

Smart Children's Night Light with Motion and Ambient Light Control Using a PIC Microcontroller

1. INTRODUCTION

This project presents the design of a smart children's night light using a PIC16F877 microcontroller. The system uses sensor inputs and PWM LED control to provide intelligent and energy-efficient lighting operation.

Key Features

- PIR sensor for motion detection
- LDR for ambient light sensing
- PWM control for LED brightness
- Automatic activation in dark conditions
- Proteus simulation and hardware prototype testing

The project also investigated practical hardware challenges including signal instability and subsystem fault diagnosis during implementation.

2. Aims

To design, construct, and evaluate a PIC-based smart night light that automatically adjusts illumination according to movement and ambient light, improving child comfort, safety, and energy efficiency.

3. Objectives

1. Review and analyse existing smart lighting systems and identify performance limitations.
2. Design a prototype integrating a PIR motion sensor, LDR sensor, and PIC microcontroller for adaptive control.
3. Develop embedded firmware implementing PWM dimming and automatic timing functions.
4. Experimentally test and evaluate system performance in terms of response speed, power consumption, and illumination uniformity.

5. RESULTS & EVALUATION

Simulation testing confirmed that the system logic operated correctly under the intended conditions.

Simulation Results

- Correct conditional logic achieved
- Motion activated lighting response verified
- PWM LED brightness control operated successfully
- LDR sensing correctly detected low-light conditions
- LED activated only when motion and darkness were detected

Evaluation

- Proteus simulation demonstrated stable system behaviour
- PWM improved energy-efficient LED control
- Sensor integration enabled intelligent system operation
- Prototype testing highlighted practical implementation challenges
- Results demonstrated importance of hardware validation alongside simulation

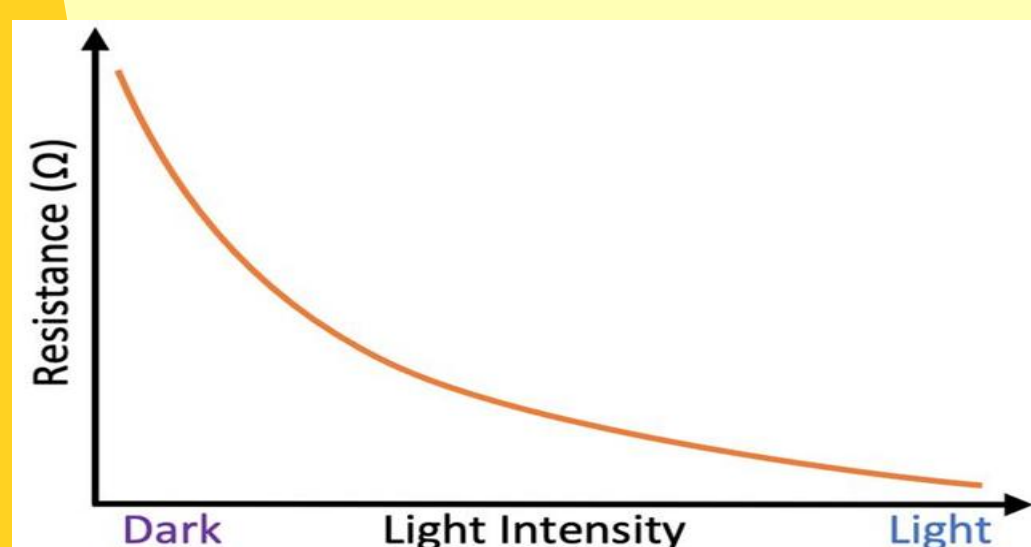


Figure 4 - LDR Response

Prototype Testing

- Hardware prototype was successfully powered and tested
- Individual subsystems were tested independently
- LED driver stage responded correctly during testing
- Sensor input behaviour differed from simulation results
- Additional hardware testing and debugging were required

