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:
 - \circ 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.
 - \circ 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

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.

- Version 2.1.38 & Dynamic Interface	te x Miniproject.asm	- a
System Clock SBUF	: (MHz) 12.0 1 Update Freq.	RST Step Pause New Could Rive CPV Pause PP P0.7 I Display-saleCol Decoder CSIDAG NR Time: 76us - Instructions: 53 U P0.6 1 Koypad Colume 2 Post - Instructions: 53 U Post 1 Koypad Colume 1
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00 00 00 10 00 00 20 00 00 30 14 00 40 00 00 50 00 00 60 00 00 70 00 00	0 0	2000 A JNC TURN_ON ; If: 102.2 i SW 2 LACE DB2 2000 C SJMP TURN_OFF ; If: 11 SW 1 LACE DB1 72.0 i SW 2 LACE DB2 SW 0 LACE DB0 TURN_ON: P3.6 i SADE WORD COMPARATOR OUTput 2000 E MOV A, TIME_LOCATION ; Ref P3.6 i 2000 E MOV A, TIME_LOCATION ; Ref P3.4 i 2000 E MOV A, TIME_LOCATION ; Ref P3.3 i 2000 E MOV A, TIME_LOCATION ; Ref P3.2 i
Copyright ©2005-2024	A James Rogers Remove All Breakpoints	; Check if time is 18:00 P3.0 1 Motor Control Bit 1[Ext. UART Fx P3.0 1 Motor Control Bit 0[Ext. UART Tx
7 6 0.0 V	LD 1 2 3 AND Gate Disab 5 4 3 2 1 0 5 4 3 2 1 0 6 0 # #	bled kbled kx x x x x x x x x x x x x x

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

😹 EdSim51DI - Version 2.1.38 & Dynamic Interface	x Miniproject.asm				- 0	×
System Clock SBUF	(MHz) 12.0	1	Update Freq.	T Step Pause Try 2004 Taves CPY Paste BP P0.7 1 Display-molect Decoder CSIDMC WR e: 302us - Instructions: 208 U P0.5 1 Keysad Column 2 P0.5 1 Keysad Column 2		Ê
R/O W/O 0x00 0x00 RXD TXD 1 1	THO TLO 0x00 0x0F TMOD 0x01	R7 0x00 E R6 0x00 ACC R5 0x00 PSW R4 0x00 IF	0xBF 0x01 0x00	P0.3 1 Keynad Row 3 DELAY_TIME EQU 100 ; Define TIME_LOCATION EQU 300 ; Define TIME_LOCATION EQU 300 ; Define TIME_COCATION EQU 300 ; D		
SCON 0x00 pins bits 0xFF 0xFFP3	TCON 0x10 TH1 TL1 0x00 0x00	R3 0x00 IE R2 0x00 PCON R1 0x00 DPH R0 0x00 DPL	0x00 0x00 0x00 0x00	P1.7 D Los 71, seg. Ap1/Los 71, se		
0xFF 0xFF P2 0x55 0x55 P1 0xFF 0xFF P0	PC 805	I SF I PSW 0 0 0 0 Modify RAM	0x07 ØØØ	Ø21 MOV TIME_LOCATION, A; St. P1.1 0 LED 1[ses 1.102] LED 15 START: P1.0 1 LED 0[ses10Ac DB0 DB0 START: P2.7 i sm 71Acc DB7 P2.6 i sm 64Acc DB6		
Data Mem 0 1 00 00 00 10 00 00	ad 2 3 4 5 6 00 00 00 00 00 00 00 00 00 00	dr 0x00 0x00 7 8 9 A B C 00 00 00 00 00 00 00 00 00 00 00 00	value ØØØ D E F ØØØ 0 0 0 ØØØ 0 0 0 ØØØ	Ø6 CLR CY ; C1 F2.5 i 5 W 5 MAOC DB5 Ø8 SUBB A, #4ØH ; Sub F2.3 i 5 W 3 MAOC DB3 Ø8 JNC TURNON ; If i F2.2 i 5 W 3 MAOC DB3 Ø8 JNC TURNON ; If i F2.2 i 5 W 3 MAOC DB3 Ø8 JNC TURNON ; If i F2.2 i 5 W 3 MAOC DB3		-
20 00 00 30 03 00 40 00 00 50 00 00 60 00 00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00		JOINT FORM_OFF , if F2.0 [1 sw 0/A0C DB0 TURN_ON: F3.7 [1 ADC R0/Comparison Output ; If it's dark enough (LD) F3.6 [1 ADC R0/Comparison Output 28E1 MOV A, TIME_LOCATION ; Rei F3.4 [1 ADC R0/Comparison Output 1		
70 00 00 Copyright ©2005-2024	James Rogers	00 00 00 00 00 00 00 00 Remove All E	0 00 00 00 Breakpoints	73.2 1 ADG INTR 73.2 1 ADG INTR 74.0 INTR 75.2 1 ADG I		
	D 5 4 3 2 1 output pe	1 2 3 4 5 6 7 8 9 • 0 # Errorl Function set n	AND Gate Disabled ey Bounce Disabled Standard V 1	U No Parity 8-bit UART @ 4800 Baud Rx Rx Rx Reset Tx Tx Send 7 11111111 ADC		

