NATIONAL INSTITUTE OF TECHNOLOGY ROURKELA,

DEPARTMENT OF ELECTRICAL ENGINEERING,

EMBEDDED SYSTEMS (EE3401)

SESSION 2023/24

COURSE INSTRUCTOR: DR. SUPRATIM GUPTA

AUTOMATIC CONTROL OF HIGHWAY LIGHT SYSTEM

TO SAVE ENERGY WE WANT TO SWITCH ON THE BLOCK OF HIGHWAY LIGHTS AHEAD OF IT AND SIMULTANEOUSLY SWITCH OFF THE TRAILING LIGHTS BY DETECTING THE VEHICLE MOVEMENT ON HIGHWAYS.

PRESENTED BY-

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LIST OF COMPONENTS USED IN HARDWARE ALONG WITH DESCRIPTION-

NAME	SPECIFICATION	QUANTITY
8051 MICROCONTROLLER	89S51	1
RESISTORS	1K OHM	10
CAPACITORS	33 MICRO FARAD	2
TRANSISTORS	2N2222	8
INFRARED SENSORS	FLYING FISH OBSTACLE SENSOR	8
CRYSTAL OSCILLATOR	12-40 MHZ	2
LED LIGHT BULBS	10 WATT	8
BREADBOARDS	-	2
RESPACK-8	1K OHM	1
CABLES AND WIRES	-	-

