



# Farm and environment information bidirectional acquisition system with individual tree identification using smartphones for orchard precision management



Jian-ping Qian<sup>a</sup>, Xin-ting Yang<sup>a,\*</sup>, Xiao-ming Wu<sup>a</sup>, Bin Xing<sup>a</sup>, Bao-guo Wu<sup>b</sup>, Ming Li<sup>a</sup>

<sup>a</sup> National Engineering Research Center for Information Technology in Agriculture, Beijing Academy of Agriculture and Forestry Science, Beijing 100097, China

<sup>b</sup> Department of Information, Beijing Forestry University, Beijing 100083, China

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## ABSTRACT

An orchard precision management system plays an important role in improvement at the management level and the enhancement of decision abilities. A single orchard tree or an orchard tree microcommunity is the basic management unit, and bidirectional information on the environment and plants is the important content for precision management. A type of RFID label was applied with a UHF chip in the core and a QR code in the surface for single tree identification. A bidirectional acquisition system for orchard production, which included farming information collection for the forward direction and environmental information acquisition for the backward direction, was designed with smart phones. In the farming information collection part, information collection flow that included QR code image acquisition, image preprocessing, barcode decoding and farming information collection was established. An improved local threshold method was adopted to improve the QR code identification rate in the smart phone platform. In the environment information acquisition part, a sensor search rule on the single tree position and a multi-point environment value model were designed. The orchard information bidirectional acquisition system was developed on an Android platform with the Java language, which has the function of QR decoding, farm record information collection, environment information acquisition, data uploading and statistical analysis. The system was tested in an apple orchard. A total of 144 trees were chosen to decode the QR codes in the tree label. The success rate was approximately 96.52%. The identification time of 85% of the trees was less than 4 s for the 20 chosen trees. In taking the temperature, for example, the difference between the computed temperature value and the measured temperature value around each tree was small. The system could decrease the cost of the professional equipment, such as portable RFID readers and writers, which was a low-cost and high-efficiency solution for orchard production information collection.

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## 1. Introduction

China is a country with a large fruit production in the world. For apples, the production in 2010 exceeded 30 million tons (Qian et al., 2013). However, the fruit quality and yield has undergone large fluctuations from year to year because of extensive issues in management (Qi et al., 2011).

Precision agriculture has the characteristic of high technology content, advanced production means and strong technology integration (Zhang et al., 2002). Flexible management is the key idea

of precision agriculture. The idea can be used in orchard management. A different method at a different time is performed in the orchard according to the individual and population diversity, which has been an efficient way to improve extensive management (Cunha et al., 2010). In orchard precision management, a single orchard tree or an orchard tree microcommunity is the basic unit, and information collection and management is the important content. The information includes two parts, one of which is the plant environment information, such as the temperature and humidity, and another is the farming operation information, such as irrigation and insecticides (Jiang et al., 2008).

A WSN (Wireless Sensor Network) provides effective support for environmental information quick acquisition and real-time monitoring (Wang et al., 2006; Fernandes et al., 2013). A WSN

\* Corresponding author. Tel.: +86 10 51503426.

E-mail addresses: [qianjp@nercita.org.cn](mailto:qianjp@nercita.org.cn) (J.-p. Qian), [xintingyang@nercita.org.cn](mailto:xintingyang@nercita.org.cn) (X.-t. Yang).