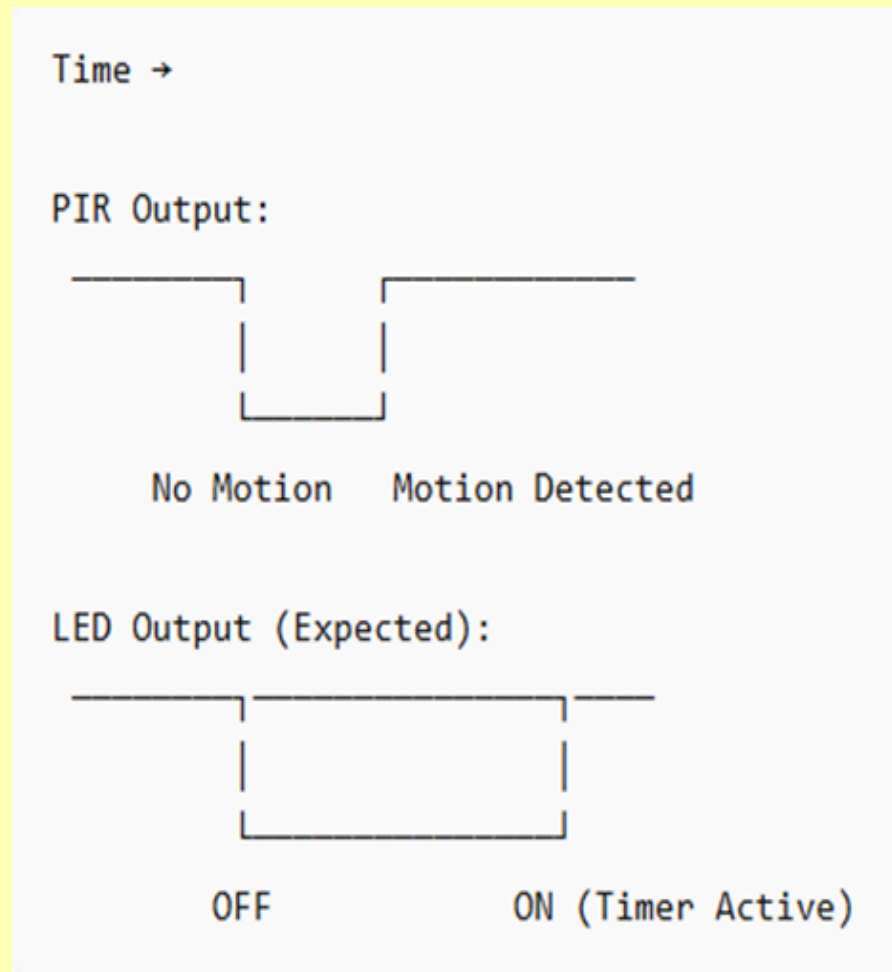


Figure 5 - Motion Detection Response

The system uses a PIC16F877 microcontroller to process sensor inputs and control LED brightness using PWM (Pulse Width Modulation). The microcontroller continuously monitors both motion detection and ambient light conditions before determining whether the LED should activate.

Main System Functions

- PIR sensor detects movement
- LDR measures ambient light intensity
- ADC converts analogue LDR signal into digital data
- PIC16F877 processes input conditions
- PWM controls LED brightness efficiently
- MOSFET driver provides stable LED switching

System Operation

- LED activates only when motion is detected
- System operates only in low-light conditions
- PWM improves energy efficiency and brightness control
- Sensor integration enables intelligent lighting behaviour