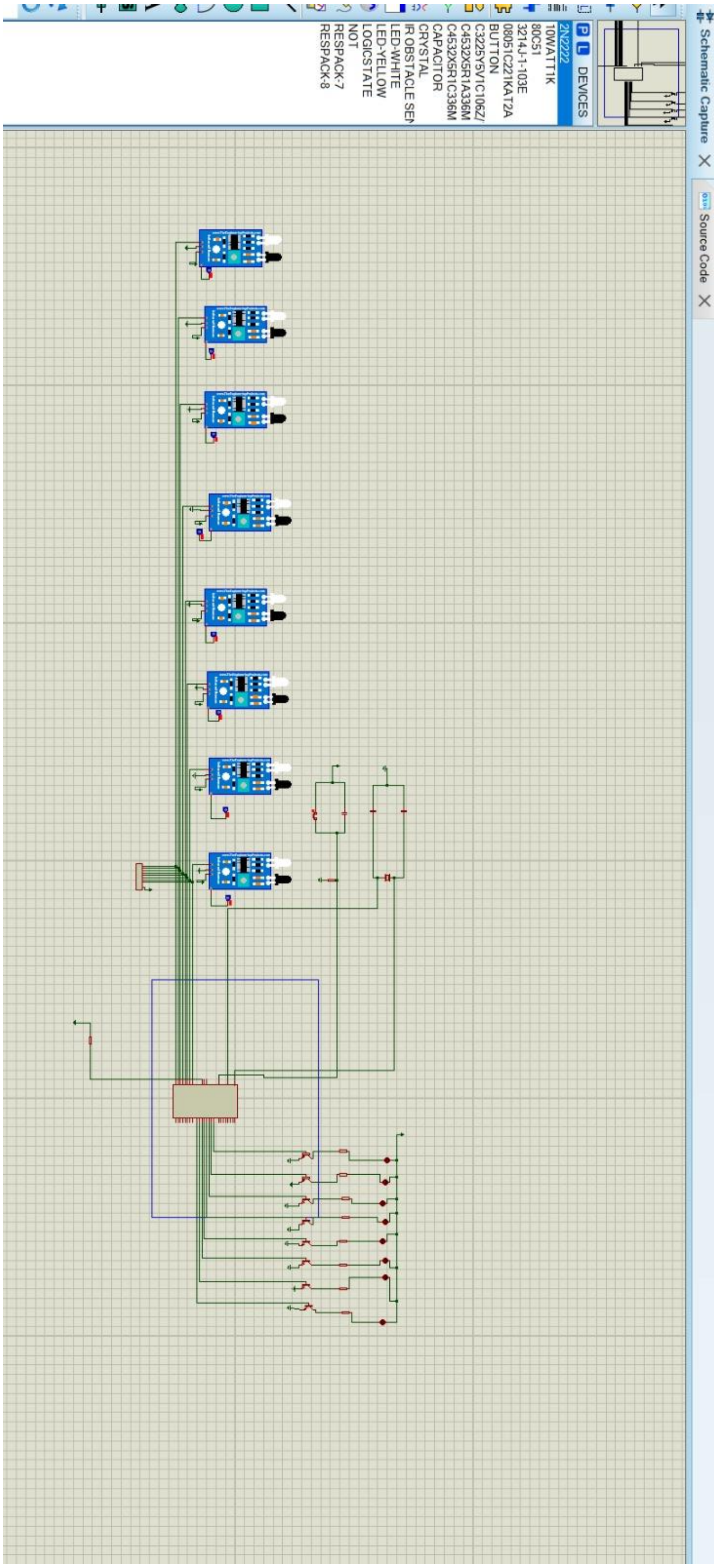
COMPONENT DESCRIPTION

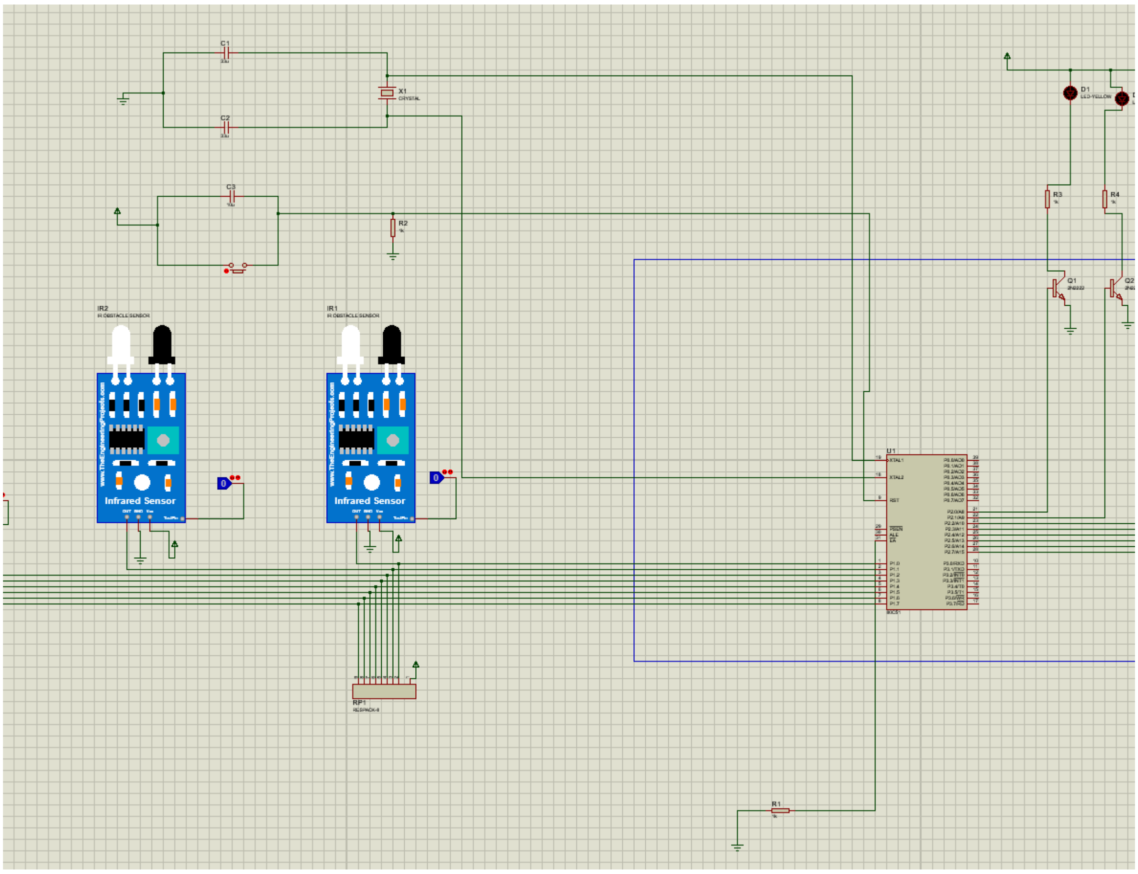
1. IR Sensors (Input):
   - IR sensors are placed alongside the highway to detect the presence of vehicles.
   - The output of each IR sensor is connected to the input pins of the 8051 microcontroller.
2. Microcontroller (8051):
   - The 8051 microcontroller is used as the central processing unit for the system.
   - A program is written to continuously monitor the status of IR sensors and to turn on the bulbs when a vehicle is detected by the IR sensors.
3. 8051 Development Board:
   - The 8051 microcontroller is connected to a development board for ease of prototyping and to ensure that the necessary power supply and clock connections are established.
4. Transistors and Resistors:
   - Transistors (such as transistor 2N2222, which is a common (NPN BJT)- bipolar junction transistor) to control the flow of current to the bulbs.
   - Connect resistors to limit the current through the transistors.
5. Bulbs/ highway lights (Output):
   - LEDs are connected to the transistors in such a way that they act as highway lights and turn on when the vehicles are detected.

