**Smart Farm Dashboard - Comprehensive Presentation Brief**

**IoT-Powered Smart Agriculture Management System**  
*Real-time monitoring and automated control for modern farming*

**🏠 Application Overview**

The Smart Farm Dashboard is a comprehensive web application built with **Next.js 16.0** and integrated with **ESP32 microcontrollers** for real-time IoT farm management. The system provides intelligent automation, monitoring, and control capabilities for modern agricultural operations.

**Key Technologies**

* **Frontend**: Next.js 16.0 with Turbopack, React, TypeScript
* **Backend**: Supabase PostgreSQL database, RESTful APIs
* **Hardware**: ESP32 microcontroller with multiple sensors
* **Real-time**: WebSocket connections for live data streaming
* **UI/UX**: Custom component library with intuitive farming interface

**🎯 Core Features**

**Real-time Monitoring**

* Live sensor data from ESP32 (temperature, humidity, soil moisture, light, motion)
* Automatic data logging and historical analysis
* Real-time alerts and notifications
* Plant health scoring algorithm

**Automated Control Systems**

* Intelligent watering based on soil moisture
* Temperature-controlled fan activation
* Scheduled feeding and care routines
* Motion-triggered security responses

**Advanced Analytics**

* AI-powered plant health insights
* Growth trend analysis
* Environmental condition optimization
* Predictive maintenance alerts

**🗂️ Navigation Structure**

The application features a **wooden-themed sidebar** with intuitive navigation:

**Main Navigation Menu**

1. **Dashboard** - Main overview and controls
2. **AI Insights** - Analytics and predictions
3. **Fun Facts** - Educational sensor information
4. **Light** - Light sensor monitoring and control
5. **Motion** - Motion detection and security
6. **Temperature** - Temperature monitoring and fan control
7. **Water** - Water tank management and irrigation
8. **Scenario 1** - Intelligent feeding automation
9. **Scenario 2** - Environmental control automation

**User Interface Elements**

* **User Profile**: "Lorem Ipsum" with score display (926 points)
* **Status Indicator**: Live connection status with ESP32
* **Time Display**: Current system time (6:78 AM format)
* **Log Out Button**: Return to selection screen

**📊 Screen-by-Screen Breakdown**

**1. 🏡 Selection Page (/select)**

**Purpose**

Choose between different smart systems

**Layout**

* Background: Scenic outdoor setting
* Three main options displayed as cards

**Options Available**

1. **Smart Farm** ✅ (Active/Implemented)
   * Robot Image: Blue farming robot
   * Functionality: Complete IoT farm management
   * Status: Fully functional with ESP32 integration
2. **Smart House** 🚧 (Coming Soon)
   * Robot Image: House management robot
   * Status: Placeholder for future development
3. **Smart Factory** 🚧 (Coming Soon)
   * Robot Image: Industrial robot
   * Status: Placeholder for future development

**User Journey**

Click "Smart Farm" → Navigate to Dashboard

**2. 📈 Dashboard Page (/dashboard)**

**Purpose**

Central hub for farm monitoring and quick controls

**Real-time Data Sources**

ESP32 sensors, Supabase database

**Main Content Areas**

**🏆 Achievement Section**

* **Display**: Trophy with coins graphic
* **Content**: User achievement status
* **Purpose**: Gamification element

**🌱 Plant Health Monitor**

* **Visual**: Plant pot with health bar
* **Calculation**: Algorithm based on soil moisture, temperature, humidity
* **Display**: Percentage with color-coded status
  + 🟢 Green: 80-100% (Excellent health)
  + 🟡 Yellow: 60-79% (Good health)
  + 🟠 Orange: 40-59% (Needs attention)
  + 🔴 Red: 0-39% (Critical condition)

**💧 Water Tank Monitor**

* **Visual**: Water tank container with level indicator
* **Real-time Data**: Current water level percentage
* **Color Coding**:
  + Blue: >60% (Full)
  + Yellow: 30-60% (Medium)
  + Red: <30% (Low - needs refill)

**Sensor Data Grid**

Real-time ESP32 data display

**🌿 Soil Moisture Card**

* **Sensor**: Capacitive soil moisture sensor
* **Display**: Percentage with plant pot graphic
* **Range**: 0-100% soil humidity
* **Alert**: Auto-watering triggers below 30%

**🌡️ Temperature Card**

* **Sensor**: DHT22 temperature sensor
* **Display**: Celsius with thermometer graphic
* **Range**: Typically 15-40°C
* **Alert**: Fan activation above 28°C

