The 15th International Citrus Congress 2024
Human-healthily, Environment-friendly, Industry-productively

CrackSense participated in the **15th International Citrus Congress** (ICC 2024) from **November 10–15 in Jeju, Korea**. Organised by the International Society of Citriculture, the event focused on advancements and challenges in citriculture under the theme "***Human-Healthily, Environment-Friendly, Industry-Productive***."

CrackSense: high throughput real-time monitoring and prediction of fruit cracking by utilizing and upscaling sensing and digital data technologies

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Smart Farming represents the application of modern Information and Communication Technologies (ICT) into agriculture, and it is based on sensor data feedback. CrackSense is an EU-based program that aims to develop and upscale sensing technologies to provide real-time sensor data for addressing the problem of fruit cracking. Fruit cracking is common in a few citrus cultivars, and may cause large-scale yield loss. Its intensity is affected by intrinsic plant traits (genetic makeup, peel characteristics), environmental parameters (climate, soil texture), and management practices (irrigation, mineral nutrition, hormonal applications). Of the environmental and horticultural variables, climate and irrigation are considered major players in determining cracking intensity, respectively. Once in a few years, the disorder aggravates to more than 50% of the fruits. It is hypothesized that extreme climatic conditions and sub-optimal irrigation regimes at certain phenological stages, reduce peel resistance to growth strains. No comprehensive model predicts climatic conditions that promote cracking incidence and severity—for specific crops and specific locations. The interaction between the climatic variables, management, and temporal fruit development is unknown. Therefore, cracking is the combined effect of multiple factors, environmental and endogenous, and has an erratic and unpredictable nature.

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Prediction of cracking incidence based on various sensing/imaging technologies by fruits and trees scanning as early as possible before the disorder becomes visible, could be ideal. So far, imaging technologies have not been developed, but upscaling and combining proximal and remote sensing tools might well allow cracking detection and the development of year-, plot- and region-based risk assessment models. Modeling requires, on the one hand, the collection of agri-environmental parameters for a given plot and growing region, and, on the other hand, high throughput and precise monitoring of fruit growth and cracking development for as many fruits, plots and regions as possible. Earth Observation satellite data, meteorological stations, and other sensors allow the collection of agri-environmental variables at all the above-mentioned levels. Other variables, such as plot location, topography, microclimate, soil texture, horticultural practices, and irrigation level, are also feasible features to collect at the required scale. Therefore, the generation of large databases pertaining to different fruit species and containing all agri-environmental variables is feasible. In contrast, the inclusion of high throughput cracking data at the level of the individual fruit, tree, and plot, and the exact timing of cracking, are challenging tasks and are therefore limited to a small number of trees and plots. The present proposal aims to upscale sensing methods for the detection of cracking at the fruit, tree, and plot levels. Exploiting several remote and proximal sensing tools is a key to generate the required dataset that could be combined with other ancillary features and be fed into prediction models. Furthermore, ML and AI methods could reveal the complex relationship between the various features and provide robust estimations of the risk of cracking. Upscaling crack monitoring by high throughput tools, in an automatic and timely manner, would improve our understanding of the phenomenon of cracking and eventually benefit the growers by providing them with better tools to manage cracking incidences and the subsequent yield loss.

Therefore, CrackSense's key objective is to upscale sensing technologies to monitor fruit cracking and yield loss at the fruit, tree, plot, and regional levels, and to integrate this data with agri-environmental monitoring data to generate models for predicting cracking incidence and risk at the fruit/plot/regional/country levels for a given year. The results and data of CrackSense will be presented and discussed.

Keywords: fruit cracking, splitting, sensing, irrigation

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