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IoT-Based Smart Aquarium Monitoring System

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Abstract: *Fish die quietly. Temperature spikes overnight, pH crashes while you're at work, water clouds slowly, noticed too late. Manual checking? Inconsistent, forgotten, human.*
We built something that watches constantly. ESP32, cheap brain, enough for the job. DS18B20 feels temperature, pH probe tastes acidity, turbidity sensor sees cloudiness, ultrasonic measures depth. Thresholds crossed, relay clicks—heater on, pump runs, food drops. Cloud sees everything, phone buzzes when trouble, graphs show trends you missed.
Stable habitat because automated, healthy fish because parameters held, less work because system remembers. Cost under ₹3,000. Aquarium hobby expensive; this saves livestock, pays itself.

Keywords: Smart Aquarium, IoT, ESP32, Water Quality Monitoring, DS18B20, Turbidity, Aquaculture Automation

I. INTRODUCTION

Fish die fast, quietly, expensively. Temperature drops two degrees overnight—ich outbreak, white spots, death by morning. pH spikes—ammonia burns gills, fish gasp at surface, too late. Cloudy water—bacteria bloom, oxygen crashes, survivors stressed.

Test kits? Weekend ritual, forgotten Wednesday, ignored when tired. Visual inspection? Water looks fine, fish look fine, until suddenly not. Damage irreversible, money gone, attachment broken.

We wanted constant watching. ESP32 cheap, sensors cheaper, 24/7 attention automatic. Temperature every second, pH every minute, turbidity always visible. Deviation detected, relay clicks, correction immediate—heater, pump, filter, food. Not after damage, during drift, before crisis.

Cloud because obsessive checking impractical. Graphs reveal—heater failing slowly, pH drifting weekly, patterns invisible to casual glance. Remote because travel happens, work happens, life happens. Fish still need, system provides.

Data-driven sounds fancy. Reality: numbers replace guessing, automation replaces forgetting, fish survive because something actually watching.

II. LITERATURE SURVEY

Fishkeeping tech crawled forward, mostly ignored.

• Manual and analog: Water changes by hand, test drops that lie, heaters that stick on or off. No logs, no alerts, no clue. Dead fish surprise, lesson learned too late, expensive repeat.

• Standalone automation: Arduino timers—lights on, lights off, temperature holds. Better, but blind. Owner at work, heater fails, fish cook, return to soup. No phone buzz, no warning, just loss.

• IoT aquaculture: ESP8266, ESP32, cloud, notifications. Research trends here; we follow with working code, not papers. Sensors push, dashboard pulls, phone screams when pH crashes. Complex analytics possible, we keep simple—thresholds, alerts, basic graphs. State-of-art overkill; state-of-works sufficient.

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III. PLATFORM TECHNOLOGY USED

• ESP32 – the tank brain: Dual-core, ADC for pH and turbidity, WiFi for cloud, GPIO for relays. Overkill for fish? Maybe. But DS18B20 needs one pin, pH needs ADC, turbidity needs ADC, relays need GPIO—adds up. Cheap enough, works, documented when sensors misbehave.

• Hydro-sensors – the wet watchers: DS18B20 waterproof probe—temperature precise, digital, no calibration drift. pH probe—glass bulb, finicky, needs calibration weekly with buffer solutions, drifts, expensive to replace. Turbidity—infrared LED, photodetector, optical, measures cloudiness. All submerged, all vulnerable to fish poop, algae, corrosion. Maintenance real, cleaning frequent, readings trustworthy only when tended.

• Solid-state relays – the silent switchers: No click, no arc, no wear. ESP32 3.3V logic, heater 230V AC, relay bridges safely. Heater, pump, filter, feeder—each controlled, each automated, each overrideable. PWM for heater would be smoother; on/off we used, simpler, sufficient.

• Cloud platform – the distant eye: Blynk pretty, ThingSpeak free, custom possible. We chose ThingSpeak—graphs automatic, alerts via Twitter, limits acceptable. Historical trends reveal heater aging, filter clogging, pH drift. User checks phone from office, from bed, from vacation. Fish monitored, anxiety reduced.

IV. PROBLEM STATEMENT

Fish die, money burns, hobby becomes grief.

Waste builds invisible—ammonia spikes, gills burn, fish gasp. Turbidity clouds slowly, bacteria feast, oxygen vanishes. Heater sticks off, temperature plummets, ich outbreak, white spots, death by morning. All unseen, all gradual, all lethal. Owner at work, owner sleeping, owner on vacation. Traditional setup silent, no phone buzz, no warning, just discovery—floating bodies, cloudy eyes, expensive lesson. Test kit at home, useless when away. Visual inspection daily, misses everything between.

