屈永华,王锦地,董 健,姜富斌.农作物冠层结构参数自动测量系统设计与试验[J].农业工程学报,2012,28(2):160-165

农作物冠层结构参数自动测量系统设计与试验

Design and experiment of crop structural parameters automatic measurement system

投稿时间： 2011-06-23 最后修改时间： 2011-08-11

中文关键词：农作物,结构参数,测量,无线传感器网络,冠层

英文关键词:crops structural parameters measurement wireless sensor networks (WSN) canopy

基金项目:国家863 计划项目(2009AA122101)

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中文摘要:

农作物冠层的结构参数，如叶面积指数与平均叶倾角，是影响太阳辐射在农田内进行重新分配的重要参数。在农业工程中，以玉米与小麦为例，这些参数的测量以传统的手持仪器为主，需要消耗较大的人力和时间，难以被应用于大区域尺度、长时间序列结构参数获取。该文设计并实现了一种基于无线传感器网络技术的农作物结构参数自动测量系统。系统由冠层上、下部光强测量节点、数据汇聚节点以及数据无线传输的路由节点组成，通过测量不同太阳高度角下冠层透过率来求解冠层的结构参数。数值模拟结果与野外实测结果表明，该文所用的结构参数反演算法稳定，测量系统可以较好的探测一天之中不同太阳高度角下的植被冠层太阳辐射透过率，基于方向透过率计算得到的叶面积指数与LAI2000仪器测量结果有较好的相关性，平均叶倾角和理论分布模式计算结果基本一致。该系统可以应用于对大区域尺度上的农作物长时间序列连续观测，提高农作物结构参数测量的自动化程度。

英文摘要:

The presented work aims to develop an automatic measurement system to collect crop parameters. In this paper, the structure parameters of land surface crops are considered. Crop structural parameters, such as leaf area index(LAI) and average leaf angle(ALA), are the main factors that can effect the solar energy re-assignment in the canopy. The traditional method to measure such parameters for crops, e.g. maize and wheat, is relied on the handy instrument, so it is difficulty to carry out the measurement on the large spatial region and on the long time series. An automatic measuring system which is designed on the basis of wireless sensors network(WSN) is present in this paper. The system is comprised of three types of node, i.e. two solar irradiance measurement nodes which are deployed beneath and above the canopy respectively, a sink node which is used to collect data from the measurement nodes, and the last type is a route node which is acted as a repeater of wireless communication. Canopy structural parameters can be calculated from the direct transmittance which is the ratio of sun radiation captured by the measurement node beneath and above the canopy on different sun altitude angles. Numeric simulation and the field preliminary validation results showed that the designed system could detect the directional canopy transmittance which is the basis to calculate the target parameters. And the further validation results revealed that the measured LAI values between LAI2000 instrument and our propose measurement system had high correlation coefficient and the calculated average leaf angles were very proximity to the theoretical values. So it is promising in the agriculture application to utilize the proposed system in measuring the crop structural parameters, and it can be an efficient way to measure such parameters in the large spatial region and on the long time series automatically.

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