

Appendices

Appendices 1. Finite State Machine (FSM) and Hysteresis Logic Pseudocode

```
// -----
// 1. FUNGSI PENGAMANAN TORSI AKTUATOR (SERVO)
// -----
FUNCTION Eksekusi_Aktuator_Aman(target_drain, target_refill):
    // Eksekusi Servo Drain
    IF target_drain != sudut_drain_sebelumnya THEN
        KIRIM_PWM(Servo_Drain, target_drain)
        sudut_drain_sebelumnya = target_drain
        waktu_gerak_drain = MILISEKON_SEKARANG()
        drain_bergerak = TRUE
    END IF

    // Eksekusi Servo Refill
    IF target_refill != sudut_refill_sebelumnya THEN
        KIRIM_PWM(Servo_Refill, target_refill)
        sudut_refill_sebelumnya = target_refill
        waktu_gerak_refill = MILISEKON_SEKARANG()
        refill_bergerak = TRUE
    END IF

    // Proteksi Overheat: Putus sinyal PWM setelah 2 detik
    IF drain_bergerak == TRUE AND (MILISEKON_SEKARANG() -
    waktu_gerak_drain >= 2000) THEN
        PUTUS_PWM(Servo_Drain)
        drain_bergerak = FALSE
    END IF

    IF refill_bergerak == TRUE AND (MILISEKON_SEKARANG() -
    waktu_gerak_refill >= 2000) THEN
        PUTUS_PWM(Servo_Refill)
        refill_bergerak = FALSE
    END IF
END FUNCTION

// -----
// 2. FUNGSI LOGIKA HISTERESIS DAN FINITE STATE MACHINE (FSM)
// -----
FUNCTION Jalankan_Sistem_FSM(tinggi_air, nilai_pH, nilai_TDS):

    // --- Evaluasi Logika Histeresis ---
    IF tinggi_air >= 80 THEN is_drain_air = TRUE
    ELSE IF tinggi_air <= 75 THEN is_drain_air = FALSE

    IF nilai_pH <= 6.5 OR nilai_pH >= 9.0 THEN is_drain_pH =
    TRUE
    ELSE IF nilai_pH >= 7.25 AND nilai_pH <= 8.5 THEN
    is_drain_pH = FALSE

    IF nilai_TDS >= 700 THEN is_drain_TDS = TRUE
    ELSE IF nilai_TDS <= 650 THEN is_drain_TDS = FALSE
```

```

// --- Transisi Finite State Machine (FSM) ---
SWITCH (state_saat_ini):
    CASE STANDBY:
        target_sudut_drain = 0
        target_sudut_refill = 0

        IF tinggi_air < 70 THEN
            state_saat_ini = REFILL
        ELSE IF (is_drain_air OR is_drain_pH OR
is_drain_TDS) THEN
            state_saat_ini = DRAIN
        END IF
        BREAK

    CASE DRAIN:
        target_sudut_refill = 0
        target_sudut_drain = 90 // Katup pembuangan terbuka

        IF (NOT is_drain_air) AND (NOT is_drain_pH) AND (
NOT is_drain_TDS) THEN
            state_saat_ini = STANDBY
        ELSE IF tinggi_air < 70 THEN
            state_saat_ini = STANDBY // Safety override
        END IF
        BREAK

    CASE REFILL:
        target_sudut_drain = 0
        target_sudut_refill = 90 // Katup pengisian terbuka

        IF (NOT is_drain_air) AND (NOT is_drain_pH) AND (
NOT is_drain_TDS) THEN
            state_saat_ini = STANDBY
        ELSE IF tinggi_air < 70 THEN
            state_saat_ini = STANDBY // Safety override
        END IF
        BREAK

    CASE REFILL:
        target_sudut_drain = 0
        target_sudut_refill = 90 // Katup pengisian terbuka

        IF tinggi_air >= 75 THEN
            state_saat_ini = STANDBY
        END IF
        BREAK

    CASE FAIL_SAFE:
        target_sudut_drain = 0
        target_sudut_refill = 0

        IF status_semua_sensor == NORMAL THEN
            state_saat_ini = STANDBY
        END IF
        BREAK
END SWITCH

Eksekusi_Aktuator_Aman(target_sudut_drain,
target_sudut_refill)

END FUNCTION

```

```

// -----
// 3. PROGRAM UTAMA (MAIN LOOP)
// -----
FUNCTION Loop_Utama():
    WHILE (SISTEM_MENYALA) DO

        // Pembacaan Sensor secara berkala (Setiap 5 Detik)
        IF (MILISEKON_SEKARANG() - waktu_baca_terakhir >= 5000)
        THEN

            // Pembacaan sensor
            pH_aktual = BACA_SENSOR(SENSOR_PH)
            TDS_aktual = BACA_SENSOR(SENSOR_TDS)
            air_aktual = BACA_SENSOR(SENSOR_ULTRASONIK)

            waktu_baca_terakhir = MILISEKON_SEKARANG()

            // Pengecekan Error Sensor (Deteksi NAN)
            IF (IS_NAN(pH_aktual) OR IS_NAN(TDS_aktual) OR
IS_NAN(air_aktual)) THEN
                durasi_error = durasi_error + 5000
                IF durasi_error >= 30000 THEN
                    state_saat_ini = FAIL_SAFE
                END IF
            ELSE
                durasi_error = 0
                status_semua_sensor = NORMAL
            END IF
        END IF

        Jalankan_Sistem_FSM(air_aktual, pH_aktual, TDS_aktual)
        KIRIM_TELEMETRI_MQTT(state_saat_ini, air_aktual,
pH_aktual, TDS_aktual)

        TUNGGU(10 ms) // Mencegah Watchdog Timer Reset (WDT)

    END WHILE
END FUNCTION

```

Curriculum Vitae



Wiswa Nath was born in Medan on June 11, 2004. He is the beloved son of Mrs. Sumadhi and the younger brother of Vivegan Syahputra and Vaishnawi Putri. He is an Indonesian citizen of Indian descent and is a devout follower of Hinduism.

He began his formal education at SD Methodist Kabanjahe, Medan, and graduated in 2016. He then continued his studies at SMP Methodist 6 Medan, completing his middle school education in 2019. In the same year, he enrolled in vocational high school at SMK N 9 Medan, where he took a major in Computer and Network Engineering (Teknik Komputer dan Jaringan), and successfully graduated in 2022.

Following his profound interest in technology and computer systems, he pursued higher education by enrolling in the Computer Science Study Program, Informatics Engineering Department, Faculty of Engineering and Vocational, Universitas Pendidikan Ganesha in 2022. During his academic years, he actively participated in various academic and practical activities to hone his skills. In his final year, 2026, he successfully completed his undergraduate studies by conducting research and defending his undergraduate thesis entitled "Design and Implementation of an IoT-Based Water Circulation Control System Using FSM-Hysteresis for Biofloc Nile Tilapia Ponds" to obtain the degree of Bachelor of Computer Science