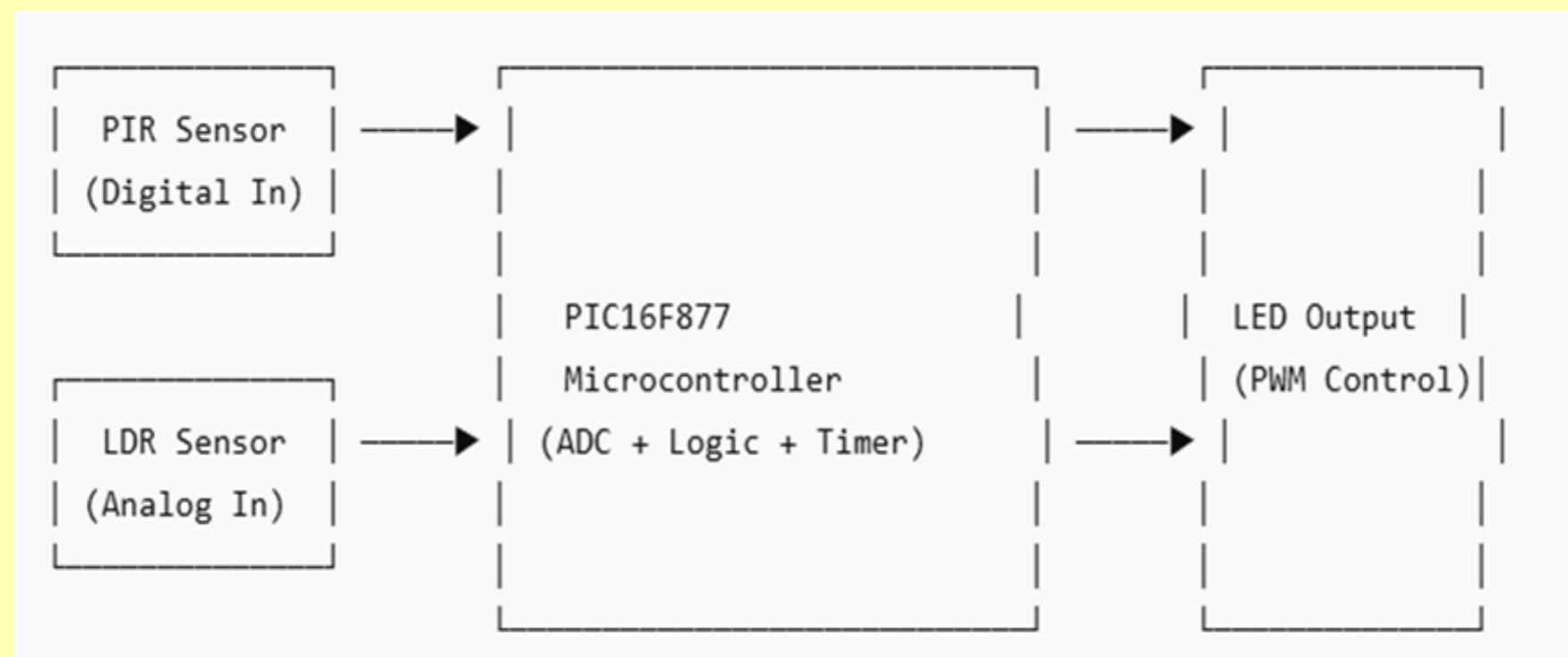


Figure 1 - System Block Diagram

4. SYSTEM DESIGN & IMPLEMENTATION

The hardware prototype was constructed on a breadboard to test the main system functions before a final PCB design.

Prototype Components

- PIC16F877 - used as the main control unit
- PIR sensor - used to detect movement
- LDR voltage divider - used to measure ambient light levels
- IRLZ44N MOSFET driver - used to switch the LED using PWM
- 5V regulated supply - used to power the microcontroller safely

Practical Testing

- The MOSFET LED driver was tested separately and confirmed working
- The system was checked in stages to identify wiring and signal issues
- Hardware testing revealed input stage instability not present in simulation
- The breadboard prototype demonstrated challenges of real-world implementation.

