

# A Geometric Model for Estimating the Volume and Surface Area of Apples

Gabriel Scarmana, Kevin McDougall and Stepanyants Yuri (Australia)

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## SUMMARY

Agricultural and food technology research and science studies frequently require estimates of surface area (SA) and volume (V) of fruits, nuts and vegetables. These estimates are essential for supporting important processes such as storage, sorting, shipping practices, respiration rates, water loss or absorption, use and extent of pesticides and heat transfer.

In this research, low-cost laser scanning and conventional close range photogrammetric methods (for SA) are combined with standard hydro-static techniques (for V) so as to create accurate and scaled 3D models of apples of different sizes and shapes. Based on these models a novel geometric representation for a quick estimation of V and SA of an apple cultivar (i.e. granny smith) is presented. In essence, this geometric model relates to a particular mathematical function referred to as the cardioid.

Accurate statistical figures of V and SA values as obtained via the proposed cardioid representation are determined by comparing the developed model to the points of truth V and SA values obtained from the afore-mentioned 3D models. Results show that for the relatively large apple samples considered, the predicted (via the cardioid representation) and the “true” figures for V and SA agree within 2.8% and 3.4% respectively.

The proposed cardioid representation can be defined with simple but precise measurements which comply with international quality standards for size and volume characteristics of apple cultivars in general, that is, apple axial dimensions such as length (L) and diameter (T). Hence, the proposed cardioid model constitutes a practical and effective tool for many applications related to apple

measuring, processing and handling.

In particular it may lead to valid applications in orchard management, production and forecasting. In this context, an example describing a field data collection/capture system for apples is carried out in a real environment using a purpose made digital calliper integrating an on-board data-logger and a GPS receiver.

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