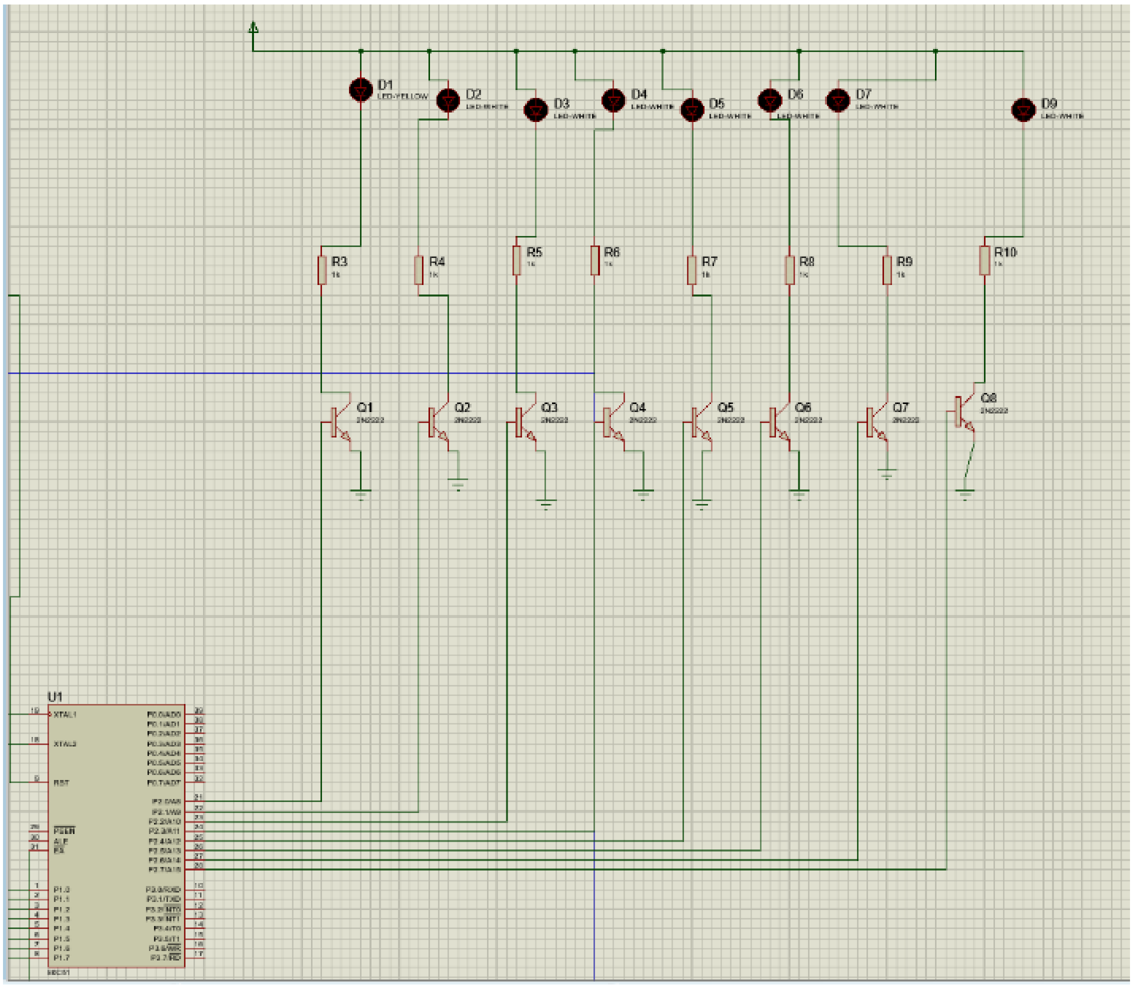
CONTROL LOGIC / CIRCUIT DESCRIPTION

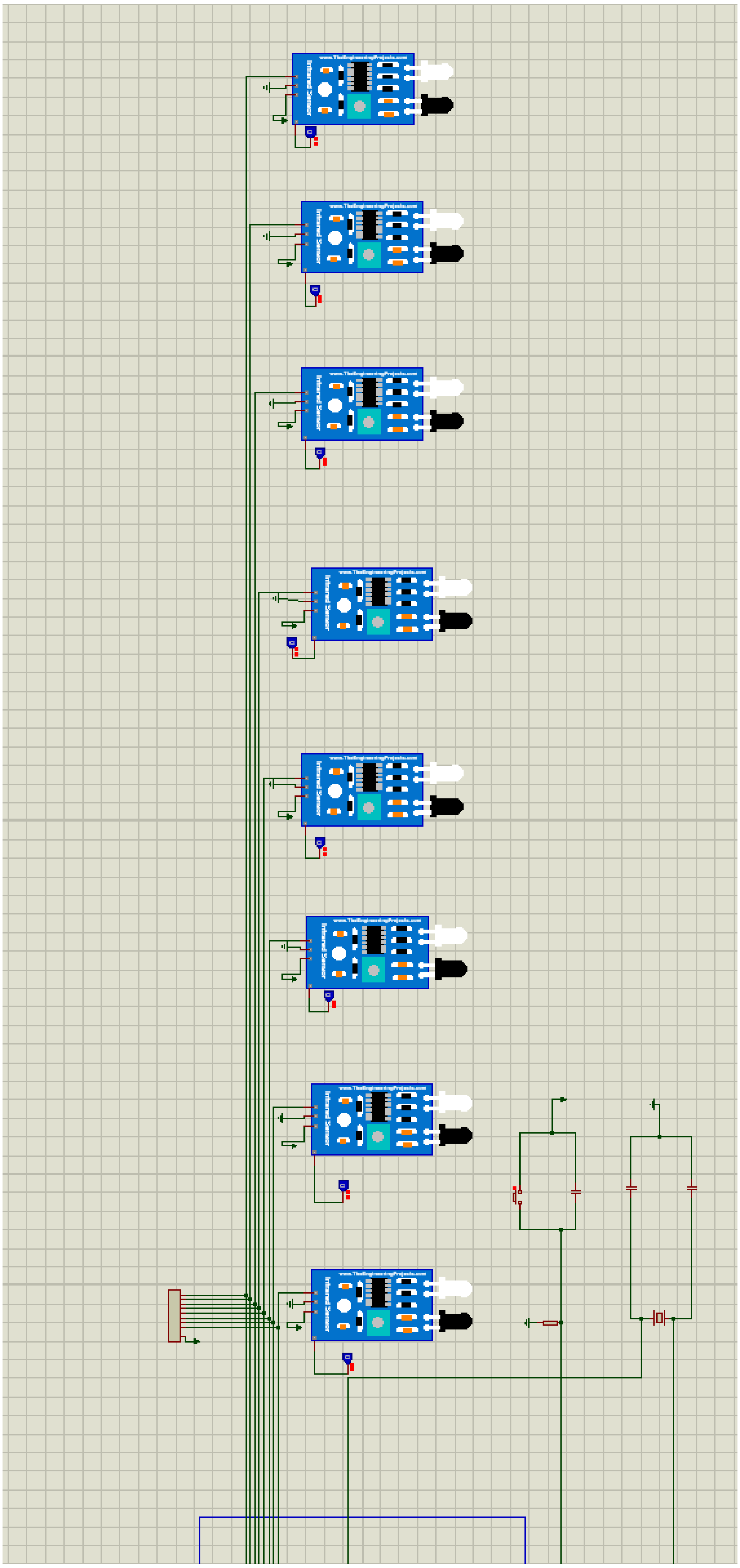
- Implement control logic in the 8051-microcontroller program to turn on the bulbs when a vehicle is detected by the IR sensors.
- IR sensors are strategically placed alongside the highway to detect the presence of vehicles. These sensors typically consist of an infrared emitter and receiver. When a vehicle passes, it interrupts the infrared beam, triggering the sensor.
- Connection to 8051: The output of each IR sensor is connected to the input pins of the 8051 microcontroller. This connection allows the microcontroller to receive signals indicating the status of each sensor (whether a vehicle is present or not).
- Once the vehicle is detected, the (lights below that particular IR sensor and the two consecutive lights in front of it are lit) and only when the vehicle crosses the particular highway light/ IR sensor does its preceding highway lights get turned off and the next highway lights get turned on.
- The lights in the beginning of the highway joining from the main road and towards the end of the highway to join the main road are always switched on, helping the cars to see where they join the highway/ leave it. These lights are marked with yellow lights whereas the other highway lights are marked with white lights.