**💨 Humidity Card**

* **Sensor**: DHT22 humidity sensor
* **Display**: Percentage with humidity icon
* **Range**: 0-100% relative humidity
* **Purpose**: Environmental condition monitoring

**☀️ Light Level Card**

* **Sensor**: LDR (Light Dependent Resistor)
* **Display**: Percentage with sun/moon icon
* **Range**: 0-100% light intensity
* **Purpose**: Day/night cycle tracking

**Control Buttons**

ESP32 command interface

**💧 Water Plant Button**

* **ESP32 Command**: 'D'
* **Action**: Activates water pump for 3 seconds
* **Logging**: Records to watering\_history table
* **Visual**: Water droplet icon

**🌀 Run Fan Button**

* **ESP32 Command**: 'B'
* **Action**: Activates cooling fan
* **Duration**: 5 seconds or until temperature drops
* **Purpose**: Temperature control

**💡 Toggle Light Button**

* **ESP32 Command**: 'A'
* **Action**: Switches LED lights on/off
* **Purpose**: Artificial lighting control
* **Visual**: Light bulb icon

**Robot Character**

Farmer robot positioned in bottom-right corner

**3. 🤖 AI Insights Page (/ai-insights)**

**Purpose**

Advanced analytics and plant health predictions

**Data Processing**

Real-time sensor fusion and trend analysis

**Main Features**

**📊 Plant Health Analytics Card**

* **Interactive Charts**: Swipeable chart display system
* **Chart Navigation**: Left/right arrows for different views
* **Chart Types**:
  1. **Growth Progress**: Plant development over time
  2. **Environmental Conditions**: Multi-sensor correlation
  3. **Health Trends**: Predictive health scoring
  4. **Watering Efficiency**: Irrigation effectiveness analysis

**🎯 Key Insights Display**

* **Real-time Recommendations**: AI-generated suggestions
* **Trend Analysis**: Growth patterns and predictions
* **Alert System**: Proactive problem identification
* **Optimization Tips**: Environmental adjustment recommendations

**📈 Performance Metrics**

* **Plant Health Score**: Overall wellness percentage
* **Growth Rate**: Development velocity tracking
* **Efficiency Ratings**: Resource utilization metrics
* **Prediction Accuracy**: AI model confidence levels

**4. 🧠 Fun Facts Page (/fun-facts)**

**Purpose**

Educational content about sensors and farming technology

**Target Audience**

Learning and engagement

**Content Sections**

**🔧 Sensor Education Grid**

1. **Soil Moisture Sensor**
   * Icon: Soil moisture graphic
   * Description: How capacitive sensors work
   * Applications: Automated irrigation systems
2. **Temperature Sensor**
   * Icon: Thermometer graphic
   * Description: DHT22 sensor capabilities
   * Applications: Climate control systems
3. **Light Sensor**
   * Icon: Light bulb graphic
   * Description: LDR technology explanation
   * Applications: Day/night cycle automation
4. **Motion Sensor**
   * Icon: Motion detection graphic
   * Description: PIR sensor functionality
   * Applications: Security and wildlife monitoring

**🌱 Agricultural Tips**

* Smart farming best practices
* IoT technology benefits
* Sustainable agriculture methods
* Modern farming techniques

**5. 💡 Light Page (/light)**

**Purpose**

Light sensor monitoring and LED control

**Hardware**

LDR sensor + LED lights on ESP32

**Main Features**

**☀️ Light Level Display**

* **Real-time Monitoring**: Current light intensity percentage
* **Visual Indicator**: Sun/moon graphics based on light level
* **Day/Night Detection**: Automatic mode switching
* **Historical Tracking**: Light pattern analysis

**🎚️ Manual Light Control**

* **Custom Slider**: Wooden-themed brightness control
* **LED Intensity**: Adjustable artificial lighting
* **Preset Modes**:
  + Dawn (25%)
  + Day (75%)
  + Dusk (50%)
  + Night (0%)

**⚙️ Automation Settings**

* **Auto Mode**: Lights activate when natural light drops
* **Schedule Mode**: Time-based lighting control
* **Threshold Settings**: Customizable light trigger levels

**6. 🏃‍♂️ Motion Page (/motion)**

**Purpose**

Motion detection for security and wildlife monitoring

**Hardware**

PIR motion sensor on ESP32

**Component Layout**

**📡 Motion Sensor Card**

* **Status Display**: Active/inactive motion detection
* **Sensitivity Settings**: Adjustable detection range
* **Real-time Alerts**: Instant motion notifications
* **Coverage Area**: Sensor range visualization

