GROUP A6

THERMOSMART

Our Team


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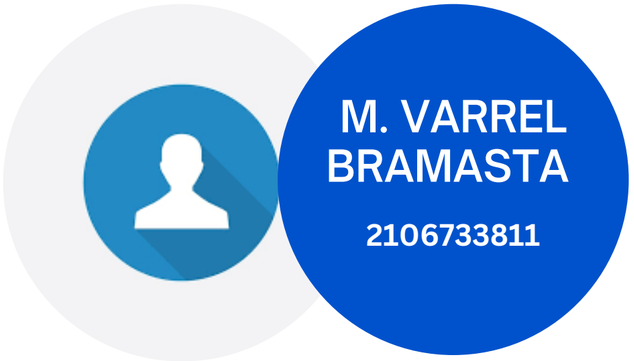
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INTRODUCTION

PROBLEM STATEMENT

In a room equipped with an air conditioner, individuals often experience discomfort due to inconsistent temperatures that do not meet their preferences. This issue is exacerbated by factors such as inadequate ventilation and leaks in the walls, which disrupt the airflow and create uneven temperature distribution throughout the room. Furthermore, the condensate water produced by the air conditioner needs to be temporarily stored. However, if the storage containers are not promptly emptied when they become full, there is a risk of flooding inside the room. Negligence in managing the condensate water can lead to physical messiness, damage to furniture, and potential seepage into the floor.

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INTRODUCTION

PROPOSED SOLUTION

Smart Control System Integration

Integrating temperature and water level sensors into the air conditioning system.

Temperature Control

Utilizing a temperature sensor to monitor room temperature.

Condensate Water Management

Water level sensor to monitor the height of discharge water in the drainage tank.

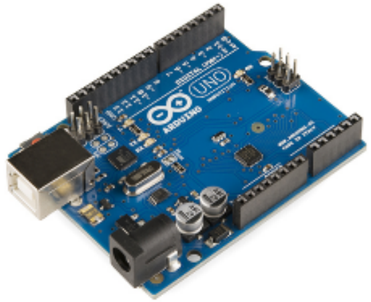

Figure 2 Arduino uno

Figure 3 LCD display

Figure.4 Water Level

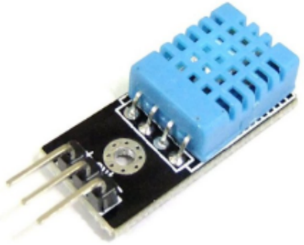

Figure.5 DHT11

IMPLEMENTATION

Hardware Design Schematic

Figure.6 Buzzer

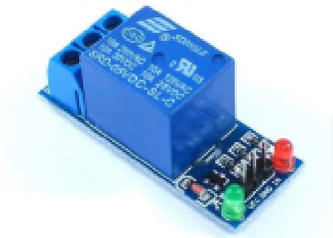

Figure.7 Relay

Figure.8 Button

IMPLEMENTATION

Hardware Design Schematic

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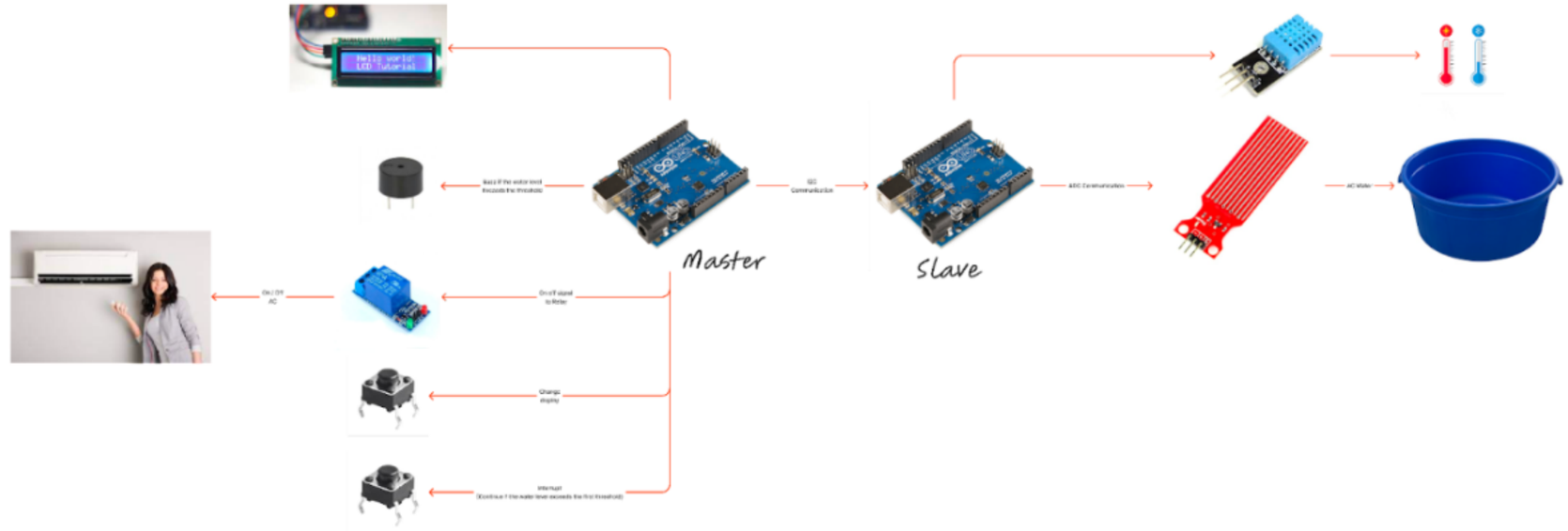


