Smart Highway Street Light Management System using 8051 Microcontroller

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Abstract- The Smart Highway Street Light Management System is designed to optimize energy consumption and enhance road safety by adjusting streetlight brightness based on ambient light levels and time of day. Utilizing the 8051 microcontroller, the system employs a Light Dependent Resistor (LDR) to sense ambient light and incorporates conditional logic to manage brightness levels or completely turn off the lights when not required. The design was implemented using Assembly language in the EdSim51 simulator. Experimental results demonstrate the system's ability to reduce energy consumption while maintaining effective lighting control.

Keywords – Street Light Management, 8051 Microcontroller, Assembly Language, Energy Optimization

I. INTRODUCTION

In recent years, the need for energy-efficient solutions in urban infrastructure has intensified. One critical area is streetlight management, where traditional systems fail to adapt to changing environmental conditions. This paper presents an automated solution leveraging the 8051 microcontroller to intelligently manage streetlight brightness based on light levels and time. The system introduces time- and sensor-based decision-making for effective streetlight control.

The rest of the paper is organized as follows: Section II explains the proposed system's algorithm, Section III presents experimental results, and Section IV concludes the study.

II. PROPOSED SYSTEM

2.1 Algorithm overview –

The Smart Highway Street Light Management System integrates ambient light sensing and time-based logic for energy-efficient control. The key components include:

1. **LDR Sensor**: Detects ambient light levels.
2. **Timer Logic**: Tracks time to determine street light behaviour.
3. **Conditional Control**: Adjusts streetlight brightness or turns them off based on predefined thresholds.

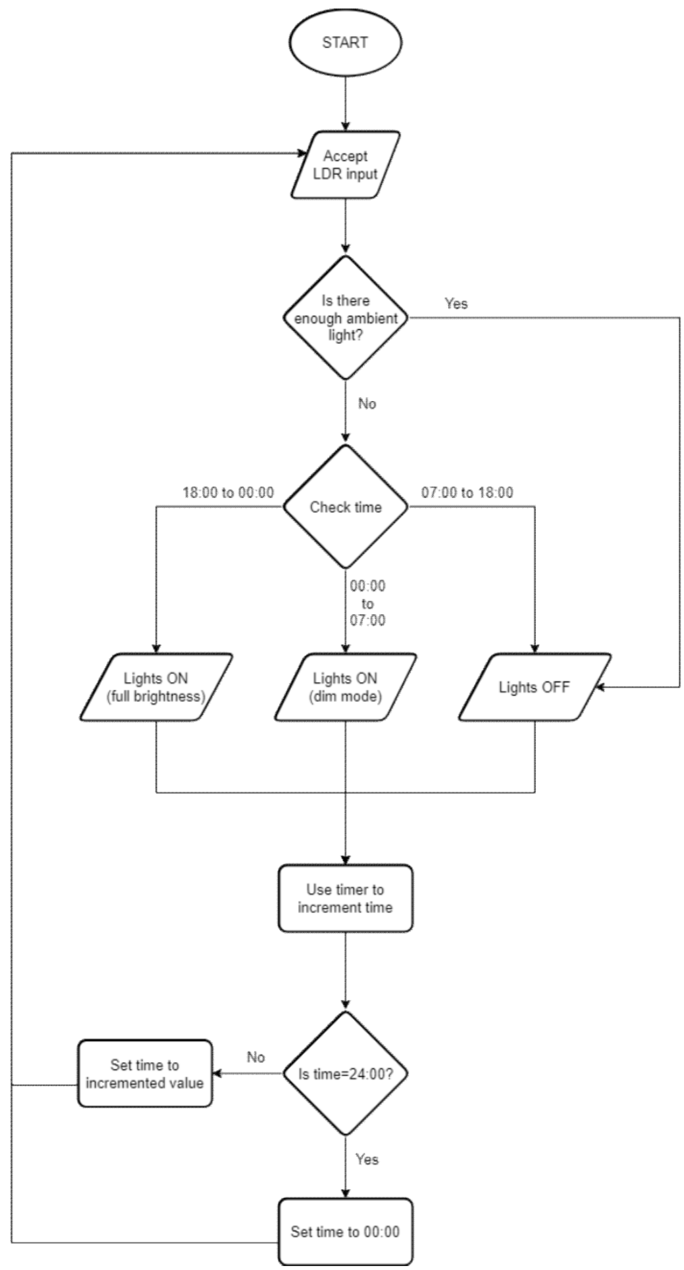

Figure 1: Algorithm flowchart

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2.2. Implementation in assembly –

Initialization:

- The time is initialized to 18:00 (0x12 in hexadecimal) and stored in internal RAM.