SCHEMATIC CAPTURE-

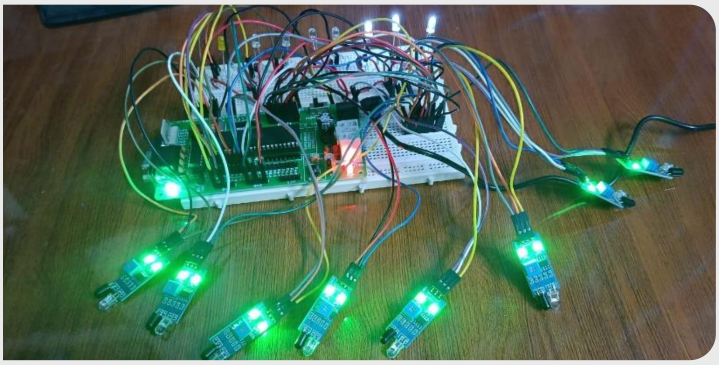



C1
C2
X1
C3
R2
IR2
IR1
Infrared Sensor
Infrared Sensor
U1
D1
R3
R4
Q1
Q2
RP1
R1


D1
LED-YELLOW
D2
LED-WHITE
D3
LED-WHITE
D4
LED-WHITE
D5
LED-WHITE
D6
LED-WHITE
D7
LED-WHITE
D9
LED-WHITE
R3
R4
R5
R6
R7
R8
R9
R10
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
U1
XTAL1
XTAL2
RST
PSEN
ALE
EA

