

# **MONITORING DAN PENGENDALIAN KUALITAS AIR AKUARIUM IKAN HIAS AIR TAWAR BERBASIS IOT DENGAN METODE FUZZY LOGIC MAMDANI**

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## **ABSTRAK**

Ikan hias air tawar merupakan komoditas bernilai ekonomi tinggi, di mana ekspor ikan hias Indonesia pada tahun 2022 mencapai USD 36,43 juta dengan pangsa pasar global sebesar 11,35%. Namun, pemeliharaan akuarium secara konvensional masih mengandalkan pemantauan manual yang kurang akurat, membutuhkan waktu dan tenaga ekstra, serta rentan terbengkalai akibat kesibukan pemilik. Oleh karena itu, penelitian ini bertujuan merancang dan mengimplementasikan sistem monitoring dan pengendalian kualitas air akuarium ikan hias air tawar berbasis Internet of Things (IoT) dengan menerapkan metode *Fuzzy Logic Mamdani* untuk menentukan persentase pengurasan air secara adaptif berdasarkan kondisi kualitas air. Sistem dibangun menggunakan tiga mikrokontroler, yaitu ESP32 sebagai *sensor node* dan aktuator, serta ESP8266 sebagai *alarm center*, yang saling berkomunikasi melalui protokol MQTT. Metode *Fuzzy Logic Mamdani* menggunakan dua variabel input, yaitu kekeruhan dan pH, dengan sembilan *rule* untuk menentukan persentase pengurasan air secara dinamis. Pengembangan sistem menggunakan metode *prototyping* dengan pengumpulan data melalui wawancara bersama ahli perikanan dan pemilik akuarium. Hasil penelitian menunjukkan bahwa sistem mampu menstabilkan nilai pH pada kisaran 6,9637,74 yang berada dalam rentang ideal bagi ikan hias air tawar serta menurunkan rata-rata kekeruhan air dari 41,19 NTU menjadi 17,63 NTU atau sebesar 57,2%. Hasil pengujian menunjukkan rata-rata akurasi sensor sebesar 96,20%, sedangkan seluruh pengujian terhadap 10 perintah bot Telegram berhasil dieksekusi dengan waktu respons 234 detik. Selain itu, sistem pencahayaan otomatis berbasis NTP dan pendinginan berbasis suhu berfungsi sesuai rancangan. Dengan demikian, sistem yang dikembangkan mampu mendukung monitoring dan pengendalian kualitas air akuarium secara lebih efektif, adaptif, dan terautomasi.

**Kata Kunci:** *Internet of Things*, Akuarium Ikan Hias Air Tawar, *Fuzzy Logic Mamdani*, MQTT, *Bot Telegram*

***IOT-BASED MONITORING AND CONTROL OF WATER QUALITY IN  
FRESHWATER ORNAMENTAL FISH AQUARIUMS USING THE  
MAMDANI FUZZY LOGIC METHOD***

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***ABSTRACT***

*Freshwater ornamental fish are high-value commodities, with Indonesia's ornamental fish exports reaching USD 36.43 million in 2022, accounting for an 11.35% share of the global market. However, conventional aquarium maintenance still relies on manual monitoring, which is less accurate, time-consuming, and prone to neglect due to the owner's daily activities. Therefore, this study aims to design and implement an Internet of Things (IoT)-based monitoring and water quality control system for freshwater ornamental fish aquariums by applying the Mamdani Fuzzy Logic method to determine adaptive water replacement percentages based on water quality conditions. The system consists of three microcontrollers: an ESP32 as the sensor node and actuator, and an ESP8266 as the alarm center, which communicate through the MQTT protocol. The Mamdani Fuzzy Logic method employs two input variables, turbidity and pH, with nine inference rules to determine dynamic water replacement percentages. The system was developed using the prototyping method, while data were collected through interviews with fisheries experts and aquarium owners. The results showed that the system stabilized pH values within the range of 6.9637.74, which is suitable for freshwater ornamental fish, and reduced the average water turbidity from 41.19 NTU to 17.63 NTU, representing a 57.2% reduction. The sensor system achieved an overall average accuracy of 96.20%, while all ten Telegram bot command tests were successfully executed with response times of 234 seconds. In addition, the NTP-based automatic lighting system and temperature-based cooling system operated as designed. Therefore, the developed system effectively supports more efficient, adaptive, and automated monitoring and control of aquarium water quality.*

**Keywords:** *Internet of Things, Freshwater Ornamental Fish Aquarium, Mamdani Fuzzy Logic, MQTT, Bot Telegram*