Main Loop:

- Ambient Light Check: Reads LDR data from port P2. If the light intensity falls below the threshold, the system proceeds to time-based checks.
- Brightness Adjustment:
  - Full Brightness: Lights are fully bright (P1 = 0x00) if the time is 18:00 or later.
  - Dim Mode: Lights are dimmed (P1 = 0x55) if the time is midnight (00:00) to 07:00.
  - Turn Off: Lights are turned off (P1 = 0xFF) after 07:00 or if ambient light is sufficient.

Time Increment: Time is incremented every minute (simulated delay using Timer 0).

2.3. Implementation diagrams –

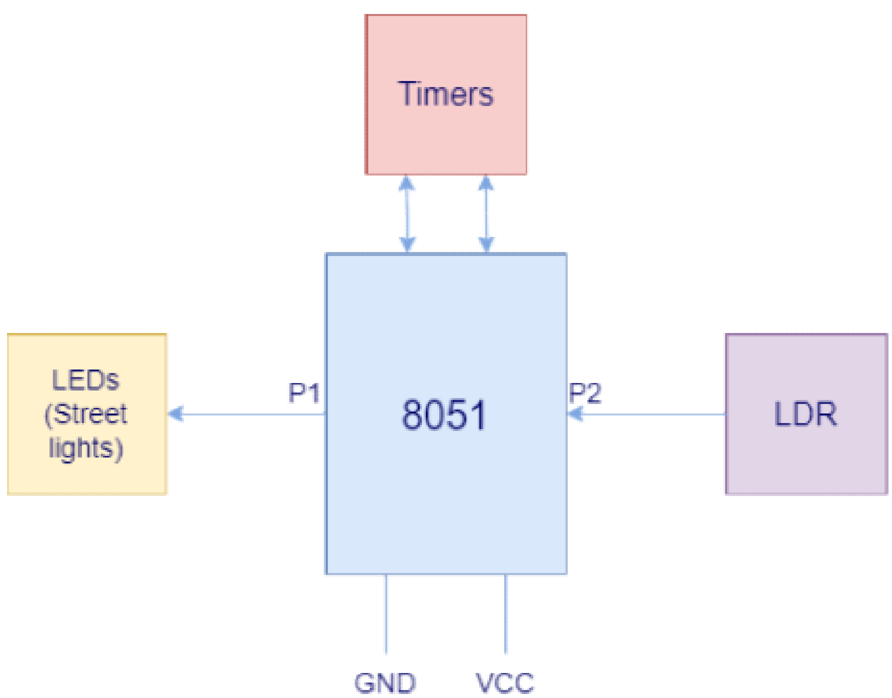

Figure 2: Proposed block diagram of components used for input and output

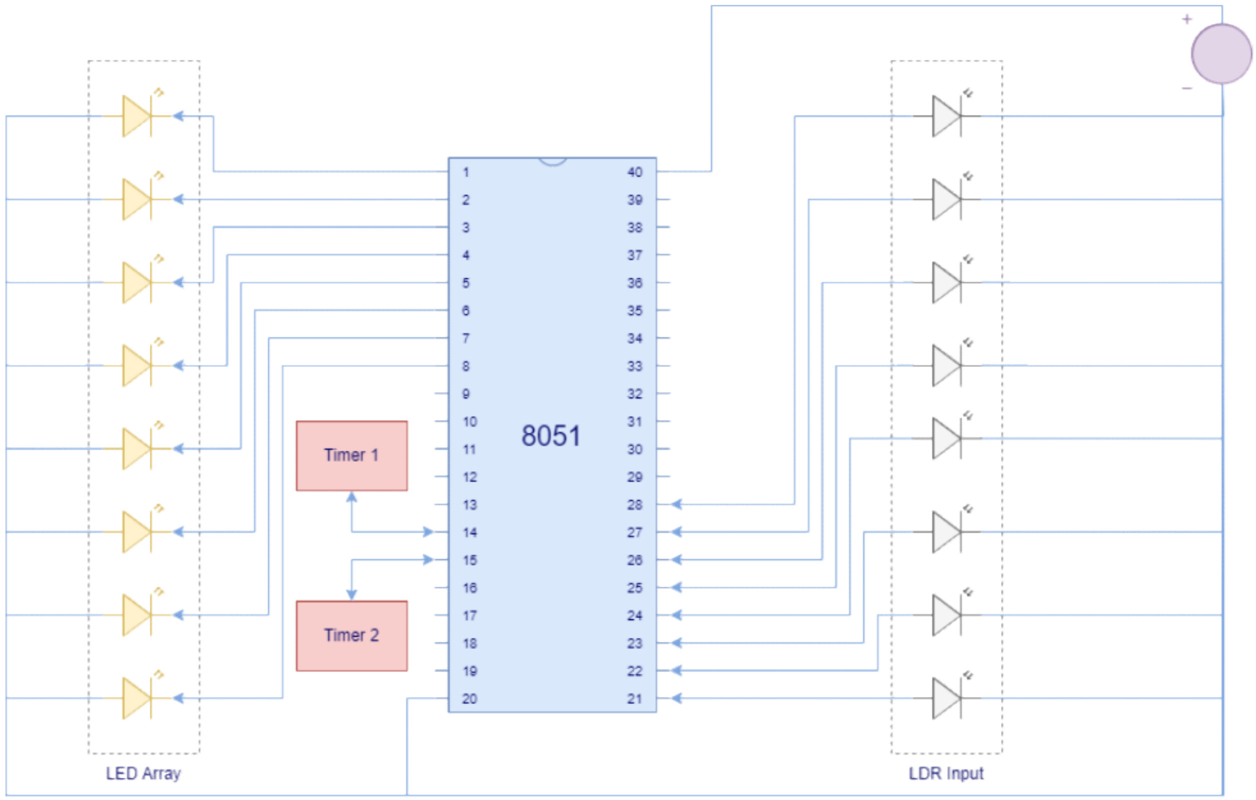

Figure 3: Proposed circuit diagram

2.4. Implemented code –

```
TIME_LOCATION EQU 30H
ORG 0000H
   MOV A, #12H
   MOV TIME_LOCATION, A

START:
   MOV A, P2
   CLR CY
   SUBB A, #40H
   JNC TURN_ON
   SJMP TURN_OFF

TURN_ON:
   MOV A, TIME_LOCATION
   CLR CY
   SUBB A, #12H
   JC CHECK_NIGHT_MODE
