Microcontroller Systems Project 2DX3

Theme Report - 2 (Reason)

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Theme

Reason

As the process of scientific research relies significantly on the application of reason and logic to study and explain natural events, the issue of the reason is frequently central to lab reports. The reason is used in our microprocessor course in the creation of hypotheses, the design of experiments, the analysis of data, and the drawing of evidence-based conclusions. Each lab contributes to the relevance of critical thinking and logical reasoning in the search for knowledge by emphasizing the function of reason in the scientific process. This can be explained in all the three labs, Lab 4, Lab 5, and Lab 6.

When considering Lab 4, the goal of the lab is to provide students with real experience dealing with embedded systems and microcontrollers by employing embedded properties and timing in C language that is cross assembled for ARM. The use of C enables low-level hardware management, while cross-assembly for ARM gives an awareness of the differences between multiple architectures. Students may visualize the impacts of timing and synchronization in embedded systems using LEDs and a stepping motor, which are critical to the proper operation of many real-world applications. The emphasis is on programming embedded systems and understanding the significance of timing and synchronization in real-world applications.

When considering Lab 5, the lab's purpose or topic is to teach students how to connect peripherals and incorporate embedded ideas to produce a viable user interface. The emphasis is on decoding keypad input, which necessitates both hardware and software interfaces. The lab focuses on the actual implementation of embedded principles.

When considering Lab 6, the goal of the lab is to integrate diverse embedded components into a functional system. The lab, in particular, expands on earlier laboratories and studios to establish a basic project platform with stepping motors, push button inputs, and LED outputs. The lab also emphasizes the significance of proper pin mapping to avoid conflicts with the functionality of the microcontroller.

A topic's or concept's main theme is frequently applied in a broader context and can be useful in a variety of sectors and specialized applications. Individuals can improve processes, optimize systems, and improve performance by understanding the causes underlying a specific topic. There are many applications such as the **reason theme of sustainability**. The sustainability topic is important in areas such as building, agriculture, and energy, where the environmental effect is a major concern. Organizations can reduce their environmental effect and promote long-term sustainability by employing sustainable practices such as waste reduction, energy conservation, and the use of renewable resources.

Background

The motivation for using the reason theme in our microcontroller is the need for accurate and reliable information to make judgments. The reason is vital in our labs for establishing hypotheses and theories depending on data and evidence. It is essential for creating and optimizing systems and processes to obtain desired results. Recognizing the significance of reason and its application in real-world situations is vital for success in many sectors, including healthcare, automation, and robots, as well as fostering informed decision-making and critical thinking.

The prevalence of misinformation and the difficulty of fostering accurate and evidence-based reasoning is one key issue relating to the reason theme. Individuals are bombarded with large volumes of information in today's society, frequently from contradictory sources, and it can be difficult to identify what information is genuine and what is not. This is especially important in public health, where misinformation can have serious effects, leading to lower vaccination rates and the re-emergence of preventable diseases. One way to overcome this issue is to implement critical and analytical thinking and evidence-based reasoning skills must be promoted.

In one of our labs, a microcontroller in conjunction with a stepper motor and a keypad is a great example of the use of the reason theme in the real world. When the keypad interfacing is done, the microprocessor assists the motor in rotating and spinning at specific angles or speeds. When we attach a sensor to this system, we can view the environment and collect data from it. This application is extremely useful in the automotive business, where a system detects and navigates its surroundings.

Theme Exemplar

This theme has been used from Lab 4 to 6 in many milestones.

<u>Lab 6: Embedded Integration</u>

The goal of this milestone is to demonstrate the ability to connect four push buttons to a microcontroller and decode the input to extract relevant data. This milestone requires us to build a C program that allows the user to control the direction and speed of the stepper motor by pressing the push buttons. LED 3 should also momentarily flash every time the motor turns 45 degrees. For this implementation, it is recommended that you adopt a state-machine design method. The state machine has four states as a result of four toggle buttons: start, clockwise, counterclockwise, and angle of rotation. The buttons were connected to PH0, PH1, PH2, and PH3.

```
void spin_CW(int totalCWSpins){ // sequence of combinations for clockwise rotation
  for(int i=0; i<totalCWSpins; i++){ // totalCWSpins has to be a multiple of 512 for complete spins
    GPIO_PORTH_DATA_R = 0b00001100;
    SysTick_Wait10ms(1);
    GPIO_PORTH_DATA_R = 0b0001001;
    SysTick_Wait10ms(1);
    GPIO_PORTH_DATA_R = 0b00000011;
    SysTick_Wait10ms(1);
    GPIO_PORTH_DATA_R = 0b00000110;
    SysTick_Wait10ms(1);
  }
}

void Rotation_Control(int direction, int numSpins){ // direction = 1 => CW, 2 = CCW
  int numtotal = 512 * numSpins;
  if(direction == 1){ // Clockwise
    spin_CW(numtotal);
  }else if(direction == 2){ // counterclockwise
    spin_CCW(numtotal);
  }
}
```

Figure 1: A portion of Lab 6 code

In the above figure, the second loop checks if the rotation is clockwise or not. The first button denotes the start of spinning. If the rotation is clockwise, the motor will spin clockwise upon pressing the second button and if not then it will spin counterclockwise upon pressing the third button with an angle of 45 degrees for each rotation. The last button denotes the angle of rotation which is 45 degrees.

