中文摘要

　　本文由工程控制學觀點，描述封閉型農業生態系統之分析架構，並建立其用辭與概念，以說明能局部或整體生產功能之農場環境的控制系統架構。基於此架構，以線性系統理論發展一系統控制模式，探討封閉型農業生態系統中能量或物質流之動態行為。並以線性非時變系統的二次調節器加輸出回授控制為研究對象。應用特殊積分二次目標函數，可將該系統中能量或物質流之變異極小化，並達成最佳或次佳控制。整體控制系統設計，脈衝及步級式干擾兩者皆納入考慮，並有效合成最佳回授比例(P)及比例加積分(PI)控制器。文中選擇台灣雲林縣一家農場，針對豬隻所排放的殘磷濃度，設計一最佳控制系統，以免因過量而造成環境污染。整體模式模擬使用 MATLAB 軟體操作。模擬結果顯示，選擇最佳權重參數所產生的成本，隨著欲求值而改變；當適切地調變所設計的最佳回授控制器，對農場中殘磷濃度，能達令人滿意的控制效果。

關鍵詞：封閉型農業生態系統；最佳控制系統；控制器；殘磷濃度

Abstract

An analytical framework for the design of an enclosed agro-ecosystem via the view point of engineering control systems is described. The terminology and the framework are developed within the context of that description to interpret a pig farm environmental control mechanism in which a partially or a fully autonomous production capacity is assigned. Based on the framework noted above and the linear systems theory, a system control model is developed to describe the dynamic behavior of energy/material flows in an enclosed agroecosystem. Linear quadratic regulators (LQRs) with output feedback of a linear-invariant system are chosen for this study. The optimization and suboptimization are defined to determine an output control loop such that the integral qua- dratic cost function meets its minimum value. Both impulse and step disturbances are taken into account and optimal proportional (P) and proportional plus integral (PI) feedback controllers are synthesized. To illustrate this procedure, the design is applied to control residual phosphorus concentration in a typical pig farm located at Yun-Lin, Taiwan. The simulations were done in complied PC-MATLAB. Numerical results from the model implementation that the optimal choice of weighting parameters and the resulting costs vary with desired equilibrium state. The designed optimal feedback controllers, when suitable tuned, give satisfactory control of residual phosphorus concentrations in the pig farm.

Keywords：Enclosed agroecosystem ; Optimal control system; Controller ; Residual phosphorous concentration