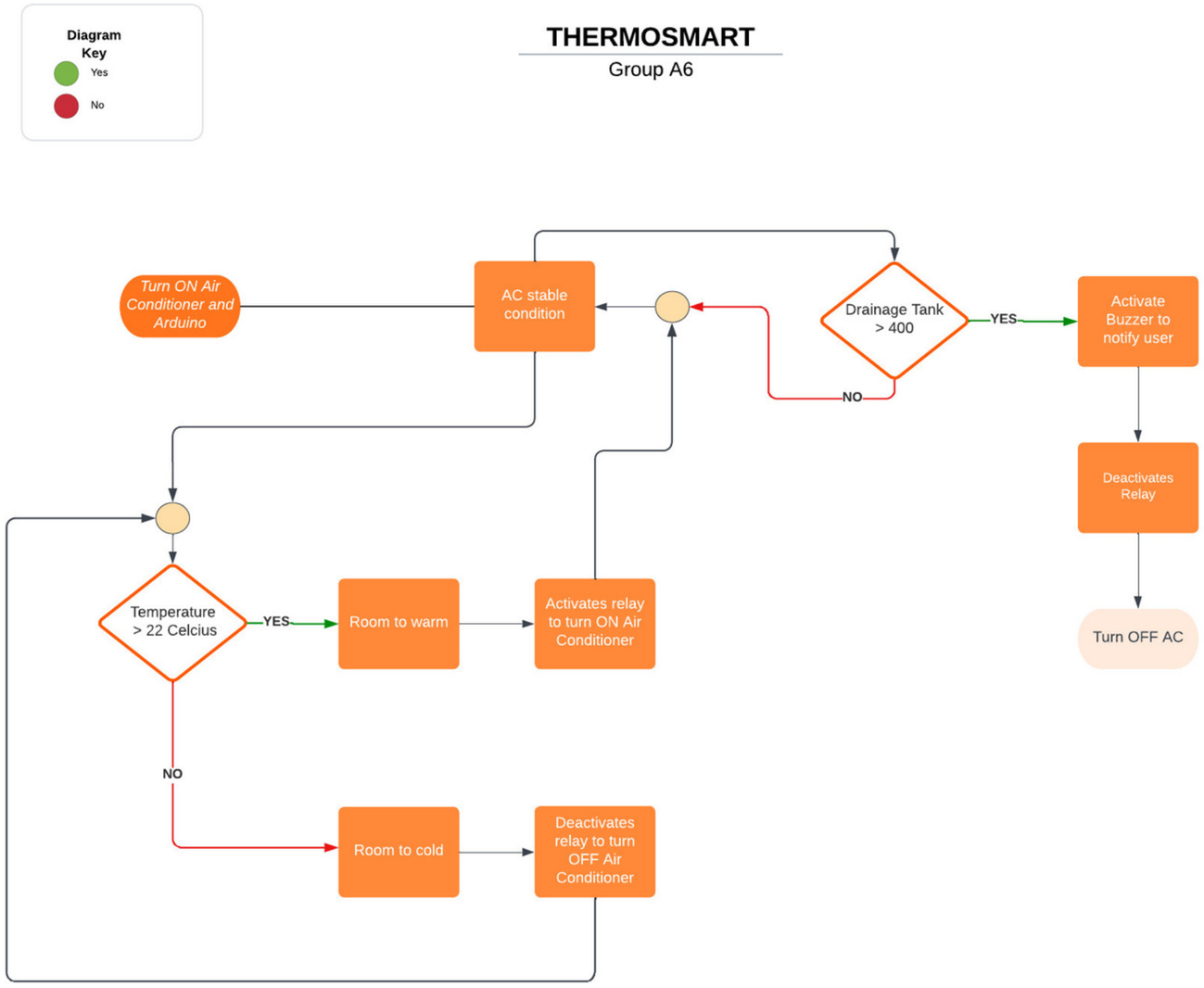
IMPLEMENTATION

Hardware Design Schematic

IMPLEMENTATION

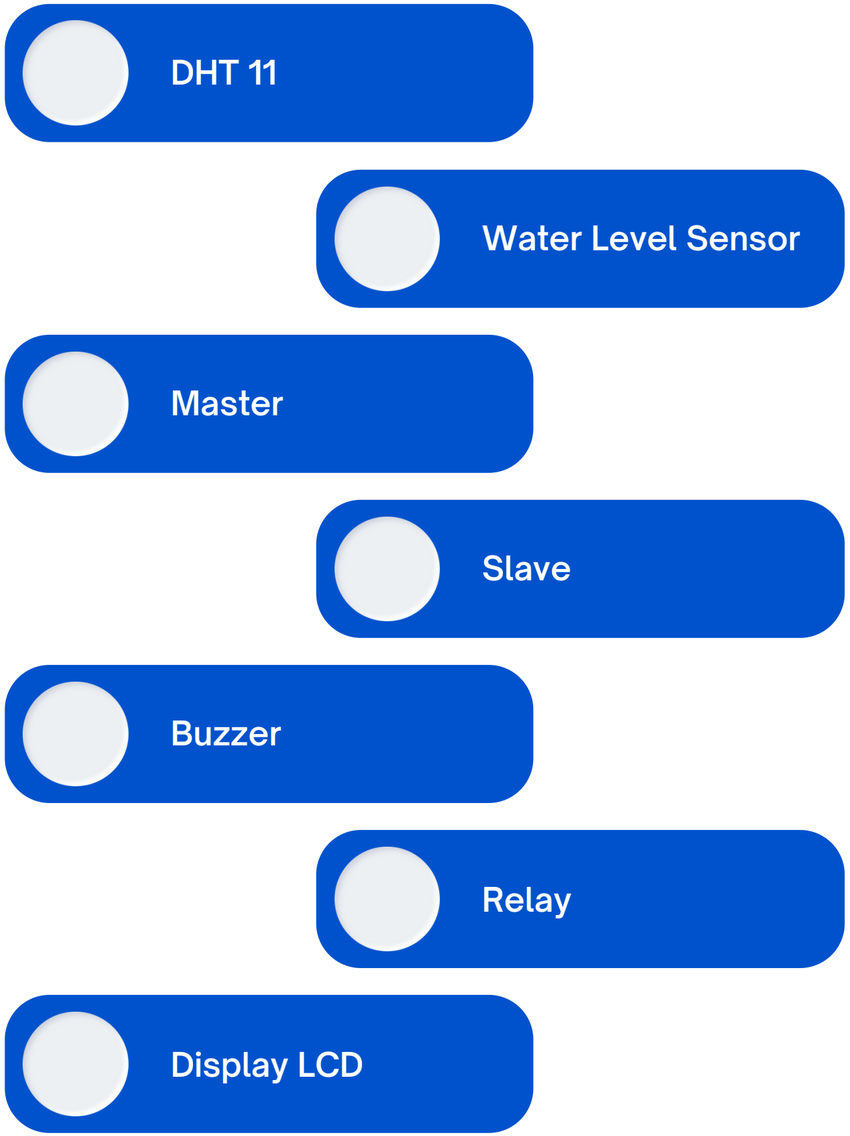
SOFTWARE DEVELOPMENT

FLOWCHART



IMPLEMENTATION

SOFTWARE DEVELOPMENT



IMPLEMENTATION

SOFTWARE DEVELOPMENT

WATER_LEVEL_SENSOR

```
;------------------------
; Assembly code to read adc measurement results from water level sensor
#define __SFR_OFFSET 0x00
#include "avr/io.h"
;---- Global Declaration ---
.global init_ADC
.global init_serial
.global print_ADC
.global main
;---- Main Label ----
main:
SBI DDRC, 0 ;sets bit 0 of DDR for port C to 1. Configures pin PC0 as O/P
LDI R20, 0x40 ;load the value 0xc0 into R20
STS ADMUX, R20 ;store the value of R20 to ADMUX. ADC = 5V, read ADC0 i/p pin
LDI R20, 0x87 ;loads the value 0x87 (10000111 in binary) into register R20
STS ADCSRA, R20 ;enables the ADC and sets its prescaler to 128
;----
init_serial:
CLR R24 ;clears register R24
STS UCSR0A, R24 ;stores the value in R24 into UCSR0A for UART
STS UBRR0H, R24 ;stores the value in R24 into the upper byte of (UBRR0H) for the UART.
LDI R24, 51 ; store in UBRR0L 51
STS UBRR0L, R24 ;to set baud rate 19200
LDI R24, 1<<RXEN0 | 1<<TXEN0 ;sets bits in R24 corresponding to RXEN0, and TXEN0 for UART.
STS UCSR0B, R24 ;enable RXB & TXB ;stores the value in R24 to UCSR0B