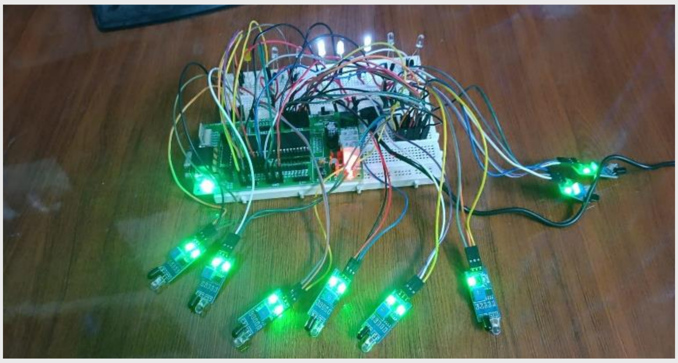


REAL TIME WORKING PHOTOS FOR DIFFERENT CASES



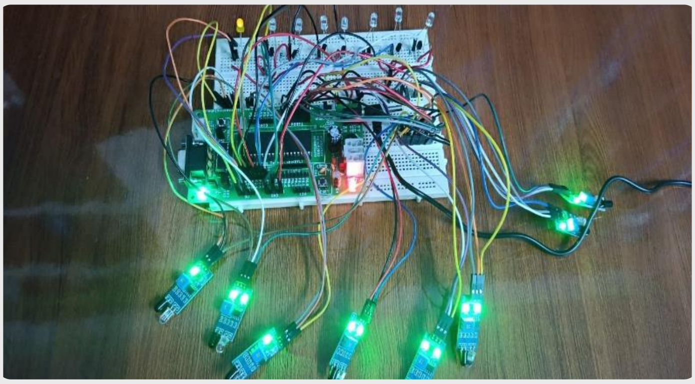
CASE-1

WHEN THE OBJECT IS STANDING UNDER THE FIRST STREET LIGHT



CASE-2

WHEN THE OBJECT IS STANDING IN THE MIDDLE OF THE PASSAGE



CASE-3-

WHEN THE OBJECT HAS REACHED THE END OF THE PASSAGE

ASSEMBLY CODE WITH EXPLANATION:-

main.asm

```
;====================================================================

$NOMOD51
$INCLUDE (8051.MCU)

;====================================================================
; DEFINITIONS
;====================================================================

;====================================================================
; VARIABLES
;====================================================================

;====================================================================
; RESET and INTERRUPT VECTORS
;====================================================================

org   0000h
jmp   MAIN
org  0400h
DB 000H, 001H, 003H, 007H, 00EH, 01CH, 038H, 070H, 0E0H
MAIN : MOV DPTR,#0400H ; ADDRESS OF TABLE TO DPTR
           MOV P1,#0FFH ;SETTING P1 FOR INPUT
           MOV P2,#00H  ;SETTING P2 FOR OUTPUT

CHECK:  CLR PSW.7  ;CLEARING THE CARRY FLAG
                MOV A,P1   ;STORING INPUT IN THE ACC
                MOV R2,#00H ;INTIALIZING COUNTER
                CJNE A,#00H,LOOP ;CHECK WHETHER ANY SENSOR IS ON
                MOV P2,#00H     ;IF NOT THEN DISPLAY "0"
                SJMP CHECK      ;CHECK AGAIN UNTIL A SENSOR IS TURNED ON
LOOP:  RRC A    ;ROTATE ACC UNTIL CARRY IS ONE
            INC R2       ;COUNT WHICH SENSOR IS WORKING
           JNC LOOP      ;CONTINUE TILL CARRY IS ZERO
OUTPUT:  MOV A,R2       ;MOVE THE COUNT OF SENSOR IN ACC
                MOVC A,@A+DPTR  ;STORE THE VALUE FOR THE CORRESPONDING SENSOR FROM LOOKUP TABLE  ;
                MOV P2,A        ;GIVE VALUE TO P2 AS OUTPUT
                LJMP CHECK  ;CONTINUE THE ABOVE PROCESS LIFETIME

;====================================================================
      END
```

org 0000h: Set the origin (starting address) of the program to 0000h.

jmp MAIN: Jump to the MAIN label to start the program.

org 0400h: Set the origin to 0400h.

DB 000H, 001H, 003H, 007H, 00EH, 01CH, 038H, 070H, 0E0H: Define bytes at addresses 0400h to 0408h with the given values.

MOV DPTR, #0400H: Load the address of the lookup table into the DPTR register.

MOV P1, #0FFH: Set P1 as an input port.