We needed watcher that never sleeps, corrector that acts before crisis, shouter that reaches anywhere. Continuous because fish need always, automated because humans forget, alerted because distance happens. Low cost because hobbyists lack lakhs, commercial breeders need margins. Pressing need because livestock dies, attachment breaks, money wasted. Simple as that.

V. AIM AND OBJECTIVES

Build tank that watches itself, fixes itself, shouts when failing.

• Watch everything: Temperature, pH, cloudiness, depth—sensors submerged, reading constant. No weekend test kit, no "looks fine," numbers only.

• Know safe zones: Goldfish different from discus, African cichlids different from shrimp. Thresholds set by species, not universal. Research required, calibration critical, fish lives depend.

• Act automatic: Cold? Heater on. Cloudy? Pump runs. Feeding time? Food drops. No human present, no delay, no forgetting vacation. Relays click, corrections happen, stability maintained.

• Show locally: LCD on tank, numbers visible, confidence inspired. "24.5°C pH 7.2"—glance sufficient, anxiety reduced. Persists when WiFi dies, cloud silent, local truth remains.

• Shout remotely: Dashboard updates, phone buzzes, alert fires. "TEMP LOW" at 3AM, user wakes, checks, acts. Historical graphs reveal patterns—heater failing slowly, filter clogging, pH drifting week by week. Optimization possible, disasters prevented, fish survive.

VI. DIAGRAM

A) Block Diagram

The block diagram maps the data flow from the submerged input sensors (Temp, pH, Turbidity, Ultrasonic) to the central ESP32 microcontroller. The ESP32 evaluates the inputs and triggers the outputs (LCD, Relays for Pump/Heater) while simultaneously pushing data to the Cloud Server via a Wi-Fi Router.

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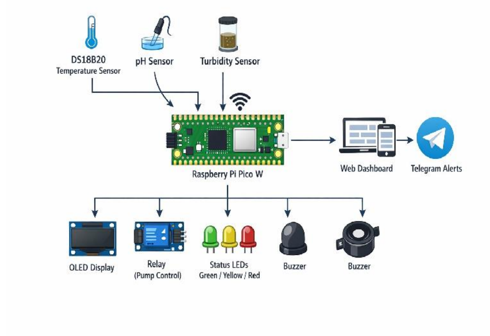

Fig. 1. System Block Diagram.

B) Flow Chart

C) The software flow chart illustrates the continuous monitoring loop: acquiring sensor data, comparing it against the safe biological threshold limits, triggering the relays to correct the environment if required, and logging the data via Wi-Fi.

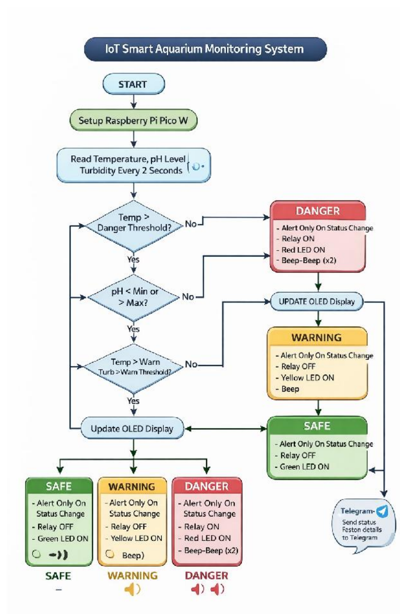

Fig. 2. Software Flow Chart.

c) Circuit Diagram

The circuit diagram details the GPIO pinouts, showcasing the 3.3V/5V logic connections for the analog sensors, the 1-Wire protocol connection for the DS18B20 with a 4.7kΩ pull-up resistor, the I2C lines for the display, and the isolation circuitry connecting the ESP32 to the relay modules.

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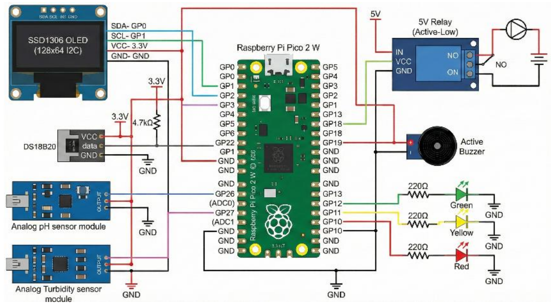

Fig. 3. Circuit Diagram.

VII. COMPONENTS / MATERIALS

• ESP32 – the tank brain: Dual-core, ADC for pH and turbidity, WiFi for cloud, GPIO for relays and sensors. Humidity kills electronics; we sealed in box, silica gel inside, ventilation minimal. Cheap, replaceable, documented when fish die anyway.