**📝 Motion Log Card**

* **Activity History**: Timestamped motion events
* **Animal Detection**: AI-powered animal identification
* **Event Details**:
  + Timestamp (e.g., "9:15AM")
  + Animal Type (Chicken, Butterfly, Rabbit)
  + Confidence Score (Detection accuracy)
  + Visual Icon (Animal-specific graphics)

**🔔 Scarecrow Security Button**

* **ESP32 Command**: 'E'
* **Action**: Activates buzzer/alarm system
* **Purpose**: Wildlife deterrent system
* **Position**: Bottom-right corner
* **Visual**: Scarecrow graphic

**Animal Detection Gallery**

* **🐔 Chicken**: Most common detection
* **🦋 Butterfly**: Gentle visitor tracking
* **🐰 Rabbit**: Garden visitor monitoring

**7. 🌡️ Temperature Page (/temperature)**

**Purpose**

Temperature monitoring and automatic fan control

**Hardware**

DHT22 sensor + cooling fan on ESP32

**Main Features**

**🌡️ Temperature Display**

* **Real-time Reading**: Current temperature in Celsius
* **Visual Thermometer**: Animated temperature gauge
* **Historical Trends**: Temperature pattern analysis
* **Range Indicators**: Safe/warning/critical zones

**🌀 Automatic Fan Control**

* **Smart Activation**: Auto-trigger above set threshold (default: 28°C)
* **Hysteresis Control**: Prevents rapid on/off cycling
* **Manual Override**: Direct fan control option
* **Energy Efficiency**: Intelligent duty cycle management

**⚙️ Control Settings**

* **Temperature Threshold**: Adjustable trigger point (25-35°C)
* **Auto Mode Toggle**: Enable/disable automatic operation
* **Fan Duration**: Configurable runtime settings
* **Alert Preferences**: Temperature warning notifications

**📊 Climate Analytics**

* **Daily Patterns**: Temperature variation tracking
* **Fan Usage Statistics**: Energy consumption monitoring
* **Optimization Suggestions**: Climate control recommendations

**8. 💧 Water Page (/water)**

**Purpose**

Complete water management system with automated scheduling

**Hardware**

Water pump, flow sensors, ultrasonic level sensor (HC-SR04 on pins 12/13)

**Main Components**

**🎮 Interactive Control Interface**

* **Robot Visualization**: Central farming robot graphic
* **Action Buttons**:
  + **Water Crops Button** (Left):
    - ESP32 Command: 'D'
    - Target: Main crop areas
    - Volume: 250ml standard dose
  + **Feed Plants Button** (Right):
    - ESP32 Command: 'C'
    - Target: Garden plants
    - Volume: 200ml standard dose

**🏢 Water Tank Monitoring Card**

* **Visual Tank Display**: Real-time water level visualization
* **Key Metrics**:
  + Current Level: Percentage and liters
  + Tank Capacity: Total storage capacity
  + Days Remaining: Estimated usage projection
  + Last Refill: Historical tracking
  + Status Indicator: Color-coded health status

**📜 Watering History Card**

* **Recent Activity**: Last 5 watering events
* **Event Details**:
  + Timestamp and duration
  + Water amount dispensed
  + Plant type targeted
  + Efficiency score calculation
* **Robot Avatar**: Visual confirmation of automated actions

**⏰ Scheduled Watering System (NEW)**

* **"New Schedule" Button**: Opens comprehensive scheduling modal
* **Schedule Types**:
  + **One Time**: Single execution at specific date/time
  + **Daily**: Repeat every day at set time
  + **Weekly**: Specific days of the week
  + **Custom**: Flexible day selection pattern

**Schedule Management Interface**

**Form Fields**:

* Schedule Name (e.g., "Morning Tomatoes")
* Plant Type (e.g., "Tomatoes", "Lettuce")
* Water Amount (ml) - customizable volume
* Duration (ms) - pump runtime
* Schedule Type - dropdown selection
* Time Selection - 24-hour time picker
* Day Selection - checkbox grid for weekly/custom
* Date Range - start and optional end dates
* Active Status - enable/disable toggle

**Schedule Display Cards**:

* **Status Badges**: Active/Inactive indicators
* **Schedule Summary**: Plant type, volume, frequency
* **Next Execution**: Countdown to next watering
* **Execution Count**: Historical run statistics
* **Action Buttons**:
  + ▶️ **Play**: Execute immediately
  + ✏️ **Edit**: Modify schedule parameters
  + 🗑️ **Delete**: Remove schedule