LDI R24, 1<<UCSZ00 | 1<<UCSZ01 | 1<<UPM01
STS UCSR0C, R24 ;asynch, even parity, 1 stop, 8 bits

```

```
;-----------------------
; Assembly Code
;-----------------------
#define __SFR_OFFSET 0x00
#include "avr/io.h"
;-----------------------
.global DHT11_sensor

;====================================================================
DHT11_sensor:
;--------------------------------------------------------------------
agn:RCALL delay_2s      ;wait 2s for DHT11 to get ready
;--------------------------------------------------------------------
;start_signal
;------------
    SBI   DDRD, 3       ;pin PD7 as o/p
    CBI   PORTD, 3      ;first, send low pulse
    RCALL delay_20ms    ;for 20ms
    SBI   PORTD, 3      ;then send high pulse
;--------------------------------------------------------------------
;responce signal
;---------------
    CBI   DDRD, 3       ;pin PD7 as i/p
w1: SBIC  PIND, 3
    RJMP  w1            ;wait for DHT11 low pulse
w2: SBIS  PIND, 3
    RJMP  w2            ;wait for DHT11 high pulse
w3: SBIC  PIND, 3
    RJMP  w3            ;wait for DHT11 low pulse
;--------------------------------------------------------------------
    RCALL DHT11_reading ;read humidity (1st byte of 40-bit data)
    MOV   R25, R24
    RCALL DHT11_reading
```