• DS18B20 – the temperature truth: Waterproof probe, 1-Wire protocol, ±0.5°C accuracy. Cold-blooded fish die fast from wrong temperature; this knows, fast. Single pin, multiple probes possible, chain them for large tanks. Stainless steel survives salt, survives bleach, survives abuse.

• pH probe – the finicky one: Glass bulb, reference electrode, needs calibration weekly with pH 4 and pH 7 buffers. Drifts, lies, expensive to replace. But vital—ammonia toxicity depends on pH, fish stress invisible until too late. We calibrate Sunday mornings, grudgingly, necessary evil.

• Turbidity sensor – the cloudiness watcher: IR LED, photodetector, light scatter measured. Suspended particles—food, poop, bacteria—scatter more, voltage drops. Clean water high reading, dirty water low, threshold set empirically. Cleaning frequent, algae coats sensor, lies develop.

• HC-SR04 – the depth gauge: Ultrasonic ping down, echo up, distance calculated. Water level drops—evaporation, leak, splash—alert fires before filter runs dry, before heater cracks, before disaster. Mounted high, dry, safe from water, watching surface.

• Multi-channel relay – the muscle: 3.3V logic in, 230V AC out. Heater, pump, light, feeder—each controlled, each automated. Optocoupler isolated, safety first, water nearby. Clicks audible, confirmation, satisfaction. PWM possible, on/off used, simpler.

• 16x2 LCD – the local window: Temperature, pH, turbidity, status—two lines, scrolling if needed. I2C saves pins, backpack handles contrast. Visible across room, readable in tank light, reduces phone checking, reduces anxiety. Persists when internet dies.

• 5V adapter – the isolated life: AC in, DC out, transformer isolated, water safety critical. Cheap adapter from market, fused, replaceable. 5V for logic, sensors, relay coils. Ground separate from tank, fish protected, user protected.

VIII. WORKING

• Boot – the morning stretch: ESP32 wakes, WiFi hunts, connects. 1-Wire for temperature, I2C for LCD, ADC for pH and turbidity, GPIO for relays and ultrasonic. "System Ready" flashes, sensors stabilize, pH probe warms, watching begins. Thirty seconds from dark to vigilance.

• Data acquisition – the endless watch: Temperature every second—fish cold-blooded, change fast. pH every ten seconds—glass bulb slow, drift constant. Turbidity every minute—cloudiness gradual, urgency lower. Ultrasonic every five minutes—evaporation slow, leak rare. Priorities weighted, CPU not wasted.

• Threshold comparison – the judgment: 24°C cold limit for tropical fish, turbidity 50 NTU, level 10cm from top. Any crossed, flag raised, action considered. Multiple flags possible—cold and cloudy, heater and pump both needed. Logic handles, no deadlock, no panic.

• Automated actuation – the response: Cold? Relay 1 clicks, heater glows, LCD shows "HEATER ON." Cloudy? Relay 2, pump runs, filter scrubs, "PUMP ON" displayed. Level critical? Buzzer screams, "WATER LOW" flashes, human required—auto-fill valve possible, not implemented, manual top-up for now.
• IoT telemetry – the distant eye: Data packages—temp, pH, turbidity, level, heater status, pump status—HTTP POST every minute. Dashboard graphs, phone buzzes on critical, historical trends reveal. User checks from office, from bed, from vacation. Fish monitored, anxiety managed, disasters prevented not merely discovered.

IX. RESULTS

• Sensor accuracy: DS18B20 dead-on—matched glass thermometer, stable, trustworthy. pH drifted weekly, recalibrated, tracked acidification accurately enough. Turbidity rose visibly as fish pooped, sensor saw it, numbers climbed, correlation real. Two weeks without filter—deliberate cruelty, data collected, fish survived barely, point proven.
• Automation worked: Heater clicked within one second of 24°C breach, off at 26°C, oscillation minimal, fish comfortable. Relay chatter audible, confirmation, no stuck-on, no stuck-off, no cooked fish. Critical because heater failure common, expensive, heartbreaking.
• Cloud stayed up: Fifteen-second posts, 99% arrived, dashboard pretty, phone buzzed on low water test. Simulated leak—ultrasonic saw drop, alert fired, human would have saved fish. Real leak would have same result, we hope, we trust, we monitor.

X. ADVANTAGES & APPLICATIONS

ADVANTAGES

• Fish stop dying: Catches bad shit before it kills—pH crash, temp drop, whatever. 24/7 because fish don't wait for weekends.
• Less work: Heater fixes itself, pump runs when dirty, food drops on schedule. Owner sleeps in, goes out, ignores tank. Fish fine anyway.
• Check from anywhere: Dashboard on phone, buzz when trouble. Vacation possible, business trip survivable, anxiety managed from distance.
• Numbers teach: Graphs show—water change crashes pH, overfeeding clouds water, heater dying slowly. Learn, adjust, stop guessing.