   MOV P1, #00H
   SJMP WAIT_LOOP

CHECK_NIGHT_MODE:
   MOV A, TIME_LOCATION
   CLR CY
   SUBB A, #07H
   JNC CHECK_MORNING_MODE
   MOV P1, #55H
```

```
    SJMP WAIT_LOOP

CHECK_MORNING_MODE:
    MOV A, TIME_LOCATION
    CLR CY
    CJNE A, #07H, WAIT_LOOP
    SJMP TURN_OFF

TURN_OFF:
    MOV P1, #0FFH
    SJMP WAIT_LOOP

WAIT_LOOP:
    MOV TMOD, #01H
    MOV TH0, #0FFH
    MOV TL0, #0FFH
    SETB TR0

WAIT_TIMER:
    JNB TF0, WAIT_TIMER
    CLR TF0
    MOV A, TIME_LOCATION
    INC A
    CJNE A, #18H, STORE_TIME
    MOV A, #0

STORE_TIME:
    MOV TIME_LOCATION, A
    SJMP START
```

III. Experiment and Result

The system was tested in the EdSim51 simulator with the following setup:

- LDR input simulated using P2.
- Time increment managed using Timer 0.

Ideally, LDR should be connected via the ADC.

Simulated Conditions:

1. **Night Mode (18:00 to 00:00)**: Lights at full brightness.
2. **Dim Mode (00:00 to 07:00)**: Lights dimmed.
3. **Day Mode (07:00 onwards)**: Lights turned off.

