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穴盘苗自动取苗机构的自适应模糊**PID**定位控制

Location control of automatic pick-up plug seedlings mechanism based on adaptive fuzzy-PID

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中文摘要:

针对目前穴盘苗移栽机控制系统定位精度不高、可靠性差、控制性能不稳定、智能化程度低等问题，该文对全自动大田移栽机中的顶苗杆式穴盘苗自动取苗机构的定位控制进行研究。经过理论计算和分析，提出采用自适应Fuzzy-PID控制算法来实现苗盘的步进输送定位控制。设计了自适应Fuzzy-PID控制器，进行了Matlab建模仿真分析以及系统调试试验。结果表明，自适应Fuzzy-PID控制下的响应时间为0.192 s，扰动超调量约为扰动信号幅值的0.88%，PID控制下的响应时间为0.359 s，扰动超调量约为扰动信号幅值的10%，且自适应Fuzzy-PID控制下的最大相对定位误差为0.27%，小于允许值1.25%。采用自适应Fuzzy-PID控制算法能够提高系统的定位精度以及改善系统的抗干扰性和作业稳定性，满足苗盘输送的定位精度要求。研究结果可为该取苗机构整个控制系统的研制提供参考和依据，也可为其他取苗移栽控制系统克服多重非线性因素影响适应于大田移栽作业环境提供一种新的解决途径。

英文摘要:

Abstract: As one of the key components of a fully-automatic field transplanter, an automatic pick-up plug seedlings mechanism has important significance in reducing labor intensity, liberating labor forces, and improving efficiency of transplanting. For a new kind of push-out type automatic pick-up plug seedlings mechanism, this paper systematically studied the method of its location control, which was aimed at enhancing its location accuracy, ensuring its operation efficiency and improving its anti-interference. Through the analysis of mechanical structure characteristics of this new mechanism, it could be concluded that the location control for conveying potted trays is a key factor in ensuring accurate operation of the entire mechanism and finally highlighting its high efficiency. That is, if the accurate location of conveying potted trays is realized when other parts of this mechanism operate with the conventional time, compared with domestic common pick-up plug seedlings manipulators, the operation efficiency of this mechanism will be greatly increased. The location accuracy requirement in conveying potted trays was obtained based on the analysis and calculation in details. At the same time, the control accuracy of the potted trays conveying system under the simple closed loop stepping location control was identified theoretically. This paper then analyzed the limitations of the stepping location control system under a simple closed loop control, fixed parameter PID control or fuzzy control, and the adaptive Fuzzy-PID control algorithm was proposed to be used to achieve the location control. In this paper, the adaptive Fuzzy-PID controller was designed, and the transfer function of the closed loop stepping location control system was constructed, and finally the modeling and simulation analysis in the Matlab were carried on, as well as the system debugging experiment. The simulation analysis showed that the response time of the adaptive Fuzzy-PID control was 0.192s, and that of PID control was 0.359s. In the interference of a disturbance signal, the disturbance overshoot of the adaptive Fuzzy-PID control as a percentage of disturbance signal amplitude was 0.88%, and that of PID control was 10%, so the former was far less than the later. The comparative analysis from above showed that the adaptive Fuzzy-PID control system had a faster response and better anti-interference, so it will have a distinct advantage in working in a complex field operation environment. The system debugging experiment then showed that the maximum relative location error of conveying potted trays under the adaptive Fuzzy-PID control was 0.27%, which was lower than the maximum relative error allowed in conveying potted trays. That is to say, the adaptive Fuzzy-PID controller can satisfy the location accuracy requirement of conveying potted trays. In sum, using an adaptive Fuzzy-PID control algorithm to fulfill the stepping location control of conveying potted trays can enhance the location accuracy, and improve the anti-interference and the system stability, which ensures the efficient operation of this automatic seedling pick-up mechanism and makes it suitable to the complex field transplanting operation environment. This paper provides not only reference and basis for the whole control system's development of this automatic seedling pick-up mechanism but also a new solution for the control system of other seedling pick-up mechanisms or transplanters to adapt the field transplanting operation environment with multiple nonlinear influence factors.

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