**Smart Farm Kit - Complete Component Analysis (HARDWARE)**

**Development Board**

* **ESP32 PLUS Development Board** (KEYESTUDIO)
  + Main microcontroller with WiFi (2.4GHz) and Bluetooth (4.2)
  + Operating Voltage: 3.3V-5V
  + Power via USB Type-C or DC 7-12V (6 AA batteries)

**Input Sensors & Modules**

**1. Button Module**

* **Pin:** io5
* **Wire:** 3PIN 15cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Digital input for manual control
* **Voltage:** 3-5V

**2. PIR Motion Sensor**

* **Pin:** io23
* **Wire:** 3PIN 15cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Detects human/animal motion within 5m range
* **Specifications:**
  + Detection angle: Y=90°, X=110°
  + Detection distance: ≤5m
  + Voltage: 3-5V, Current: 3.6mA, Power: 18mW

**3. Ultrasonic Module (SR01 V3)**

* **Pins:** io12 (TRIG), io13 (ECHO)
* **Wire:** 4PIN Divided (Blue-TRIG, Green-ECHO, Red-VCC, Black-GND)
* **Functionality:** Distance measurement (3-8cm range in this kit)
* **Voltage:** 5V

**4. DHT11 Temperature & Humidity Sensor**

* **Pin:** io17
* **Wire:** 3PIN 20cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Measures ambient temperature and humidity
* **Output:** Digital signal

**5. Photoresistor (Light Sensor)**

* **Pin:** io34
* **Wire:** 3PIN 15cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Measures light intensity (0-4095 analog value)
* **Voltage:** 3-5V

**6. Steam Sensor (Rain Sensor)**

* **Pin:** io35
* **Wire:** 3PIN 15cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Detects water/rain presence (0-4095 analog value)
* **Specifications:**
  + Voltage: 3-5V
  + Current: 1.5mA, Power: 7.5mW

**7. Soil Humidity Sensor**

* **Pin:** io32
* **Wire:** 3PIN 20cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Measures volumetric soil moisture content (0-4095 analog value)
* **Voltage:** 3-5V

**8. Water Level Sensor**

* **Pin:** io33
* **Wire:** 3PIN 25cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Measures water level via exposed parallel lines (0-4095 analog value)
* **Note:** Only detection area is waterproof

**Output Actuators & Modules**

**9. White LED Module**

* **Pin:** io27
* **Wire:** 3PIN 20cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Controllable lighting (supports PWM dimming)
* **Voltage:** 3-5V

**10. Passive Buzzer**

* **Pin:** io16
* **Wire:** 3PIN 20cm (Yellow-S, Red-V, Black-G)
* **Functionality:** Generates tones/music via PWM signals (200-5000Hz)
* **Specifications:**
  + Voltage: 3-5V
  + Current: ≤5mA, Power: ≤25mW

**11. 9G 180° Servo**

* **Pin:** io26
* **Wire:** 3PIN (Yellow-io26, Red-V, Black-G)
* **Functionality:** Controls feeding cabin door (80°=open, 180°=closed)
* **Note:** Must be initialized to 180° before assembly

**12. 130 Motor + Fan**

* **Pins:** io18 (IN-), io19 (IN+)
* **Wire:** 4PIN Divided (Green-IN-, Blue-IN+, Red-V, Black-G)
* **Functionality:** Temperature control/ventilation (PWM speed control)
* **Note:** High power device - requires battery power

**13. 5V Relay Module + Water Pump**

* **Control Pin:** io25
* **Wire:** 3PIN 20cm (Yellow-S, Red-V, Black-G)
* **Pump Specs:**
  + Voltage: 5V
  + Static current: 2mA
* **Relay Specs:**
  + Max contact voltage: 250VAC/30VDC
  + Max current: 10A
* **Functionality:** Controls water pump for irrigation
* **Wiring:**
  + Relay COM → Water pump red wire
  + Water pump black → ESP32 GND
  + Relay NO → ESP32 3.3V

**Display Module**

**14. I2C 1602 LCD Display**

* **Interface:** I2C (Green-SCL, Blue-SDA, Red-VCC, Black-GND)
* **Wire:** 4PIN Connected (Black-Red-Blue-Green)
* **Functionality:** Displays sensor values and system status
* **Specifications:** 16 characters × 2 lines

**Power Supply**

**15. 6-slot AA Battery Holder**

* **Output:** DC 7-12V to ESP32 board
* **Capacity:** 6 AA batteries (not included)
* **Note:** Required for high-power devices (motor, pump)

**16. Solar Panel**

* **Specifications:**
  + Voltage: 5V
  + Current: 80mA
  + Power: 400mW
  + Dimensions: 60×60mm
* **Functionality:** Powers LED indicator (yellow) based on light intensity
* **Wavelength range:** UV (150-400nm), Visible (400-760nm), IR (760-4000nm)