IMPLEMENTATION

SOFTWARE DEVELOPMENT

DHT_11

```
#define __SFR_OFFSET 0x00
#include "avr/io.h"
;-----------------------

.global main
;=====================================================================
main:
    SBI   DDRC, 0       ;set pin PC0 as i/p for ADC0
    ;-------------------------------------------------------------
    LDI   R20, 0xE0     ;internal 2.56V, left-justified data, ADC0
    STS   ADMUX, R20
    LDI   R20, 0x87     ;enable ADC, ADC prescaler CLK/128
    STS   ADCSRA, R20
    JMP   LCD_write
    RET
;---------------------------------------------------------------------
LCD_write:
    LDI   R23, 48       ;constants used to get ASCII values
    LDI   R24, 7        ;for chars 0-->9 & A-->F
    ;-------------------------------------------------
    LDI   R16, 0xFF
    OUT   DDRD, R16     ;set port D o/p for data
    OUT   DDRB, R16     ;set port B o/p for command
    CBI   PORTB, 0      ;EN = 0
    RCALL delay_ms      ;wait for LCD power on
    ;-------------------------------------------------
    RCALL LCD_init      ;subroutine to initialize LCD
    ;-------------------------------------------------
    RCALL disp_msg      ;display message on 1st line
    ;-------------------------------------------------
 ;   LDI   R16, 0xC0     ;cursor beginning of 2nd line
;    RCALL command_wrt
    RCALL delay_ms
    ;-------------------------------------------------
       LDI   R16, 0x20
    RCALL data_wrt      ;display LSD on LCD
```

IMPLEMENTATION

SOFTWARE DEVELOPMENT

DISPLAY_LCD

IMPLEMENTATION

SOFTWARE DEVELOPMENT

RELAY

```
#define __SFR_OFFSET 0x00
#include "avr/io.h"
;-----------------------
.global main
;============================================================
main:

    LDI   R16, 0b000100000 ;to toggle PB5 (D13)
    LDI   R17, 0b00000000
    ;-----------------------------------------
    SBI   DDRD, 5         ;set PD5 for o/p
    OUT   PORTD, R17      ;PD5 = 0
    CBI   DDRC, 0         ;set PC0 as i/p
    SBI   PORTC, 0        ;input pullup
    rjmp loop

loop:
    SBIC  PINC, 0
    RJMP loop

relay_toggle:
    EOR   R17, R16        ;R17 = R17 XOR R16
    OUT   PORTD, R17
    ;LDI   R18, 0
    RJMP  loop


relay_toggle_on:
    SBI   PORTB, 3
    RET

relay_toggle_on:
    CBI  PORTB, 3
    RET
```

IMPLEMENTATION

SOFTWARE DEVELOPMENT

BUZZER

```
#define __SFR_OFFSET 0x00
#include "avr/io.h"
;-----------------------
.global main
;============================================================
main:
    LDI   R16, 0b00100000 ;to toggle PB5 (D13)
    LDI   R17, 0b00000000
    ;-----------------------------------------
    SBI   DDRB, 5         ;set PB5 for o/p
    OUT   PORTB, R17      ;PB5 = 0
    CBI   DDRC, 0
    SBI   PORTC, 0
    LDI R18, 100
agn:
    LDI   R17, 0b00000000
    OUT   PORTB, R17
    SBIS  PINC, 0
    RJMP l1
    RJMP agn

;Subroutine to generate 1000hz square-wave
l1: RCALL delayhalfms   ;apply delay via timer0
    ;-----------------------------------------
    EOR   R17, R16        ;R17 = R17 XOR R16
    OUT   PORTB, R17
    SBIS  PINC, 0         ;toggle PB5
    RJMP  l1              ;go back & repeat toggle
    RJMP  agn
;============================================================
delayhalfms:            ;0.5 ms delay via Timer0 for generating 1kHz tone
    ;-------------------------------------------------------
    CLR   R20
    OUT   TCNT0, R20      ;initialize timer0 with count=0
    LDI   R20, 125
    OUT   OCR0A, R20      ;OCR0 = 125
```

