**EMBEDDED SYSTEM FINAL PROJECT**

**DESIGN AN EMBEDDED PROJECT USING THE LPC1768 MICROCONTROLLER TO MONITOR AND CONTROL A GREENHOUSE WITH PUMP CONTROL**

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I. PROJECT OBJECTIVES

Upon completion of this project, you will be able to:

* Be able to use GPIO, ADC, TIMERS, SPI modules using multitask programming.
* Students have ability to develop multi-task programming using RTX-RTOS

II. SYSTEM DESIGN

A LPC1768 microcontroller is to be used as the basis of a greenhouse climate controller. It has the following sensors, actuators, and interfaces:

**Sensors**

* Temperature sensor: outputs a signal of 100mV/oC.
* Soil Moisture sensor: outputs a linear signal in the range 0V (very dry) to 4.5V (saturated).
* Light Sensor: outputs a linear signal whereby 0V is completely dark, 4V is bright sunlight.

**Actuators (all activated by a logic signal)**

* Water sprinkler,
* Heater,
* Light Source.

**Interfaces**

Light Emitting Diode, indicating control function is active, A modular user interface with keypad and display, with GPIO interconnection.

In simple terms, the control system monitors light intensity and duration, soil moisture, and temperature, and activates the actuators as necessary. Operational settings can be varied by the user through the user interface. The system is to be powered by 5 AA alkaline cells, while actuators receive their power independently.

1. Draw a design for the microcontroller circuit, in the form of a detail circuit. Include all aspects necessary to make a complete and working system. Each sensor, actuator, and interface may be shown as a block, connected as appropriate to the microcontroller. The LPC1768 pin connection diagram is given in LPC1768 Data Sheet In drawing your circuit, it is not necessary to draw microcontroller pins which have no connection made to them.
2. Explain briefly but clearly all design decisions you make, explain the reason.
3. Explain briefly how Ports Pins will need to be configured for your design.

A diagram of a machine

Description automatically generated

II. HARDWARE COMPONENTS

1. LPC1768 microcontroller board (e.g., MCB1700 Kit)

2. GLCD with SPI interface

3. Joystick

4. Moisture sensor

5. Relay module for pump control

6. Water pump

7. Node MCU

8. Jumper wires and breadboard (if necessary)

III. SOFTWARE REQUIREMENTS:

1. Keil uVision5 IDE with the LPC1768 board support package
2. RTX-RTOS library for LPC1768 (can be downloaded from the Keil website)
3. Arduino IDE for NodeMCU Coding

**II. PROJECT PROCEDURE:**

**Step 1: Setting up the Hardware**

Connect the hardware components as follows:

1. Connect the GLCD to the SPI interface of the LPC1768 board.

2. Connect the joystick to the appropriate GPIO pins of the LPC1768 board.

3. Connect the moisture sensor to an analog input pin of the LPC1768 board.

4. Connect the relay module to a digital output pin of the LPC1768 board.

5. Connect the water pump to the relay module.

**Step 2: Setting up the RTX-RTOS**

1. Create a new project in Keil uVision5 for the LPC1768 board.

2. Import the RTX-RTOS library into your project.

3. Configure the RTX-RTOS using the provided Keil configuration files. Refer to the RTX documentation for detailed instructions on configuration.

**Step 3: GLCD and Joystick Setup**

1. Import the GLCD library for the LPC1768 board into your project. You can find the library on the Keil website or other reliable sources.

2. Initialize the GLCD and joystick by configuring the necessary GPIO pins and SPI interface.

3. Implement functions to draw the menu, handle menu selections, and update the display.

**Step 4: ADC and Moisture Sensor**

1. Configure the ADC module of the LPC1768 to read analog values from the moisture sensor.

2. Implement a function to read the moisture level from the sensor using the ADC.

3. Based on the moisture level, determine whether watering is required or not.

**Step 5: Timer and Pump Control**

1. Configure a timer interrupt to trigger at regular intervals. This interval will be the watering time.

2. Write a timer interrupt handler to control the water pump. When the timer interrupt occurs, turn on the pump for a specified duration and then turn it off.

3. Adjust the watering time using the joystick.

**Step 5: UART for Pump Control from Internet**

1. Configure UART to set time for the timer interrupt to trigger at regular intervals. This interval will be the watering time.

2. Adjust the watering time from UART.

**Step 6: Implementing the Menu**

1. Create a menu structure to display options on the GLCD.

2. Use the joystick to navigate through the menu and select options.

3. Implement functions to handle menu selections, such as changing the watering time and adjusting the moisture threshold.

**Step 7: RTX-RTOS Integration**

1. Enable RTX-RTOS in your project and configure the required tasks and resources.

2. Create tasks for reading the moisture level, controlling the pump, and managing the menu.

3. Use RTX-RTOS synchronization mechanisms (e.g., semaphores, events) to coordinate the tasks.

**Step 8: Compile and Test**

1. Compile your project and flash the LPC1768 board.
2. Test the functionality of your embedded project by observing the GLCD display, adjusting the watering time using the joystick, and verifying the pump control based on the moisture sensor readings.

**IV. PROJECT REPORT GUIDELINE**

Students write a report which includes Related theory, Hardware connection, Algorithm flowchart and C++ Code for each experiment. In each block of the code or line of code, give the comments for the meaning of this block of code.

