POMELO FRUIT PICKING ROBOT FOR UNSTRUCTURED ENVIRONMENTS

Shangshang Cheng[1], Zhengwei Yu[1], Qingru Fan[1], Zhen Li[1,2,*] , Shilei Lyu[1,2], Wei Wen[2], Zhou Yang[3]

[1]College of Electronic Engineering (College of Artificial Intelligence), South China Agricultural University, Guangzhou, 510642, China
[2]Division of Citrus Machinery, China Agriculture Research System of MOF and MARA, Guangzhou, 510642, China
[3]Guangdong Ocean University, Zhanjiang, 524088, China

*cheng_shangshang@163.com, yuzhengwei@stu.scau.edu.cn, 1834277156@qq.com@email.com, *lizhen@scau.edu.cn, lvshilei@scau.edu.cn, luckypig@scau.edu.cn, yangzhou@scau.edu.cn*

China is the world's largest producer and consumer of pomelo, with a total output value exceeding billions of yuan. It has become one of the key industries driving agricultural rural economic development in southern regions. Due to terrain conditions and planting patterns, manual labor plays a crucial role in pomelo orchard production and management, accounting for approximately 50-70% of the total production cost. Particularly during the picking process, labor costs make up 61.5% of the overall expenses. Implementing mechanized and intelligent harvesting methods for pomelo fruits is an effective approach to enhance stability and competitiveness within the industry chain. This project aims to design a cutting mechanism for pomelo fruits and study tree optimization techniques. The main objectives include: 1) Utilizing principles from physics, material mechanics, and finite element analysis to investigate the physical and mechanical characteristics of pomelo fruits as well as their cutting performance when detached froming mechanism responsible for fruit stem fracture. 2) Developing a method that can predict both position and orientation of fruit stems while incorporating key features in complex environments. Additionally, establishing a theoretical model for recognizing pomelos and locating fruit stems even under occlusion. 3) Studying robotic arm actuators with long arm spans and wide working ranges; devising motion methods along with control theory models that enable multi-position cutting capabilities. 4) Exploring appropriate pruning technology management practices specifically tailored for pomelo trees within plantations; enhancing picking point identification while reducing collision probabilities through branch removals and thinning out excess fruit. Experimental results demonstrate that this robot achieves an accuracy rate of 94% with a harvesting efficiency rate of 2 per minute.

Keywords: Pomelo Fruit-picking, Robotics, Citrus Cultivation, Intelligent Agricultural Machinery, Smart Agriculture