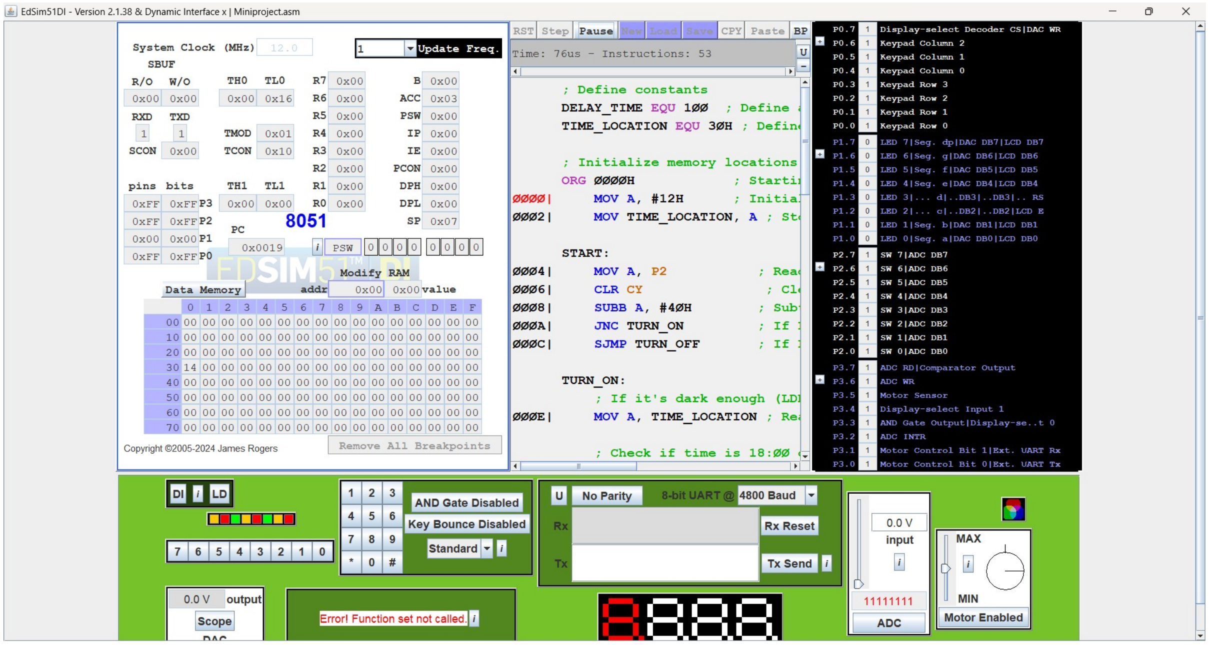

Figure 4: Screenshot of EdSim51 showing the time as 14H (20:00) and LDR input as 0FFH (not sufficient light) hence LEDs on in full brightness mode