IMPLEMENTATION

SOFTWARE DEVELOPMENT

MASTER

```
#define __SFR_OFFSET 0x00
#include "avr/io.h"
;-----------------------
.global main
;=============================================================
main:
  .equ SCK, 5
  .equ MOSI, 3
  .equ SS, 2

  ;-------------------------------------------------------------
  ; SPI for DHT
  ;-------------------------------------------------------------
  LDI R17, (1<<MOSI)|(1<<SCK)|(1<<SS)
  OUT DDRD, R17       ; set MOSI, SCK, SS as o/p
  LDI R17, (1<<SPE)|(1<<MSTR)|(1<<SPR0)
  OUT SPCR, R17       ; enable SPI as master, fsck=fosc/16, mode 0
  RJMP  again
RET

again:
  ;-----------------------------------------------------
  ; SPI for DHT and Water Sensor
  ;-----------------------------------------------------
  RCALL dht_start     ;data read in R18
  CBI PORTD, SS       ;enable slave device
  OUT SPDR, R18       ;transmit byte to slave
  loop:
    IN R18, SPSR
    SBRS R18, SPIF    ;wait for byte transmission
    RJMP loop         ;to complete

  RCALL sensor_Water
  OUT SPDR, R16  ; transfer low byte sensor water
    loop1:
    IN R16, SPSR
```

```
#define __SFR_OFFSET 0x00
#include "avr/io.h"
;-----------------------

.global main
;====================================================================

;============================================================
SPI_slave:
;------------------------------------------------------------

main:
    SBI   DDRC, 0       ;set pin PC0 as i/p for ADC0
    ;-------------------------------------------------------------
    LDI   R20, 0xE0     ;internal 2.56V, left-justified data, ADC0
    STS   ADMUX, R20
    LDI   R20, 0x87     ;enable ADC, ADC prescaler CLK/128
    STS   ADCSRA, R20
    LDI R21, 0xF0
    OUT DDRD, R21 ;port D[7:4] is o/p
    LDI R17, (1<<SPE)
    OUT SPCR, R17 ;enable SPI as slave

  ;-----------------------------------------------------
  ; SPI reading
  ;-----------------------------------------------------
  l22: ;read byte temp
    IN R18, SPSR
    SBRS R18, SPIF  ;wait for byte reception
    RJMP l22
  IN R28, SPDR       ;i/p byte from data register

    LDI R17, (0<<SPE)
    OUT SPCR, R17 ;disable SPI as slave
    RCALL LCD_write
```

IMPLEMENTATION

SOFTWARE DEVELOPMENT

SLAVE

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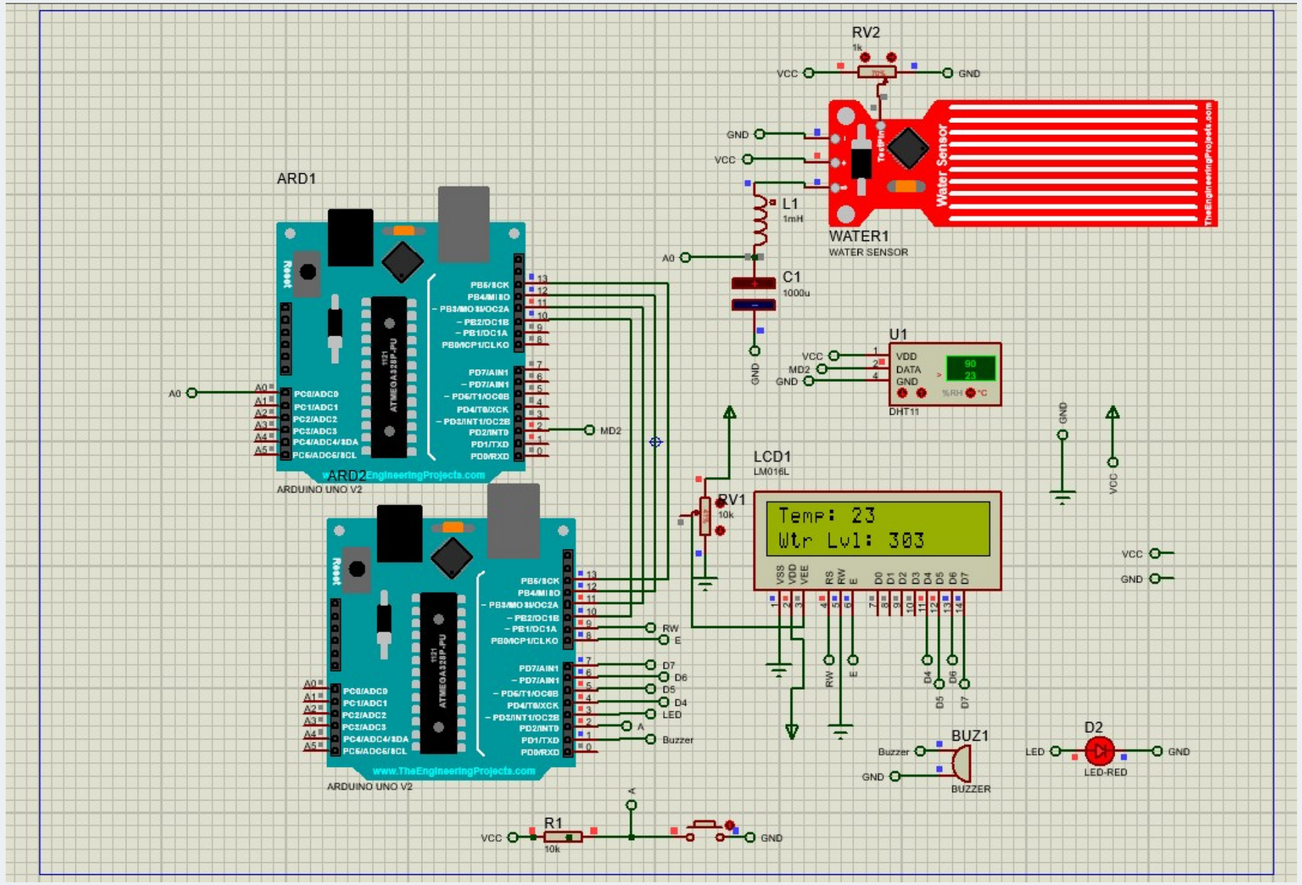
Hardware and Software Integration



