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基于无线传感器网络的节能型水产养殖自动监控系统

Energy-efficient automatic monitoring system of aquaculture based on WSN

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中文摘要:

水产养殖的规模化发展和人力成本的不断上升迫切需要建立水质参数的无人值守自动监控系统。该文提出了一种基于改进型低能耗分层分群协议（LEACH）的Zigbee无线传感网络的水质监测和基于西门子PLC的变频增氧控制系统。在LEACH-C通信协议中，由基站根据各节点剩余能量的估算值选定簇首，达到各节点供电电池剩余能量的均衡，同时从系统的实际控制精度出发，当节点测量到的溶解氧浓度值与上次发送值误差在0.02 mg/L范围内时，不向簇首发送数据，达到节约供电电池能量的目的，经试验发现采用优化后的LEACH-C协议，比采用常规的LEACH协议网络有效寿命延长33.33%。适合鲈鱼生长的水体溶解氧质量浓度大于4.5 mg/L，但随着浓度的上升增氧效率将逐步降低，因此设定应急增氧的区间为4.5～5.5 mg/L。控制系统根据无线传感网络测量的溶解氧质量浓度值，采用PI-PID控制水体溶解氧浓度。保证了水体溶解氧质量浓度始终适合鱼类生长。通过试验验证，与人工粗略控制相比，这种控制方法大幅降低了人力成本和节约了51%的电能。该文可为水产养殖自动控制研究提供参考。

英文摘要:

Abstract: Because of the expanding scale of aquaculture and rising labor costs, it is urgent to establish an automatic monitoring and control system of water quality. The optimized protocol of centralized low-power hierarchical clustering (LEACH-C) for a wireless sensor network communication and frequency control aeration system based on a programmable logic controller (PLC) was adopted. In a LEACH-C communication protocol, cluster heads were selected according to the residual energy of each node by the base station with fixed power supply. The aim of balancing the residual energy of each node was reached. From the actual control accuracy of the system, the changes in dissolved oxygen concentration was less than 0.02 mg/L than the value last time, and the corresponding node sent no data to its cluster head for saving energy. The test proved that the lifetime of a network adopted optimized LEACH-C protocol was 33.33% longer than that of a network adopted conventional LEACH protocol. The concentration of dissolved oxygen in water which was suitable for the perch growth was no less than 4.5 mg/L. As the concentration increased, the aeration efficiency will be gradually reduced. Therefore, the range of emergency oxygen was set from 4.5 to 5.5 mg/L. Based on measured value of dissolved oxygen content from the wireless sensor networks, a PI-PID algorithm was used in controlling the concentration of dissolved oxygen in the water body. When the error was large, the use of a set of PI parameters could quickly narrow the error; while error-hour, using a set of PID parameters could remain stable. In order to ensure the smooth switching of the two sets of parameters, a hysteresis switching area was set. This would ensure the timeliness and efficiency in oxygen supply when the dissolved oxygen concentration in water was less than 4.5 mg/L, or more than 5.5 mg/L. The dissolved oxygen in water was always suitable for the growth of fish. It is verified by experiment that compared with the artificial rough control, labor costs were significantly reduced and nearly half of the electricity was saved by this control method.

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