NANYANG TECHNOLOGICAL UNIVERSITY

MA4830 : Software for Realtime Mechatronic System

CA Assignment - Signal Generator Program

The documnet serves to guide you through the process of accomplishing the tasks associated with the CA and in the submission of your report. The asignments are an integral component of the MA4830 course, both in terms of making the learning more meaningful and serves as to support as an ongoing continuous assessment exercise. The CAs contributte to course grades (40%).

Complete the following basic assignment in preparation for the topics that will be covered during the second half of the semester (RT issues).

A Cookbook Approach to Programming for the CA ....

Function 1 : Sine Wave Generator
The D/A port has a 16-bit resolution. It is programmed by a write to 16-bit port registers which configes the output range and voltage.

Write a short program to generate a sine wave,

- Using the "**sin**" function, calculate & print the sine of zero to 2π in 100 steps.
  - Is this sufficient or too many points?
  - What determines a reasonable number of points?
  - Print the values onto the screen, to help in degugging your code.
  - Scale data to a range of 0x0000 to 0xffff (16 bit resolution).
  - Mid range is 0x7fff

Note: The sine function has a range of -1 to +1 and needs to be scaled from 0x00 to 0xffff for a unipolar output range.

- *Connect the D/A output to an oscilloscope*
  - *Send data to D/A port*
  - *Observe the data on oscilloscope.*
- *Can you determine a method to change the output frequency?*
  - *Introduce a delay between points!*
  - *Correlate between delay & frequency.*
- *Can you change the amplitude and/or frequency?*
- *Would it be better with fewer points?*
  - *Try fewer points and lower resolution*

Attempt to produce a function thet can produce a continuous waveform with the ability to change frequency, mean and amplitude.

Function 2 : Convert function to output other waveforms.

- Write equivalent functions for square and triangular waveforms.
- Enhance the previous function to allow a choice of waveforms.

The Square wave has only two levels, 0x0000 for half of the cycle and a maximum value (0xffff) for the second half. The Triangular wave increases from 0 to 0xffff for the first half of the cycle and decreases to 0x0000 for the second half of the cycle. The Sawtooth wave ramps up from 0x0000 to 0xffff for one full cycle and repeats again for the next cycle.

Function 3 : Command line arguments

- Refer to your lecture notes on the processing of command line arguments.
- Modify the simple program to extract 'triangular', 'sawtooth', 'square', and 'sine'
- Incorporate into your first program to allow a choice of waveforms, at command line.
- Try multi parameter passing: type of waveform, frequency, amplitude etc.
- Check the values submitted at the command line for range correctness.

Function 4 : Additional Inputs

- **Use the A/D input to change the amplitude of your waveform**
  Read in the value and use it to scale the amplitude of the waveform
- **Use the digital port as an alternative to terminating your program (instead of ctrl-C).**
  Read in digital port pattern and exit if pattern changes.

Function 4 : Consider the use of the file I/O

- *Read a potentiometer port and write out the data to disk. Output this pattern to D/A*
- *Whilst the data is being read provide an illustration on the Oscilloscope.*

Intergration of Basic Functionality (Incorporating Realtime Programming features)

The above problems may have been developed using a simple sequential structure and running on one program (Single process with ONE thread). More advance realtime techniques have been presented, in your lectures on RTOS, by week #7/8. Your next objective is to restructure your program to utilize the RT techniques.

Realtime Techniques: Multi-Process and Multi-Threads

- Modify the above program to be comprise of two or more processes/ threads
  - One 'ask' could handles user I/O
  - Other 'tasks' handles DAC, ADC, DIO and file I/O services
- The program should run till terminated, by user, in a controlled manner.
  - Either from the terminal or switch.
  - The terminal would need to reflect board status
- The communication between processes may be realized by the MsgSend, MsgReceive, MsgReply mechanism or pipes.
- Threads can communicate using global parameters and coordinated using "Mutex".
- All threads and processes should be created by executing only ONE program.

Submission dateline: Friday, 22rd of November 2019

General CA Submission Requirements

- Group Size: 4-6 persons
- Group Submission - submits one program with an accompanying short report
- Source program, compiled program and report in soft and hardcopies.
  - Programs needs comments
- Formal Report with professional presentation

Report Structure

1. Name of members and a group photograph identifying individual members
2. Description of the program and its use
3. Remarks on any positive attributes of your program and its uniqueness
4. Commented listing and flowchart
5. Provide pictures showing screen shots are appropriate.