**Backend Integration**

* **Database Tables**:
  + watering\_schedules: Schedule definitions
  + watering\_schedule\_logs: Execution history
* **API Endpoints**:
  + CRUD operations for schedule management
  + Execution system for manual/automatic triggers
* **Smart Calculations**:
  + Automatic next execution time computation
  + Timezone handling and daylight savings
  + Conflict resolution for overlapping schedules

**9. 🤖 Scenario 1 Page (/scenario-1)**

**Purpose**

Intelligent Feeding Automation System

**Activation**

Manual trigger via sidebar button (safety feature)

**Automation Overview**

This scenario implements a comprehensive feeding system that monitors plant health and automatically dispenses appropriate nutrition based on real-time sensor data and plant growth stages.

**System Components**

**🧠 Intelligence Engine Card**

* **AI Status Display**: Current automation state
* **Decision Matrix**: Real-time reasoning display
* **Sensor Integration**: Multi-parameter analysis
* **Learning Capabilities**: Adaptive feeding patterns

**🌱 Plant Health Analysis**

* **Multi-factor Assessment**:
  + Soil moisture levels (optimal: 60-80%)
  + Growth stage detection
  + Nutrient deficiency indicators
  + Environmental stress factors
* **Health Scoring**: 0-100% wellness calculation
* **Feeding Recommendations**: Personalized nutrition advice

**⚙️ Automated Feeding Rules**

1. **Seedling Stage**: Light, frequent feeding
2. **Growth Stage**: Increased nutrition frequency
3. **Flowering Stage**: Specialized nutrient mix
4. **Harvest Stage**: Minimal feeding, focus on quality

**📊 Feeding Schedule Display**

* **Next Feeding Time**: Countdown timer
* **Feeding History**: Recent nutrition events
* **Quantity Tracking**: Volume and type dispensed
* **Success Metrics**: Growth response analysis

**🎮 Manual Controls**

* **Emergency Stop**: Immediate system halt
* **Manual Feed**: Override automatic schedule
* **Calibration Mode**: System parameter adjustment
* **Schedule Override**: Temporary automation bypass

**📈 Performance Analytics**

* **Growth Rate Improvement**: Before/after comparison
* **Resource Efficiency**: Nutrition utilization metrics
* **Yield Predictions**: Expected harvest outcomes
* **Cost Optimization**: Feeding efficiency analysis

**Safety Features**

* **Initial Activation Required**: Prevents accidental triggering
* **Manual Override**: User control at all times
* **Error Recovery**: Automatic system fault handling
* **Logging System**: Complete audit trail

**10. 🌿 Scenario 2 Page (/scenario-2)**

**Purpose**

Environmental Control Automation System

**Activation**

Manual trigger via sidebar button (safety feature)

**Automation Overview**

Advanced environmental management system that maintains optimal growing conditions through intelligent monitoring and automatic adjustments of temperature, humidity, light, and air circulation.

**System Architecture**

**🌡️ Climate Control Matrix**

* **Multi-sensor Monitoring**: Continuous environmental assessment
* **Predictive Adjustments**: Proactive condition management
* **Energy Optimization**: Efficient resource utilization
* **Seasonal Adaptation**: Dynamic response to weather patterns

**⚙️ Automated Control Rules**

**Temperature Management**

* **Cooling Activation**: Fan triggers above 28°C
* **Heating Protocol**: Warming system for cold periods
* **Gradient Control**: Uniform temperature distribution
* **Thermal Shock Prevention**: Gradual temperature changes

**Humidity Regulation**

* **Optimal Range**: Maintains 60-70% relative humidity
* **Misting System**: Fine water spray for humidity increase
* **Ventilation Control**: Air circulation for humidity reduction
* **Condensation Prevention**: Surface moisture management

**Irrigation Automation**

* **Soil Moisture Triggers**: Watering below 30% soil humidity
* **Drought Protection**: Emergency watering protocols
* **Water Conservation**: Efficient usage algorithms
* **Root Zone Targeting**: Precise water delivery

**Light Management**

* **Photoperiod Control**: Day/night cycle management
* **Intensity Adjustment**: LED dimming based on natural light
* **Spectrum Optimization**: Color temperature for growth stages
* **Energy Scheduling**: Peak hour avoidance

**📊 Environmental Dashboard**

* **Real-time Conditions**: Live sensor data display
* **Trend Analysis**: Historical pattern recognition
* **Alert System**: Immediate notification of issues
* **Efficiency Metrics**: System performance indicators

