PROJECT 6: ANALOG SIGNAL DETECTION AND RAPID RESPONSE SYSTEM

EE 663: Real Time and Embedded Systems

Abstract

A twin platform system based out of QNX purple box and Freescale board. The QNX board detects an analog voltage supplied to it, which is quantized, range checked and then communicated to the Freescale board. The Freescale board receives the data from the QNX, interprets and diagnoses the signal before providing visual indication of the received data on a PWM controlled servo motor.

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1. Problem Statement

Design and implement an embedded, real-time stand-alone system to provide a rough indication of voltage using a servo motor.

Design Constraints

- The signal generator voltage is measured with the A/D converter on the “purple box” using a QNX Neutrino program.
- The voltage of the signal generator must be constrained to -5 volts to +5 volts to protect the Diamond Systems hardware.
- The measured voltage is indicated by driving one servo using your program on the Freescale prototype board.
- Set the signal generator frequency low enough to allow the servo to respond in real-time.
- The sampling frequency of the signal generator must be sufficient to provide smooth operation of the servo.
- A push-button on the Freescale prototype board is used to start the servo motor. No other user interface is required nor permitted.
- The communication mechanism between the two platforms is at your discretion. Please see the instructor if you’d like any suggestions.
- Each platform must provide a visual or audio indication of a fault condition (communication link is down, out-of-range voltage, etc.)

2. Overview

The objective of the project is to sample the continuous analog data from the signal generator, sample and quantize with enough accuracy that signal can be effectively visually indicated on the servo motors. The displacement of the motor is directly proportional to the amplitude of the analog voltage of the signal. The Analog to Digital conversion is performed on the QNX purple box and is strobed periodically by a reconfigurable timer. The sampling frequency of the analog signal depends on the time interval configured for the timer. After the analog conversion has been performed, the data is loaded onto a parallel port, before a strobe signal is generated to indicate that new data is available. The Freescale board detects the strobe signal and then reads the received data in digital IO port and generates a PWM pulse of duty cycle proportional to the received data

3. Areas of Focus

- The hardware interfacing, algorithm and timing was primarily handled by Siddharth Ramkrishnan.
- The software implementation, error diagnosis and monitoring was largely implemented by Vyoma Sharma

4. Analysis / Design

4.1. QNX Operations

- The software waits for signal in PortC [0] to toggle, indicating the triggering of software operation by user pushbutton intervention.
- The A/D converter is triggered to perform A/D conversion, and the status register is polled to detect completion of conversion operation
- Signal plausibility range check is performed and error is indicated if signal is out of range.
- If no error is detected, then the signal is loaded to PortA and a single bit signal is strobed.

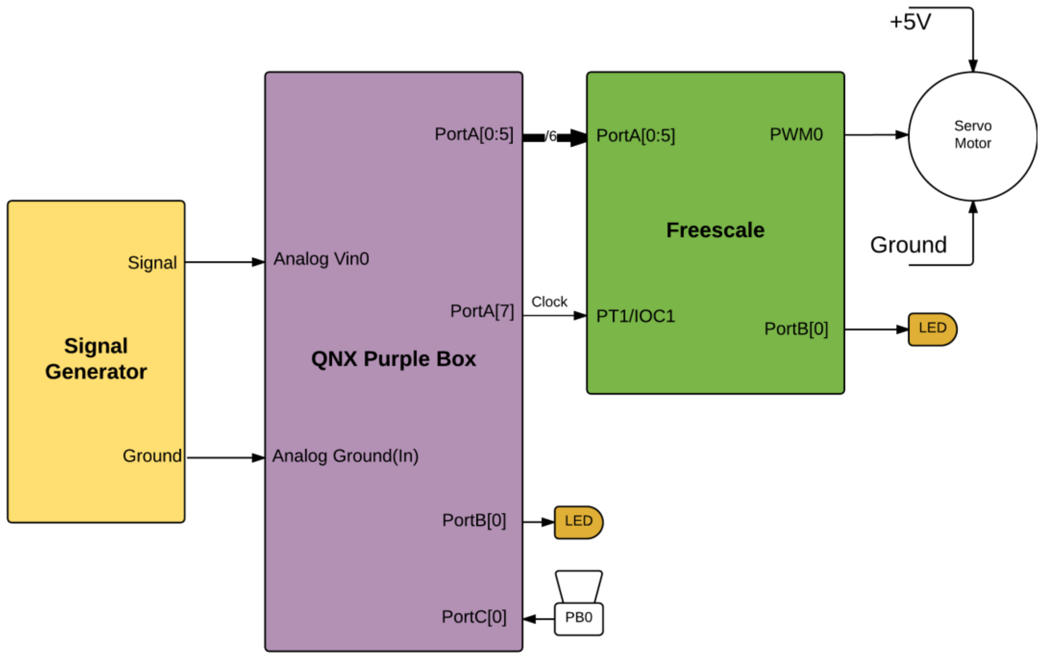

Figure 1. Hardware perspective of System Implementation

4.2. Freescale Operations

- The strobe signal is mapped to an interrupt (PT1/IOC1), which starts operation when a signal is received.
- The digital data is read and range checked, and error is set
- If the signal is within valid range, then duty cycle corresponding to the received digital data is generated.