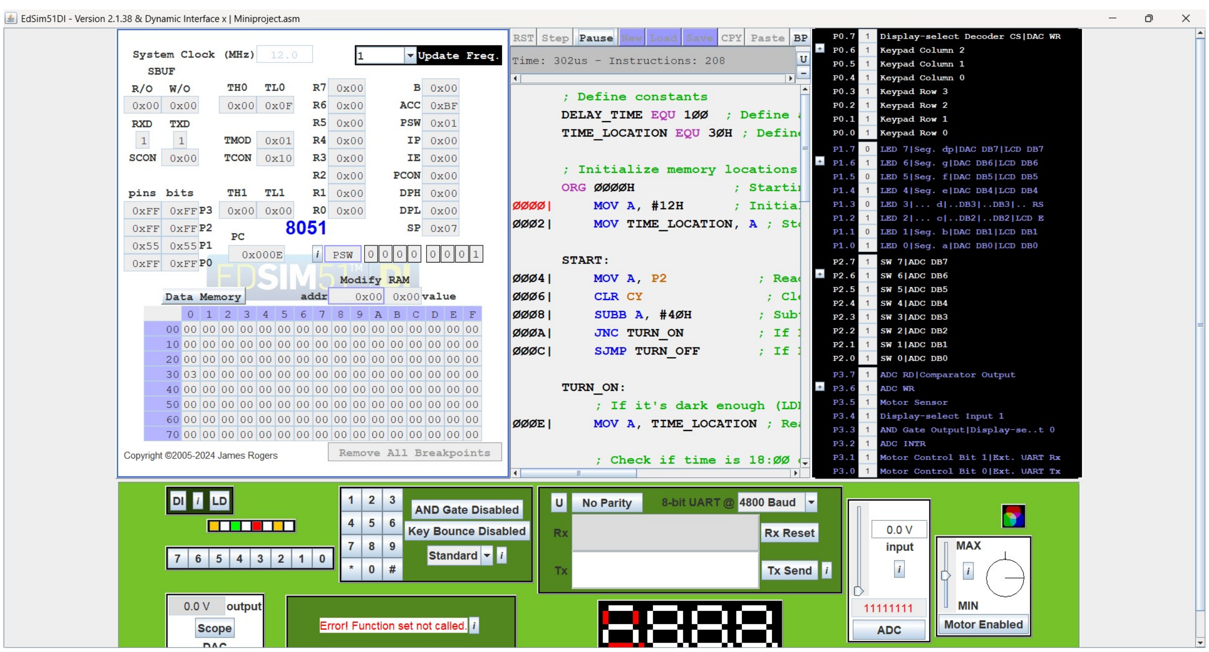

Figure 5: Screenshot of EdSim51 showing the time as 03H (03:00) and LDR input as 0FFH (not sufficient light) hence LEDs on in dim mode

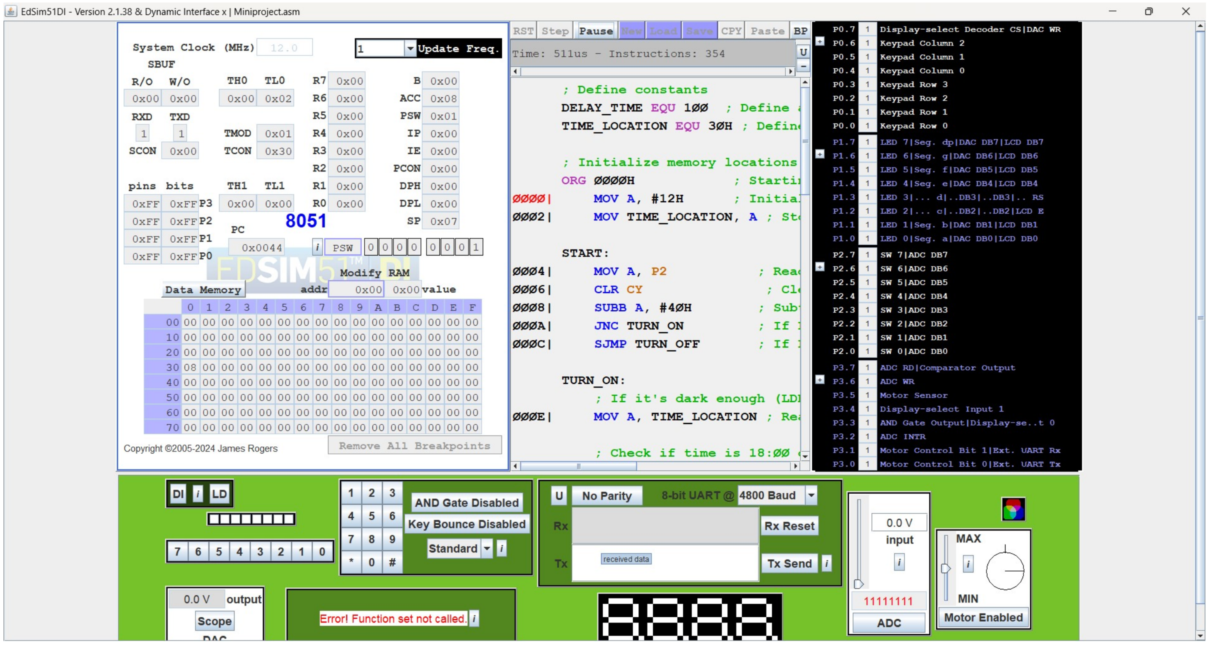

Figure 6: Screenshot of EdSim51 showing the time as 08H (08:00) and LDR input as 0FFH (not sufficient light) hence LEDs turned off