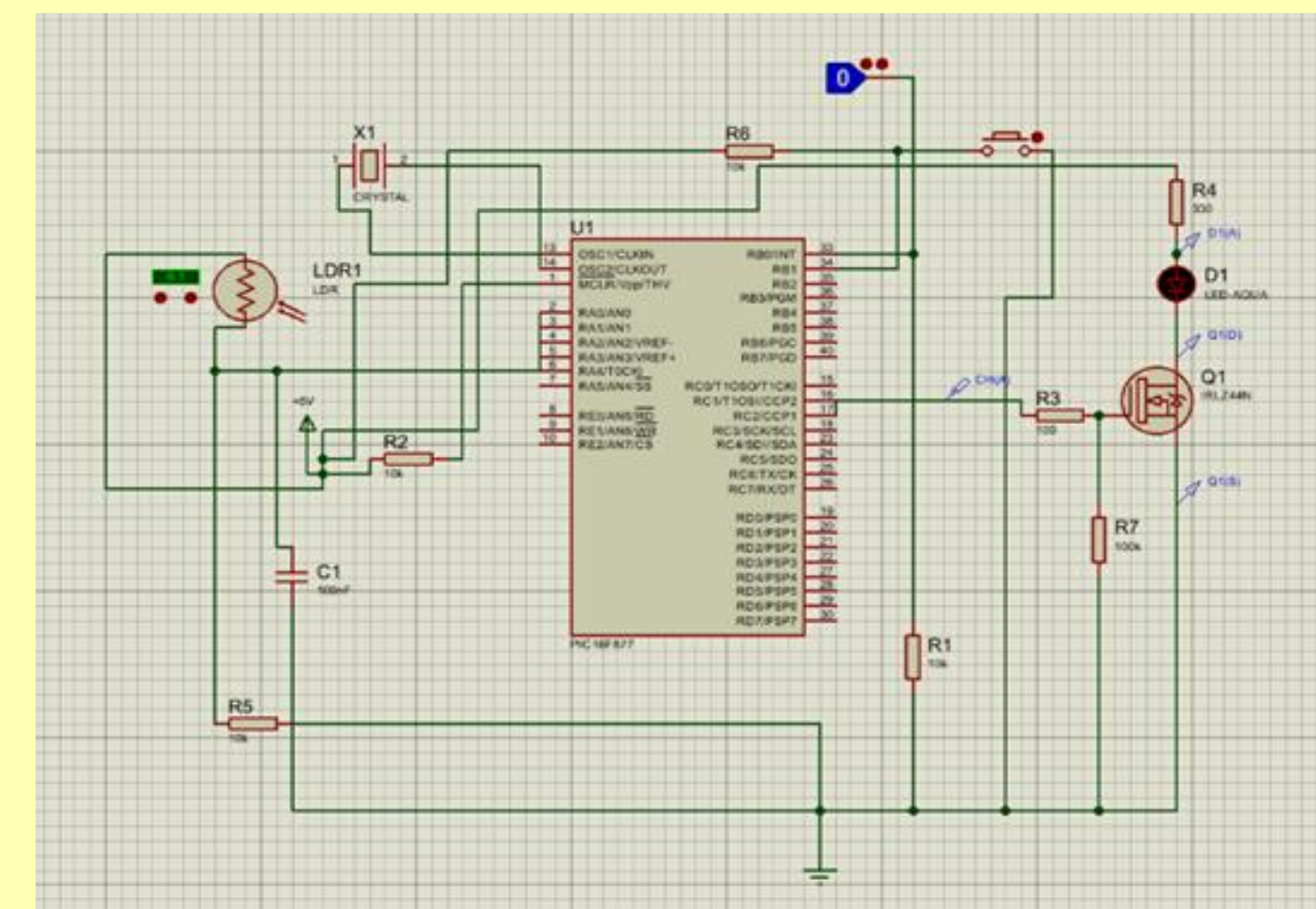


Figure 2 - Proteus Simulation Design

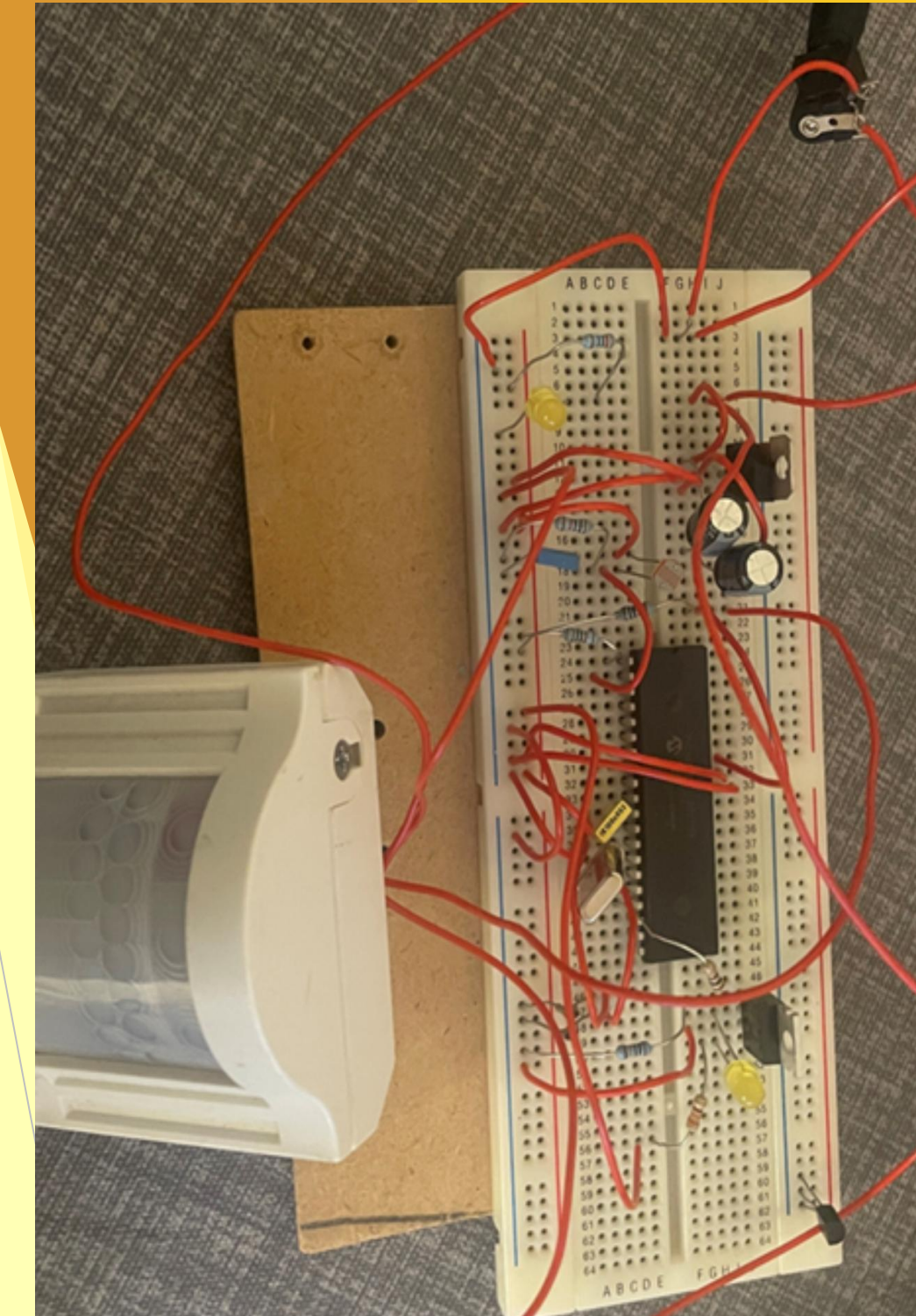


Figure 3 - Breadboard Prototype

6. FAULT ANALYSIS

Hardware testing identified instability within the input stage during prototype implementation. While the system operated correctly in simulation, the physical circuit produced inconsistent behaviour during testing.

Fault Finding Process

- Power supply connections were verified
- PIC16F877 operation and MCLR voltage were tested
- RC2 PWM output was measured during operation
- MOSFET driver stage was tested independently
- LED successfully activated using direct gate drive testing
- Input stage behaviour was isolated for further investigation

Fault Analysis Results

- MOSFET driver stage confirmed operational
- PWM output functionality verified
- Voltage instability observed during PIR input testing
- Input stage behaviour differed from simulation results
- Fault diagnosis process isolated the issue to the sensor input stage

Fault Diagnosis Figure

The fault diagnosis diagram illustrates the step-by-step troubleshooting process used during hardware testing. Each subsystem was tested independently to isolate the source of the fault and verify correct operation of the output stage before investigating the sensor input circuitry.