**Complete System Breakdown**

**System 1: Lighting System**

* **Components:** LED Module (io27), Button Module (io5), Photoresistor (io34)
* **Functionality:**
  + Manual LED control via button
  + Automatic light control (LED on when photoresistor < 800)
  + PWM dimming support

**System 2: Alarm System**

* **Components:** PIR Motion Sensor (io23), Passive Buzzer (io16), LED Module (io27)
* **Functionality:**
  + Motion detection triggers buzzer alarm and LED blinking
  + Plays tones/music

**System 3: Rain Detection System**

* **Components:** Steam Sensor (io35), Passive Buzzer (io16)
* **Functionality:**
  + Detects water/rain
  + Buzzer volume increases with detected water level

**System 4: Smart Feeding System**

* **Components:** Ultrasonic Module (io12/io13), 9G Servo (io26)
* **Functionality:**
  + Detects animals within 3-8cm range
  + Opens feeding cabin door automatically

**System 5: Temperature Control System**

* **Components:** DHT11 Sensor (io17), LCD 1602 (I2C), 130 Motor + Fan (io18/io19)
* **Functionality:**
  + Monitors temperature and humidity
  + Activates fan when temperature ≥29°C
  + Displays readings on LCD

**System 6: Soil Humidity Monitoring System**

* **Components:** Soil Humidity Sensor (io32), LCD 1602 (I2C), Passive Buzzer (io16)
* **Functionality:**
  + Monitors soil moisture (0-4095)
  + Buzzer alarms when humidity < 200
  + Displays readings on LCD

**System 7: Water Level Monitoring System**

* **Components:** Water Level Sensor (io33), LCD 1602 (I2C), Passive Buzzer (io16)
* **Functionality:**
  + Monitors water level (0-4095)
  + Buzzer alarms when level < 200
  + Displays readings on LCD

**System 8: Auto-Irrigation System**

* **Components:**
  + Soil Humidity Sensor (io32)
  + Water Level Sensor (io33)
  + Relay Module + Water Pump (io25)
  + LCD 1602 (I2C)
  + Passive Buzzer (io16)
  + Button Module (io5)
* **Functionality:**
  + Activates pump when soil humidity < 500 AND water level > 1000
  + Alarms when water level < 500
  + Button stops alarm
  + Displays all readings on LCD

**System 9: Solar Power System**

* **Components:** Solar Panel with LED
* **Functionality:**
  + Demonstrates renewable energy
  + LED brightness varies with light intensity
  + No code required (hardware only)

**System 10: Web-Controlled Smart Farm**

* **Components:** All sensors and actuators
* **Functionality:**
  + ESP32 creates web server on local WiFi (2.4GHz)
  + Displays real-time sensor values
  + Remote control of LED, fan, servo, and water pump
  + Accessible via PC/mobile browser

**System 11: APP-Controlled Smart Farm**

* **Components:** All sensors and actuators
* **App:** "IOT Farm" (Android/iOS)
* **Functionality:**
  + Real-time monitoring: temperature, humidity, soil moisture, light, water level, rainfall
  + Remote control: LED, irrigation, fan, feeding box, buzzer music
  + Requires 2.4GHz WiFi connection

**Pin Assignment Summary**

| **Pin** | **Component** | **Type** |
| --- | --- | --- |
| io5 | Button Module | Digital Input |
| io12 | Ultrasonic TRIG | Digital Output |
| io13 | Ultrasonic ECHO | Digital Input |
| io16 | Passive Buzzer | PWM Output |
| io17 | DHT11 Sensor | Digital I/O |
| io18 | Motor IN- | PWM Output |
| io19 | Motor IN+ | PWM Output |
| io23 | PIR Motion Sensor | Digital Input |
| io25 | Relay Module | Digital Output |
| io26 | 9G Servo | PWM Output |
| io27 | LED Module | PWM Output |
| io32 | Soil Humidity Sensor | Analog Input |
| io33 | Water Level Sensor | Analog Input |
| io34 | Photoresistor | Analog Input |
| io35 | Steam Sensor | Analog Input |
| I2C | LCD 1602 (SDA/SCL) | I2C Bus |

**Required Libraries**

1. **ESP32Servo.h** - Servo control
2. **WiFi.h** - WiFi connectivity
3. **WebServer.h** - Web server functionality
4. **DHT.h** - DHT11 sensor
5. **LiquidCrystal\_I2C.h** - LCD display
6. **BuzzerMusic.h** - Music playback (custom)

**Safety Notes**

* **Waterproofing:** Keep water in plastic sinks only
* **Battery Safety:** Remove batteries if wet to prevent explosion
* **Servo Protection:** Don't block door or insert fingers
* **Power Requirements:** Use batteries for motor/pump, USB insufficient