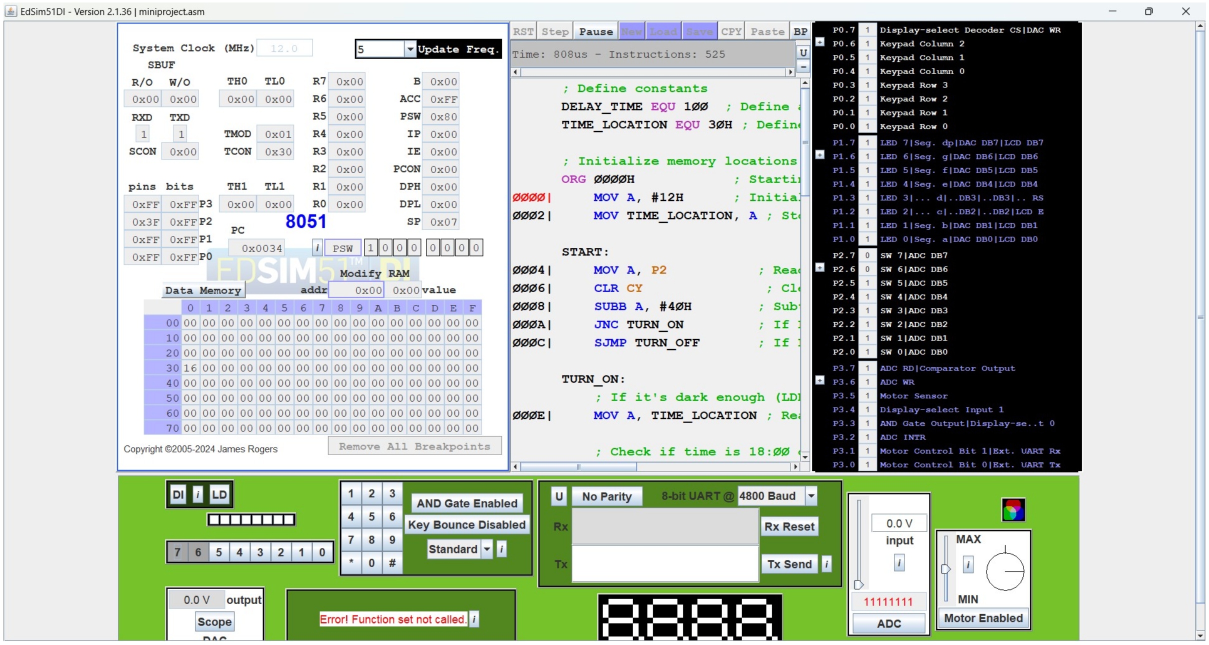

Figure 7: Screenshot of EdSim51 showing the time as 16H (22:00) and LDR input as 3FH (sufficient light) hence LEDs turned off

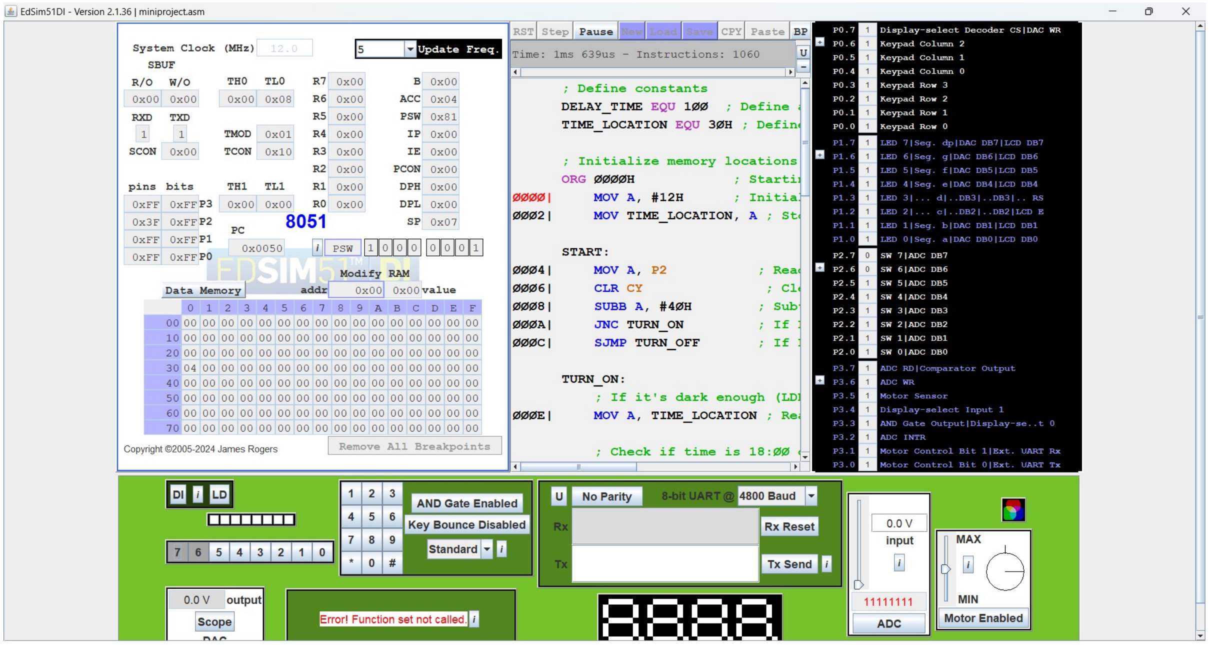

Figure 8: Screenshot of EdSim51 showing the time as 04H (04:00) and LDR input as 3FH (sufficient light) hence LEDs turned off