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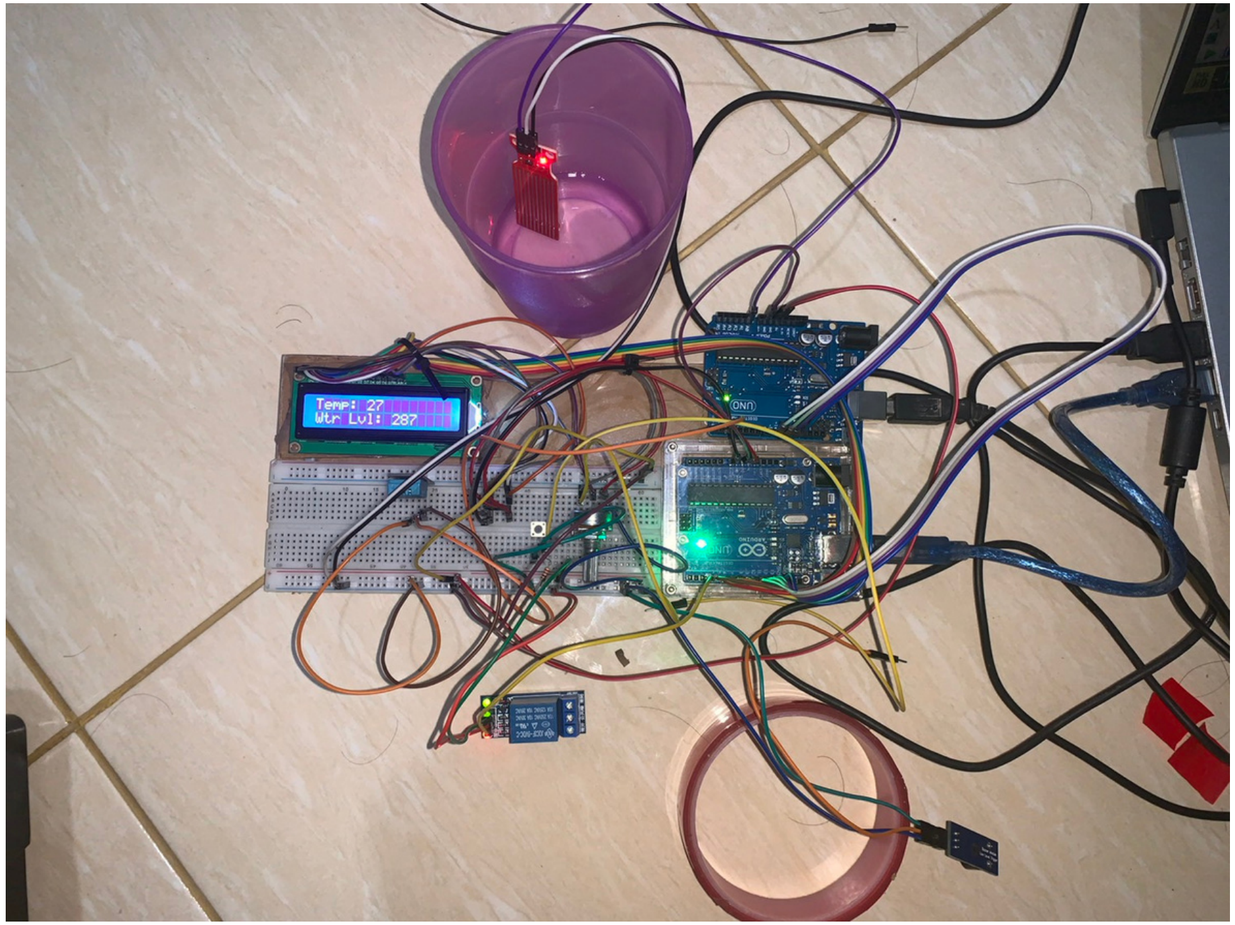
TESTING AND EVALUATION

Testing and Results

Low Water Level & High Temperature

The first condition to test is a scenario with a low water level and a high temperature. In this case, the water level in the condensate container is below the predefined threshold (under 400 value), indicating that it does not requires attention. The temperature in the room is above the desired range (above 22 Celcius), signifying the need for cooling. During this test, the expected output from Thermosmart is as follows. The LED indicator turns ON and the AC is turned ON to cool the room and maintain a comfortable temperature for the occupants.