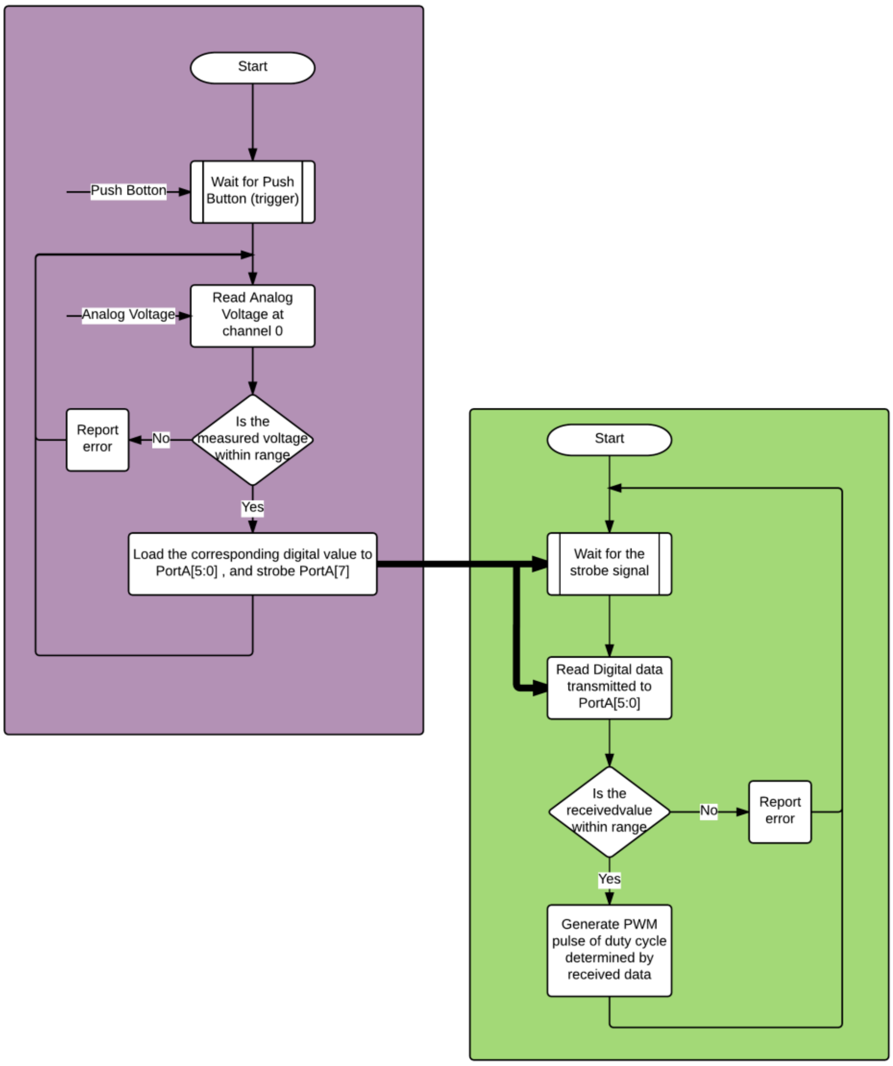

Figure 2. Algorithm for System Implementation

5. Test Plan

- Servo speed had to be checked against signal frequency
- The system is tested for different amplitude voltages and different signal patterns (sine, triangle and square) pulse pattern.
- Signal Amplitude is increased to trigger signal out of range error in the QNX system.
- Short Circuit to battery error is simulated on the communication lines to trigger plausibility error in Freescale system

6. Project Output / Results

The system operation was verified for different frequencies and amplitudes. The movement of the servo was indicative of the signal pattern selected and the amplitude of the generated signal. It was seen that the speed of the servo was modified with variations in signal frequency. The out of range voltage signal was designed to be +4.8 V to -4.8 V. The plausible digital data was designed to be between 0 to 32. PortA [5] was used to verify is signal plausibility error was present.

7. Lessons Learned

- Importance of communication synchronization in multi-platform systems.
- Impact of sampling frequency on the quality and reproducibility of the system
- Role of communication protocol on the system operation speeds. Different communication methods were experimented (unsuccessfully) and parallel clocked communication was adapted for ease of operation and simplified implementation

8. Conclusion

The system operation was verified for different frequencies and amplitudes. The movement of the servo was indicative of the signal pattern selected and the amplitude of the generated signal. It was seen that the speed of the servo was modified with variations in signal frequency. The speed of movement was indicative of the signal frequency and the type of signal.