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

ersion 2.1.38 & Dynamic Interfac	e x Miniproject.asm	n			- 0
System Clock SBUF	(MHz) 12.0	1	Update Freq.	RST St	pp Pause Wey Load Tave CPV Paste Bp Po.7 1 Display-realect Decoder CSIDAC WR Silus - Instructions: 354 U Po.5 1 Keypad Column 1
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pins bits 0xFF 0xFFP3 0xFF 0xFFP2	THI TLI 0x00 0x00 PC	R2 0x00 R1 0x00 R0 0x00 051	PCON 0x00 DPH 0x00 DPL 0x00 SP 0x07	<mark>øøøø </mark> Øøø2	 Finitialize memory locations Fi.6 1 LDB 61seg, g1DA D881LCD D86 Fi.6 1 LDB 61seg, g1DA D861LCD D86 Fi.6 1 LDB 61seg, g1DA D861LCD D84 Fi.6 1 LDB 61seg, g1DA D81LCD D84 Fi.6 1 LDB 61seg, g1DA D81LCD D84
0xFF 0xFFP1 0xFF 0xFFP0 Data Me 0 1 0000 00	0x0044	i PSW 0 Modif addr 0x0 6 7 8 9 00 00 00 00	0 0 0 0 0 0 0 1 y RAM 0 0x00 value A B C D E F 00 00 00 00 00 00	ØØØ4 ØØØ6 ØØØ8 ØØØA	START: P1.0 1 ZED 0 [seg., s]ABC DB0 [LED DB0 MOV A, P2 ; Reak P2.7 1 Sw 7 [Abc DB7 CLR CY ; Cl. P2.8 1 Sw 6 [Abc DB6 SUBB A, #409H ; Subb P2.3 1 Sw 8 [Abc DB6 JNC TURN_ON ; If P2.2 1 Sw 8 [Abc DB5
10 00 00 20 00 00 30 08 00 40 00 00 50 00 00 60 00 00 70 00 00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00 00 00 00 0 0 00 00 00 00 00 00 0 0 00 00 00 00 00 00 0 0 00 00 00 00 00 00 0 0 00 00 00 00 00 00 0 0 00 00 00 00 00 00 0 0	30 00 00 00 00 00 30 00 00 00 00 00 30 00 00 00 00 00 30 00 00 00 00 00 30 00 00 00 00 00 30 00 00 00 00 00 30 00 00 00 00 00 30 00 00 00 00 00 30 00 00 00 00 00	ØØØC	SJMP TURN_OFF ; If 72.0 (1) NN (JAC DOL 72.0 (1) NN (JAC DOL 72.1 (1) NN (JAC DOL 72.0 (1) NN (JAC DOL 72.1 (1) NN (JAC DOL 7
Copyright ©2005-2024	James Rogers	Remov	e All Breakpoints		P3.2 1 ADC INTR ; Check if time is 18:00 (P3.1 1 Motor Control Bit 1[Ext. VART Rx P3.0 1 Motor Control Bit 0[Ext. VART Tx
7 6	LD 5 4 3 2	1 2 4 5 7 8 * 0	AND Gate Disab Key Bounce Disa Standard •	iled ibled	V No Parity 8-bit UART @ 4800 Baud • tx Rx Reset fx Input Input MAX Input MAX

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

🛓 EdSim51DI - Version 2.	1.36 miniproject.asm					- 0 X
EdSim51DI - Version 2.	136 (minprojectasm System Clock SBUF R/O W/O 0x00 0x00 RKD XXD 1 1 SCON 0x00 Pins bits 0xFF 0xFFP3 0xFF 0xFFP73 0xFF 0xFFP70 Data Meme 0 1 0 00 00 0 0 1 0 00 00 2 0 00 00 2 0 0 00 0 2 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0	(MHz) 12.0 THO TLO 0x00 0x00 0x00 0x01 TCON 0x30 THI TLI 0x00 0x00 PC 8(0x034 0x034 0x030 0x034 0x0 0x034 0x0 0x034 0x0 0x034 0x0 0x034	F7 0x00 R6 0x00 R5 0x00 R4 0x00 R3 0x00 R4 0x00 R0 0x00 R1 0x00 D51 // / PSW / PSW 0 0x0 00 0x0 00 0x0 00 0x0 00 0x0 00 0x0 00 0x0	Update Freq. B 0x00 ACC 0xFF PSW 0x00 IP 0x00 IP 0x00 DPL 0x00 DPL 0x00 DPL 0x00 SP 0x0 Ox0 0x0 Ox0 0x0 SP 0x0	RST S1 Time: 1 90000 90002 90004 90004 90004 90008 90000 90000	<pre>- 0 x tep Pause first fact fact for the part of t</pre>
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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