Results Low Water Level & High Temperature

TESTING AND EVALUATION

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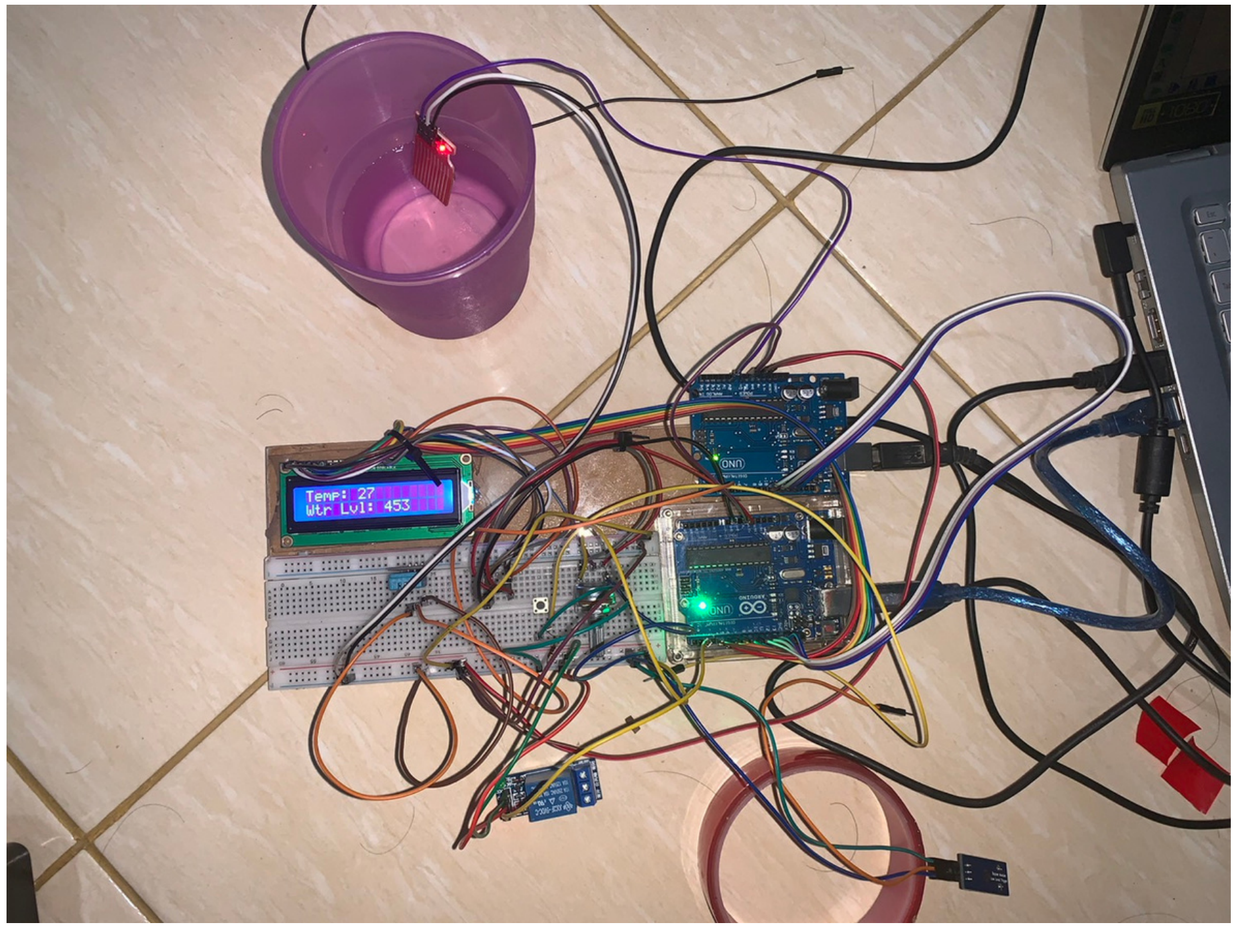
TESTING AND EVALUATION

Testing and Results

High Water Level & High Temperature

During this test, the expected output from Thermosmart is as follows. The LED indicator turns OFF, indicating that the water level is high and has reached its maximum capacity. Also the temperature is above the desired range. This serves as a visual alert to the user to promptly empty the container to prevent overflow or potential damage. Additionally, the AC is turned OFF to prevent further cooling and stopping the water leakage from the container. This condition will also trigger a buzzer to notify the user that the drainage tank is Full.



Results High Water Level & High Temperature

TESTING AND EVALUATION

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TESTING AND EVALUATION

Testing and Results

Low Water Level & Low Temperature

During this third condition test, the expected output from Thermosmart is as follows. The LED indicator turns OFF, indicating the low water level that does not requires attention. However, since the temperature is already within the desired range, the AC remains OFF. This ensures energy efficiency by not activating unnecessary cooling when the temperature is already comfortable.

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TESTING AND EVALUATION

Testing and Results

High Water Level & Low Temperature

During this fourth condition test, the expected output from Thermosmart is as follows. The LED indicator turns OFF, indicating the high water level that requires prompt action. Since the temperature is already within the desired range, the AC remains OFF as cooling is not necessary and stopping the water leakage from the container.

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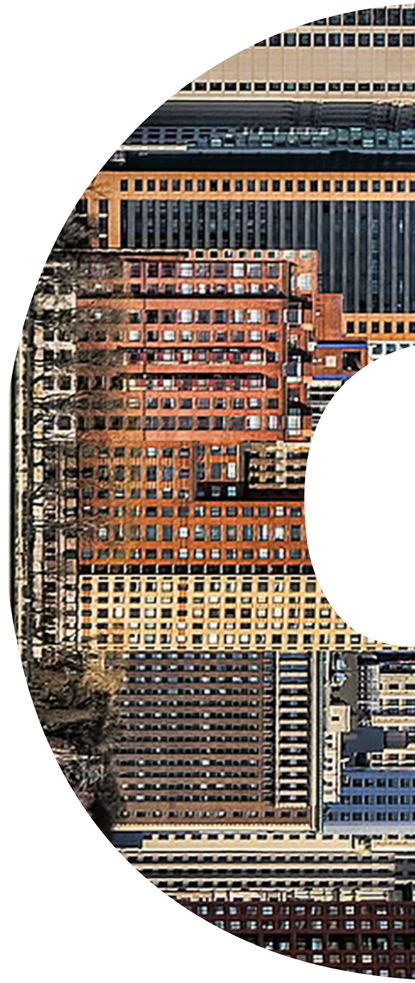
TESTING AND EVALUATION