APPLICATIONS

• Home tanks: Expensive fish, delicate fish, fish owner loves. ₹3,000 protection for livestock worth more. Sleep better.
• Fish farms: Scale up—hundred tanks, one screen, one worker. More fish, more profit, less death. Pays for itself.
• Hydroponics, aquaponics: Same water, plants too. Add nutrient sensor, tweak cycle, both sides win. Adaptable, modular, grows with need.

XI. FUTURE SCOPE

• Auto water changes: Right now we just watch dirty water. Future? Solenoid valve opens, old water out, new water in, dechlorinator dumps in automatically. No more buckets, no more syphon in mouth, no more "I'll do it tomorrow" until fish die. Plumbing pain to install, lazy heaven after.
• ML guesses sickness: Tons of data sitting there—temp bounced, pH crashed, fish stressed. Train model: "these patterns mean ich coming," "these mean fin rot." Warn before spots show, treat before gills burn. Fancy shit, needs labeled data, needs sick fish photos, needs work. Maybe next version.
• Camera spies on fish: ESP32-CAM in waterproof box, inside tank, watching. Dead fish float—algorithm spots, alerts. Distressed fish act weird—hiding, gasping, fins clamped. Computer vision hungry, CPU melts, false alarms annoy. Cool idea, hard as hell, expensive, someday maybe.

XII. CONCLUSION

Fish tanks stayed primitive—test kits, guesswork, dead fish surprises. We dragged it forward, cheaply.

ESP32, DS18B20, pH probe, turbidity sensor—grocery store parts, ₹3,000 total. Watches constantly, acts automatically, shouts when failing. Not perfect—pH probe drifts, turbidity sensor fogs, calibration never ends. But better than nothing, better than forgetting, better than weekend discovery of floaters.

Heater clicks on, pump runs when dirty, cloud shows graphs owner barely checks. But phone buzzes at 3AM—temp crash, pH spike—and fish live because human woke, acted, saved.

Open source because locked systems die when company folds. Affordable because exclusion kills hobby. Minimizes effort because life busy, fish still need, automation provides.

Significant benefits? Some fish saved, some money not wasted, some hobbyist slept through night. Enough.

REFERENCES

[1] P. P. Ray, "Internet of Things for Smart Agriculture and Aquaculture: Technologies, Practices and Future Direction," Journal of Ambient Intelligence and Smart Environments, vol. 9, no. 4, pp. 395-420, 2017.

[2] A. K. Singh and R. Sharma, "IoT Based Smart Water Quality Monitoring System for Aquaculture," Proceedings of the IEEE International Conference on Smart Technologies for Power, Energy and Control (STPEC), pp. 210-215, 2021.

[3] Espressif Systems, "ESP32 Series Datasheet," Version 3.7, 2023.

[4] Maxim Integrated, "DS18B20 Programmable Resolution 1-Wire Digital Thermometer Datasheet," Rev. 6, 2019.

[5] S. K. Rajput and P. K. Sharma, "Automated Aquarium Monitoring and Microclimate Control using IoT," Proceedings of the IEEE International Conference on Smart Agriculture and Aquaculture (ICSAA), pp. 112-118, 2022.

[6] DFM Atlas, "Analog pH Sensor / Meter Pro V2 Technical Documentation," 2021.

[7] M. A. A. Mashud, M. S. Rahman, and M. H. Kabir, "Design and Implementation of an IoT Based Smart Security and Monitoring System," Proceedings of the IEEE International Conference on Electrical, Computer and Communication Engineering (ECCE), pp. 1-5, 2019.

[8] S. F. Hussain et al., "Development of an Efficient Automated Control System for Smart Aquaculture Facilities," International Journal of Electronics and Communication Engineering, vol. 9, no. 1, pp. 1-8, 2022.

[9] C. Perera, A. Zaslavsky, P. Christen, and D. Georgakopoulos, "Context Aware Computing for The Internet of Things in Smart Environmental Monitoring," IEEE Communications Surveys & Tutorials, vol. 16, no. 1, pp. 414-454, 2014.

[10] S. V. Kulkarni and V. K. Sharma, "IoT-based Smart Ventilated Structures and Water Quality Management Systems," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 8, no. 6, pp. 115-120, 2019.

[11] Arduino Libraries, "OneWire Library for DS18B20 Communication," Arduino Reference Documentation, 2024.

[12] H. M. Yasin, "A Comprehensive Review on IoT-Based Smart Monitoring Systems with Real-Time Data Logging," International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), vol. 4, no. 2, pp. 1823-1830, 2024.

[13] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions for Smart Environments," Future Generation Computer Systems, vol. 29, no. 7, pp. 1645-1660, 2013.