Microcontroller Systems Project 2DX3
Theme Report - 1 (Observe)

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Theme:

Observe

Background:

Engineering, scientific research, and daily life all depend on observation. In order to acquire information, draw conclusions, and spot patterns, it includes attentively observing and documenting happenings. In order to create accurate models and create intelligent systems, observations must be made utilizing a variety of senses, tools, and technologies. We can gather information, draw conclusions, and create precise models by closely monitoring phenomena, which enables us to comprehend the universe and create intelligent systems. Throughout the labs, we have been observing minute details to carefully understand the working of the microcontroller and how we can use it with Analog Discovery - 2 to control different elements of the lab content, for example, the frequency of a sinusoidal waveform or the working of the clock. These observations not only help to grasp the lab content fully but also increases the general knowledge by introducing those details which are often ignored. From controlling the blinking of the LED on the microcontroller from different ports to graphing signals as a sinusoidal waveform, everything needs accurate and comprehensive observation skills to learn from data, recognize patterns, and make predictions.

For making wise decisions and engaging with the environment in daily life, observation is a crucial skill. To navigate the world and accomplish their objectives, people pay attention to their surroundings, other people's conduct, and the results of their own actions. They utilize their senses and instincts to form opinions and forecasts, and they might also make use of various techniques like cameras, microphones, and sensors to broaden their field of view.

Theme Exemplar:

The observation theme has been used in every lab in many different ways. In Lab 1, I used an observation theme to understand how the blinking of the LED can be controlled from different ports by doing minute changes in the C code. Some of the changes that we made in Lab 1 were changing the Port address and changing the resistor value. By making these changes in the code, it detected and manipulated simple digital signals which controlled the blinking of the LED on the microcontroller. We also used the buttons in this lab. It is very crucial to understand how the momentary switch should be connected to the breadboard and with the pins so that there is no overloading in the circuit. Therefore, depending on my student number, I made sure that I am wiring the switch correctly to light up the correct LED.

In Lab 3, we were supposed to convert a DC signal from Analog to Digital. This also required us to convert the decimal number to a hexadecimal bit. Additionally, to convert the Analog signal to Digital, we needed to graph a sinusoidal waveform. A sinusoidal waveform is a periodic signal that varies with time. To come up with the correct waveform, it is crucial to select a frequency value that ensures that the signal is within the voltage range. The waveform was created using the wavegen software along with Analog Discovery - 2 which was used to design the circuit and connect it to the software. The waveform obtained generated a sinusoid whose voltage was within the range of 0 to 3 V at the assigned frequency.

Debugging Exemplar:

It can be difficult for IDEs to assist in troubleshooting real-time systems since halting an embedded program can change the values that the programmer is trying to analyze (besides, it's not real-time when it's paused) [1]. Although we used different troubleshooting methods for each lab, however, I will illustrate the troubleshooting exemplar that we used in the bonus milestone of Lab 2. The debugging method that was used in the bonus milestone of Lab 2 is the visual feedback from the blinking stage of LEDs. This visual feedback might be useful for troubleshooting the FSM and making sure it is operating properly. We can determine which state the program is in while it is operating by altering the FSM's code to output the current state binary code to the onboard LEDs. The LED output can be used to determine which state the program is stuck in or which transition isn't happening as planned if the FSM isn't working as it should. This can assist in finding and fixing any code issues.

To describe what I did in this method, I assigned a unique code to each state in the Finite State Machine which comprised 3 bits. The code modification was done in such a way that the output of the code is the present state of the LED in the form of binary code. This allowed us to exactly see what state the program is in during the operation. The visual feedback method was used because it provides real-time information about how the system behaves.

Synthesis:

In Lab 1, we did some minor changes in the code to control the blinking of the LED. This relates to the theme as we need knowledge of how the code modification works for different ports in order to control the ON and OFF state of the LED. The code was mainly modified by changing the port address and choosing the required resistor value based on the base address. We need observation skills to understand which resistor value is suitable for a port as well as how it controls the blinking of LED. As illustrated before that we also used a momentary switch in the lab, wiring the momentary switch input to a controller requires using observation skills because if the wiring is incorrect, it will not light up the correct number of LEDs on the microcontroller. This example demonstrates how the observation theme is used to obtain useful information from complex systems such as the C code in this lab.

In Lab 3, we converted analog signals to digital using the Analog-Discovery 2 and the wavegen software. Analog signals can be converted into accurate and dependable digital signals using observation-based methods. We can make sure that the digital signal accurately replicates the analog signal and satisfies our requirements for frequency, amplitude, and phase by attentive monitoring and changing the analog signal and the conversion procedure.

Reflection:

The examples illustrated the value of observation in engineering and scientific inquiry. They demonstrated the precise observation and measurement of phenomena using a variety of senses, tools, and technologies, as well as the utilization of these observations to maximize performance. Lab 1 example emphasizes the value of measurement and observation in software development, particularly in assembly programming where it's critical to comprehend how the code behaves and controls the blinking of LED. It demonstrates how observation-based methods can be used to find and fix coding issues, and enhance program performance. In conclusion, this example helped me better grasp how observation may be utilized to create dependable and effective software using microprocessors and intelligent systems.

Lab 3 example emphasizes the value of observation and measurement in engineering and signal processing. It demonstrates how analog signals can be transformed into digital signals to facilitate processing and analysis, and it demonstrates how carefully monitoring the behavior of the conversion process is necessary for producing precise and dependable digital signals. Overall, I gained a better grasp of how observation may be used to create signals and analyze data utilizing microprocessors and intelligent systems as a result of this instance. Both exemplars also helped me to gain an understanding of the working of intelligent systems such as microprocessors based on how they are built.

References:

[1] S. Athar, T. Doyle, and Y. Haddara, “Computer Engineering 2DX3 2022-2023 Laboratory Manual.” McMaster University Faculty of Engineering, Hamilton, 2023.