💩 EdSim51DI - Version 2.1.36 miniproject.asm	- o ×
System Clock (MHz) 5 Update Freq. SBUF F/O W/O THO TLO R7 0x00 B 0x00 0x00 0x00 0x00 R6 0x00 B 0x00	RST Step Pause Not Ford Event BP P0.7 Display-select tecoder CS DAC WR Time: Zmm 517us - Instructions: 1625 U P0.6 Keyped Colume 1 I Image: Select and S
RXD TXD R5 0x00 PSW 0x80 1 1 TMOD 0x01 R4 0x00 IP 0x00 SCON 0x00 TCON 0x10 R3 0x00 IE 0x00 R2 0x00 X00 X00 R2 0x00 R000	DELAY_TIME EQ0 100 ; Define wypat Rev 1 TIME_LOCATION EQU 30H ; Define F0.1 i wypat Rev 1
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Data Memory Modify RMM 0 1 2 3 4 5 6 7 8 9 A B C D E F 0 0 2 3 4 5 6 7 8 9 A B C D E F 0 0 0 0 0 0 0 0 0 0 D	26064 MOV A, P2 ; Read ■ 22.6 0 \$W 6 [Ance Da6 96066 CLR CY ; Cl : SW 6 [Ance Da5 96068 SUBB A, #40H ; Sub #2.4 1 \$W 6 [Ance Da5 96068 JNC TURN_ON ; If 1 \$P2.2 1 \$W 1 [Ance Da5 96060 SJMP TURN OFF ; If 1 \$P2.2 1 \$W 1 [Ance Da5
	Image: Control of the second secon
DI Z LD 1 2 3 AND Gate Enable Key Bounce Disat	<pre>; Check if time is 18:98 ; P2.1 1 Notor Control Bit 1 [Rft. UART RF i P2.0 1 Notor Control Bit 0 [Rft. UART 72 ed U No Parity 8-bit UART @ 4800 Baud Rx Rx Reset 0.0 V input MAX</pre>
7 6 5 4 3 2 1 0 # Standard 7 0.0 V output Errorl Function set not called 7<	TX TX Send /

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.

REFERENCES

- [1] Mazidi, M. A., Mazidi, J. G., & McKinlay, R. D. (2011). The 8051 Microcontroller and Embedded Systems: Using Assembly and C. Pearson Education.
- [2] Ayala, K. J. (2004). The 8051 Microcontroller: Architecture, Programming, and Applications. Cengage Learning.
- [3] Rogers, J. (n.d.). EdSim51 User Manual. Available at: EdSim51 Official Website.
- [4] Kumar, D., & Verma, S. (2015). Street Light Automation Using LDR and Microcontroller. International Journal of Science and Research, 4(2), 981-984.
- [5] Singh, R. P. (2020). Street Light Control System using 8051 Microcontroller. International Journal of Emerging Technology and Advanced Engineering, 10(3), 215-220.
- [6] Jha, Kamal. (2022). 8051 Microcontroller Fundamentals and Programming: Project Based Learning Approach.
- [7] Gimenez, Salvador. (2019). Timers/Counters of the 8051 Core Microcontroller. 10.1007/978-3-319-76439-9_8.
- [8] MacKenzie, I. (2009). The 8051 Microcontroller. 10.1007/978-1-4419-0606-9_3.
- [9] Maheshwari, Prakhar & Agrawal, Monika & Goyal, Vishal. (2021). Design and Analysis of Smart Automatic Street Light System. 10.1007/978-981-15-8377-3_13.
- [10] Kodali, Ravikishore & Yerroju, Subbachary. (2017). Energy efficient smart street light. 190-193. 10.1109/ICATCCT.2017.8389131.
- [11] Patel, Jagdish & Thorat, Saloni & Dusane, Srushti. (2020). Automatic Street Lighting Control System Using Microcontroller and Sensors. International Journal of Scientific Research in Science, Engineering and Technology. 571-574. 10.32628/IJSRSET2072114.