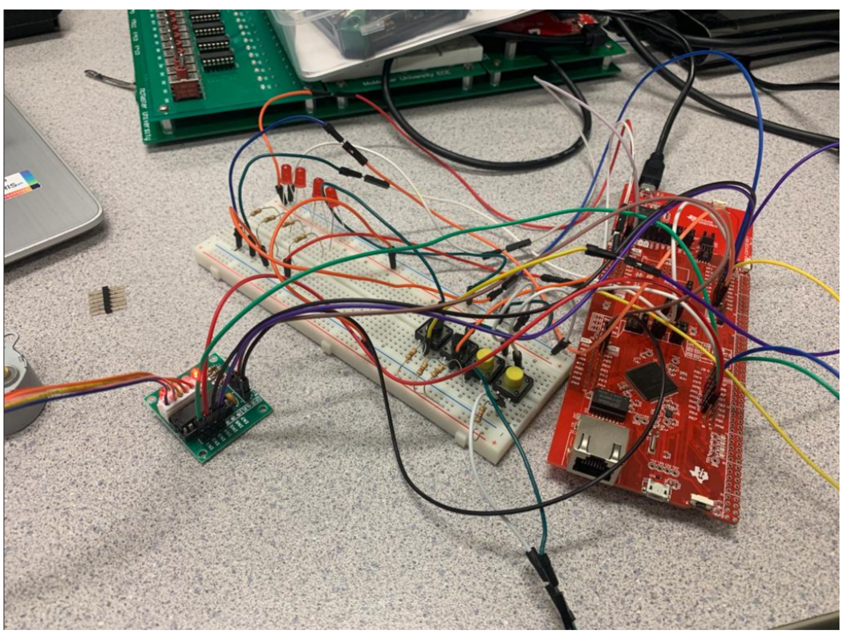

Figure 2: Physical circuit from Lab 6

The above figure gives a clear understanding of the working of four push buttons in Lab 6. Lab 6 was about decoding the input to extract useful information and save the output in memory. This is an essential ability for many applications in electronics and embedded systems.

Debugging Exemplar

An example that was utilized in Lab 5 milestone is determining the functionality of the program. The program should provide us with the hexadecimal input and output of the key pressed in the 4x4 keypad. For this milestone's debugging, we added variables to the code for input and output, then proceeded to the debugging tab and added watchers for those variables, which would provide us with a new hexadecimal value that depends on which key is pressed.

Pressed Key	Binary Key	Input	Output
0	0000	1011	1110
1	0001	0111	0111
2	0010	1011	0111
3	0011	1101	0111
4	0100	0111	1011
5	0101	1011	1011
6	0110	1101	1011
7	0111	0111	1101
8	1000	1011	1101
9	1001	1101	1101
A	1010	1110	0111
B	1011	1110	1011
C	1100	1110	1101
D	1101	1110	1110
*	1110	0111	1110
#	1111	1101	1110

Table 1: Input and Output values based on which key is pressed

Synthesis

Lab 4: Duty Cycle and Pulse Timing

In the milestone of this lab, the aim is to construct a function named IntensitySteps that generates a square wave with a frequency of 100 Hz and a duty cycle that steps from 0% to 100% in 10% increments and then drops from 100% to 0% in 10% decrements. The IntensitySteps function invokes another function called DutyCycle_Percent, which accepts an unsigned integer input specifying the percentage duty-cycle to output. Each duty cycle is repeated ten times in the lab to observe the effect of the duty cycle on the LED. The duty cycle is adjusted by altering the input to the DutyCycle_Percent function. The milestone also necessitates checking the duty cycle of the generated square wave on the AD2's oscilloscope. This milestone is related to the reason theme since it seeks to investigate the effect of altering the duty cycle of a square wave on LED brightness. To construct a function that generates a square wave with variable duty cycles, we must first understand why the duty cycle influences the brightness of the LED. We may obtain a better grasp of how the duty cycle of a square wave can be utilized to control the brightness of the LED by monitoring and researching the effect of different duty cycles on the brightness of the LED. This knowledge can then be used to construct more complex LED control capabilities in future milestones.

Reflection

The reason theme is an important issue in scientific inquiry is that it emphasizes the need for critical thinking and logical reasoning in the search for knowledge. The application of reason in computer labs can be seen in the creation of hypotheses, the planning of experiments, the analysis of data, and the drawing of evidence-based conclusions. Each lab emphasizes the importance of reason and its function in the scientific process. The labs are especially focused on embedded systems and microcontrollers, where logic is critical for low-level hardware control, timing, synchronization, and pin mapping to minimize conflicts with the microcontroller's capabilities. These laboratories are intended to give students hands-on experience with embedded systems and microcontrollers, which are becoming more common in today's environment.

Furthermore, the reason theme is applicable not only in the context of microprocessors but also in a variety of sectors and specific applications. The use of logic aids in the improvement of processes, the optimization of systems, and the enhancement of performance. Manufacturing, healthcare, banking, insurance, construction, agriculture, and energy all require a grasp of logic to accomplish desired results and encourage long-term sustainability. However, in today's society, the proliferation of misinformation poses a big barrier, and fostering accurate and evidence-based reasoning is becoming increasingly crucial. Individuals must be able to discriminate between reliable and misleading information, particularly in sectors such as public health, where disinformation can have serious effects. Promoting critical thinking and evidence-based reasoning abilities is key to addressing this issue.