Evaluation



An evaluation of the Serial Peripheral Interface (SPI) communication in both Proteus and physical circuit reveals a discrepancy in their behavior. In Proteus, the SPI communication can run smoothly, allowing multiple transmissions within a loop. However, in the physical circuit implementation, the SPI communication only sends data once, and subsequent transmissions do not occur as expected.To further enhance the efficiency and effectiveness of the smart control system, it is crucial to evaluate and improve the system's logic. By incorporating advanced algorithms or machine learning techniques, the system can adapt more accurately to occupants' preferences and maximize energy efficiency. Additionally, implementing a mechanism to display the water level in percentage using assembly language simplifies understanding and enables timely management of condensate water. Introducing an enhanced interrupt button allows users to forcefully activate the air conditioner when needed, regardless of system logic, while adjusting the settings to allow the AC to continue operating when the storage container reaches maximum capacity ensures uninterrupted cooling. These improvements enhance user control, comfort, and safety within the environment.

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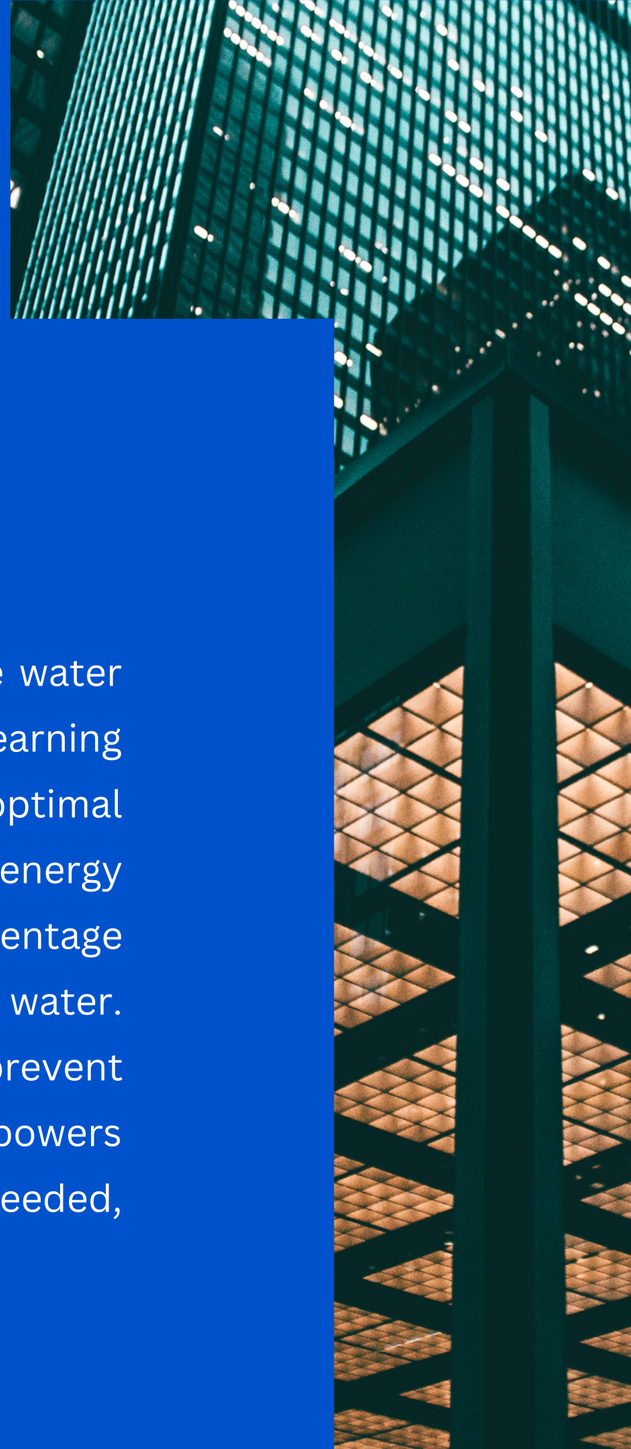
CONCLUSION

Conclusion

Thermosmart offers a comprehensive solution for air conditioner temperature and condensate water management. By evaluating and refining the system's logic, incorporating advanced algorithms, learning techniques, Thermosmart could achieves enhanced efficiency and effectiveness in maintaining optimal temperature control. This ensures a comfortable environment for occupants while maximizing energy efficiency. Additionally, the implementation of a mechanism to display the water level in percentage using assembly language enhances usability and facilitates timely management of condensate water. With Thermosmart, users can easily monitor the water level and take appropriate actions to prevent overflow or potential damage. Moreover, the integration of an enhanced interrupt button empowers users to have more control over the air conditioner. This allows for immediate cooling when needed, regardless of the system's predefined thresholds.



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Thank You