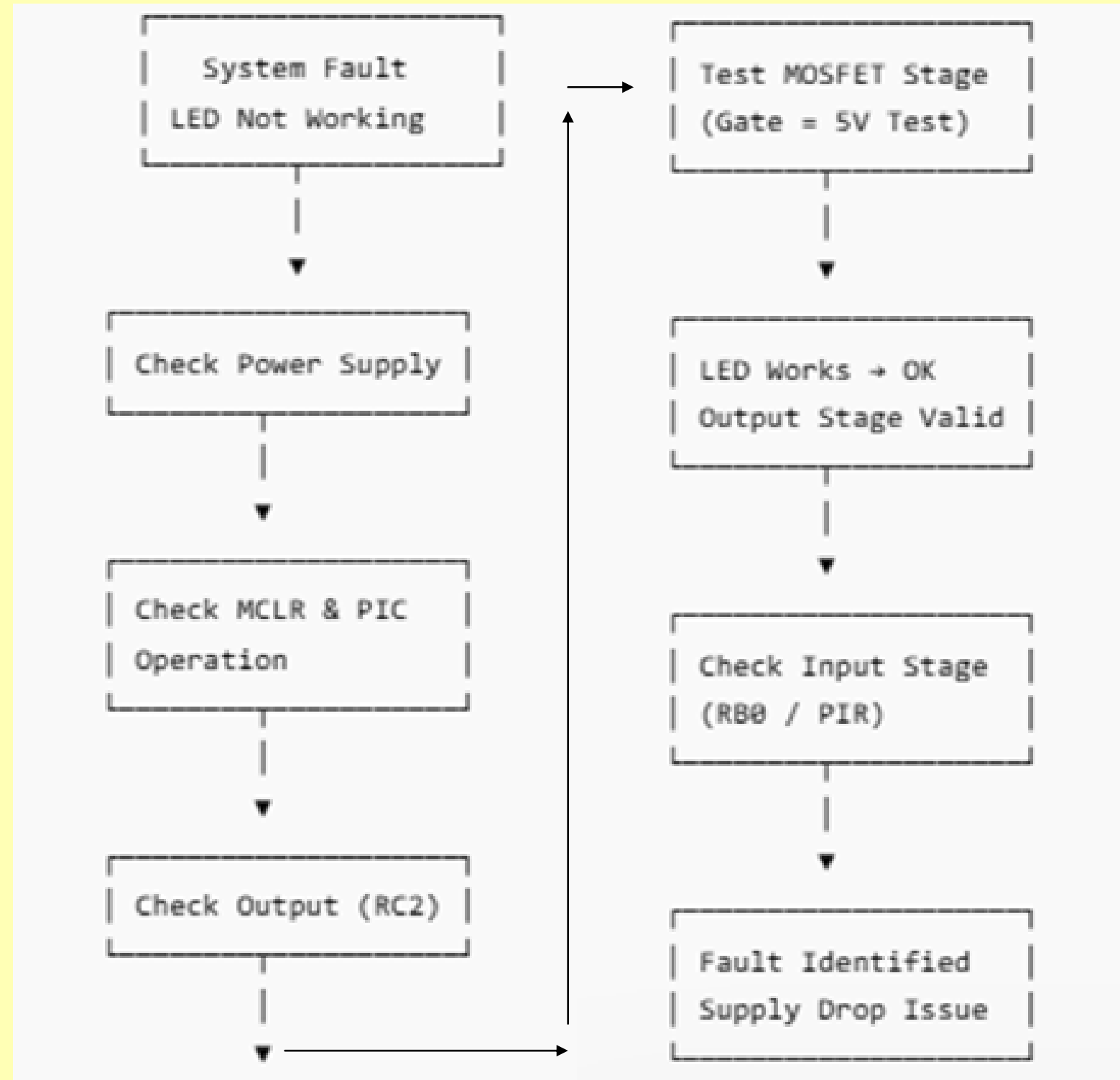


Figure 6 - Fault Diagnosis Process

7. CONCLUSION & FUTURE WORK

Conclusion

- Intelligent lighting control concept successfully demonstrated
- PIR and LDR sensor integration achieved in simulation
- Conditional system logic operated correctly in Proteus
- Partial hardware prototype successfully constructed and tested
- Hardware testing identified instability within the input stage
- Project demonstrated importance of practical hardware validation

Future Work

- Develop a PCB-based implementation for improved reliability
- Improve signal filtering and input stability
- Further investigate PWM output behaviour in hardware
- Use higher accuracy digital light sensors
- Implement improved motion detection filtering
- Add wireless monitoring or remote-control functionality

KEY ENGINEERING INSIGHT

Simulation worked correctly, but hardware testing revealed real-world signal instability and integration faults.

References

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