MOV P2, #00H: Set P2 as an output port.

CLR PSW.7: Clear the carry flag.

MOV A, P1: Move the value from port P1 to the accumulator (A).

MOV R2, #00H: Initialize a counter R2 to 0.

CJNE A, #00H, LOOP: Compare A with 00H, and if not equal, jump to the LOOP label. This checks if any sensor is active.

MOV P2, #00H: If no sensor is active, set P2 to 00H.

SJMP CHECK: Jump back to CHECK to keep checking for sensor activation.

RRC A: Rotate the accumulator right through the carry flag until the carry is in bit 0.

INC R2: Increment the counter R2, counting which sensor is active.

JNC LOOP: If there is no carry (i.e., carry is zero), jump back to LOOP to continue checking.

MOV A, R2: Move the count of the active sensor to the accumulator.

MOVC A, @A+DPTR: Move the value at the address (A+DPTR) to the accumulator using the table at 0400h.

MOV P2, A: Set the value in the accumulator as the output on port P2.

LJMP CHECK: Jump back to CHECK to continue the sensor checking loop.

PRACTICAL APPLICATIONS :-

1. Energy Saving with LED Street Lights:

- LED (Light Emitting Diode) street lights are often used in automatic street light systems due to their energy efficiency, compared to traditional high-pressure sodium (HPS) or incandescent lights.
- Studies have suggested that the adoption of LED street lights can lead to energy savings ranging from 50% to 70%, depending on the efficiency of the previous lighting technology.

2. Smart Lighting Systems:

- Smart lighting systems, including those with automatic control features, can further enhance energy savings. These systems may incorporate sensors, timers, and dimming capabilities to adjust light levels based on factors such as ambient light conditions and pedestrian or vehicular activity.
- According to various reports, smart street lighting systems can contribute to additional energy savings of up to 30% compared to static, non-responsive lighting systems.

3. Motion Sensors and Dimming:

- Street light systems that incorporate motion sensors to activate lights only when needed and dimming features during low-traffic periods can result in substantial electricity savings. Depending on the implementation and the frequency of dimming, energy savings of 20% to 50% may be achievable.

4. Global Impact:

- Cities worldwide have been transitioning to energy-efficient lighting solutions, including automatic and smart street light systems, as part of their sustainability initiatives. The cumulative impact of these efforts contributes to a reduction in carbon emissions and lowers overall energy consumption for public lighting.

CONCLUSION:-

Challenges Faced:

1. Sensor Placement and Calibration: Determining optimal locations for IR sensors and calibrating their sensitivity posed challenges to ensure accurate vehicle detection.
2. Programming Complexity: Crafting a precise program for the 8051-microcontroller required meticulous attention to logic and timing and also to include edge cases.
3. Power Supply Stability: Maintaining a stable power supply for the entire system was critical, demanding careful consideration of voltage levels and current requirements.

   Solution: Implementing voltage regulators and surge protection mechanisms can enhance power supply stability. Careful consideration of power requirements for each component and adherence to recommended voltage levels contribute to a more robust system.

Advantages:

1. Energy Efficiency: The system promotes energy efficiency by activating highway lights only when vehicles are detected, reducing unnecessary power consumption.
2. Automated Operation: The automation provided by the microcontroller enables a seamless and responsive control system, enhancing safety on the highway.
3. Customizable Logic: The programmable nature of the 8051 microcontroller allows for the implementation of customizable logic, adapting the system to specific environmental conditions.

Disadvantages:

1. Initial Setup Complexity: Designing and setting up the circuit requires technical expertise, making initial implementation complex.
2. Maintenance Challenges: Ensuring long-term reliability may be challenging due to environmental factors, such as weather conditions affecting sensor performance.
3. Dependency on Power: The system relies heavily on a stable power supply, and any interruptions may impact its functionality.

   Solution: Implementing backup power solutions, such as batteries or uninterruptible power supplies (UPS), can provide a temporary power source during outages, ensuring continued operation and minimizing disruptions.