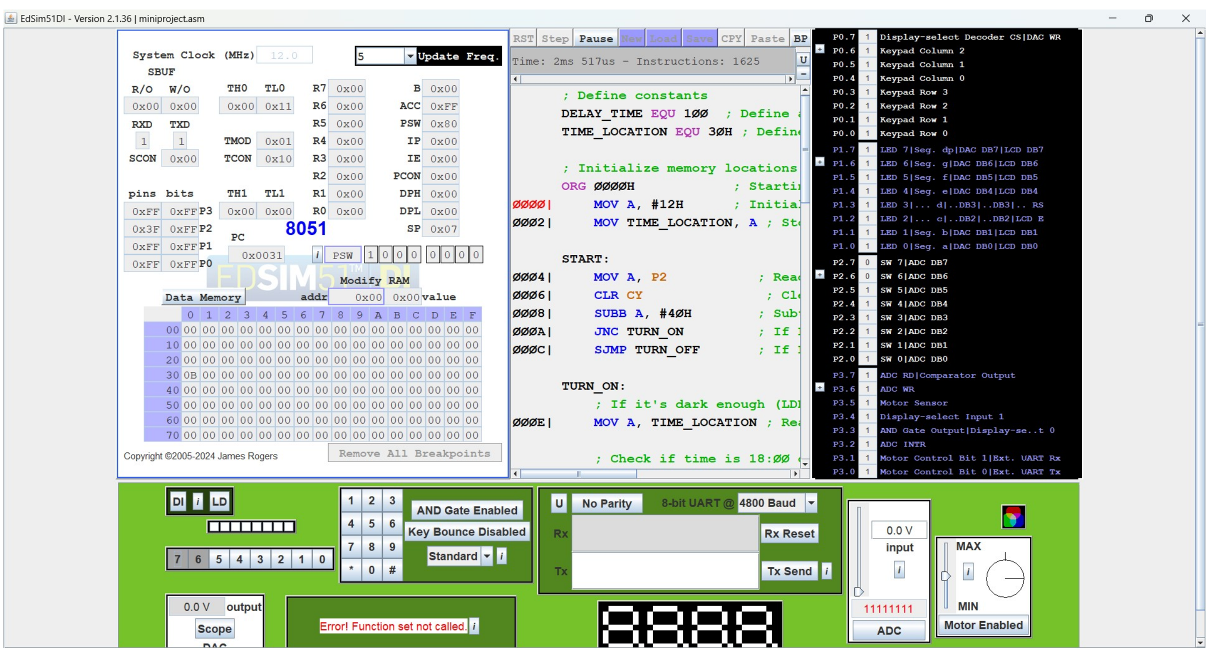

Figure 9: Screenshot of EdSim51 showing the time as 0BH (11:00) and LDR input as 3FH (sufficient light) hence LEDs turned off

Observations:

- The system effectively adjusted brightness levels based on LDR readings and time.
- Energy consumption was optimized by turning lights off during daylight.

Ambient light (LDR input)	Time	Street light status

Insufficient (> 0x40)	0x14 (20:00)	Turned ON (full brightness)
Insufficient (> 0x40)	0x03 (03:00)	Turned ON (dim mode)
Insufficient (> 0x40)	0x08 (08:00)	Turned OFF
Sufficient (< 0x40)	0x16 (22:00)	Turned OFF
Sufficient (< 0x40)	0x04 (04:00)	Turned OFF
Sufficient (< 0x40)	0x0B (11:00)	Turned OFF

IV.CONCLUSION

This project demonstrates the feasibility of an intelligent streetlight management system using the 8051 microcontroller. The system adapts to real-time conditions, ensuring energy efficiency and road safety. Future work includes expanding functionality with solar power integration and IoT connectivity for centralized control.

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