate and scaled 3D models of a fruit cultivar (i.e. red papaya) of different size and shape. Based on these models a geometric representation for a rapid estimation of V and A of a papaya is presented. In essence, this representation relates to a particular mathematical function based on a 3D shape formed by two halves of ellipsoids that have separate radius dimensions. This representation will be referred to as dual ellipsoid for the remaining of this manuscript.

Statistical data regarding V and A as obtained via the proposed dual ellipsoid is determined by comparing said data with that obtained from the above mentioned hydro-static and laser scanning techniques. Results show that for the relatively large papaya samples considered, the predicted (via the proposed representation) and the "true" figures for V and A agree within 1.7% and 2.0 % respectively.

The model representation is defined by fruit dimensions which comply with international standards for size and V characteristics of papaya cultivars in general, that is, papaya axial dimensions such as width (W) and length (L). In this work these axial dimensions are derived from measurements taken on scaled digital images of the fruit using an open source digital image analysis software. Hence, the proposed model may constitute a practical and effective tool for many applications related to field measurement, mapping, growth monitoring, harvesting, processing, storing and handling of

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this highly perishable fruit.

In particular it may lead to applications in farm management, production and forecasting. For example, many present practices related to monitoring of fruit growth in the field are still relying on calipers and/or measuring gauges. In this context, a GIS (Geographical Information Systems) field measuring scheme is suggested, capable of storing pictorial information of papayas, including related attributes like location (i.e. latitude and longitude) of measurements, weather and time of measurements amongst others.