**🎯 Rule Management Interface**

* **Priority System**: Conflict resolution hierarchy
* **Custom Thresholds**: User-defined trigger points
* **Seasonal Profiles**: Automatic seasonal adjustments
* **Emergency Protocols**: Critical condition responses

**📈 System Intelligence Features**

1. **Adaptive Learning**: Pattern recognition improvement
2. **Predictive Maintenance**: Equipment failure prevention
3. **Weather Integration**: External condition consideration
4. **Growth Stage Optimization**: Development phase customization

**Control Interface Elements**

* **System Status**: Overall automation health
* **Manual Overrides**: Individual system control
* **Emergency Stop**: Complete system shutdown
* **Calibration Tools**: Sensor adjustment interface

**🔧 Technical Architecture**

**Hardware Integration**

* **ESP32 Microcontroller**: Main processing unit
* **Sensor Array**:
  + DHT22: Temperature and humidity
  + Capacitive: Soil moisture detection
  + LDR: Light intensity measurement
  + PIR: Motion detection
  + HC-SR04: Ultrasonic distance (water level)
* **Actuators**:
  + Water pumps for irrigation
  + Cooling fans for temperature control
  + LED lights for supplemental lighting
  + Buzzers for alerts and deterrence

**Communication Protocol**

* **WebSocket Connection**: Real-time bidirectional communication
* **Command Structure**: Single-character commands (A, B, C, D, E)
* **Data Streaming**: Continuous sensor data transmission
* **Error Handling**: Connection recovery and retry mechanisms

**Database Schema (Supabase PostgreSQL)**

* **sensor\_readings**: Historical sensor data
* **watering\_history**: Irrigation event logging
* **feeding\_events**: Nutrition dispensing records
* **watering\_schedules**: Automated watering configurations
* **watering\_schedule\_logs**: Schedule execution tracking
* **motion\_events**: Motion detection history
* **plant\_health\_logs**: Wellness tracking over time

**API Endpoints**

* /api/sensor-data: Live sensor readings
* /api/watering: Irrigation management
* /api/watering-schedules: Schedule CRUD operations
* /api/feeding-events: Nutrition tracking
* /api/motion-events: Motion detection logs
* /api/plant-health: Health scoring system
* /api/water-tank: Tank level monitoring

**🎯 Key Presentation Points**

**Innovation Highlights**

1. **Real-time IoT Integration**: Live ESP32 sensor data streaming
2. **Intelligent Automation**: AI-driven decision making
3. **Comprehensive Monitoring**: Multi-parameter plant health assessment
4. **User-friendly Interface**: Intuitive farming-themed design
5. **Scalable Architecture**: Modular system expansion capability

**Business Value**

* **Increased Yield**: Optimized growing conditions
* **Resource Efficiency**: Reduced water and energy consumption
* **Labor Savings**: Automated routine maintenance
* **Risk Mitigation**: Proactive problem detection
* **Data-driven Decisions**: Historical trend analysis

**Technical Excellence**

* **Modern Web Stack**: Next.js 16.0 with Turbopack
* **Real-time Performance**: Sub-second response times
* **Reliable Hardware**: Industrial-grade ESP32 integration
* **Scalable Database**: PostgreSQL with real-time subscriptions

**User Experience**

* **Intuitive Navigation**: Farming-themed visual design
* **Instant Feedback**: Real-time status indicators
* **Safety Features**: Manual override capabilities
* **Educational Content**: Built-in learning resources
* **Gamification**: Achievement and scoring system

**🚀 Live Demonstration Flow**

**Recommended Presentation Sequence**

1. **System Overview** (2 minutes)
   * Navigate through main selection screen
   * Highlight Smart Farm option
2. **Dashboard Tour** (3 minutes)
   * Show real-time sensor data
   * Demonstrate manual controls
   * Explain plant health calculation
3. **Individual Sensor Pages** (5 minutes)
   * Temperature: Show automatic fan control
   * Motion: Demonstrate security features
   * Water: Display tank monitoring and scheduling
4. **Advanced Features** (4 minutes)
   * AI Insights: Show predictive analytics
   * Scenario 1: Explain intelligent feeding
   * Scenario 2: Demonstrate environmental control
5. **Real-time Interaction** (1 minute)
   * Press physical buttons on ESP32
   * Show immediate dashboard response
   * Highlight WebSocket communication speed

**Key Demo Elements**

* ✅ Live sensor readings updating
* ✅ Physical button press → immediate web response
* ✅ Automated system activations
* ✅ Data logging and history display
* ✅ Scheduling system functionality