SFWRENG 3K04: Software Development

Assignment 1 – Part 3

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October 27, 2019

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# Likely Requirement Changes

* Utilizing features on the microcontroller (shield) such as the accelerometer to design a rate-adaptive pacemaker
* Measure impedance using the circuit on the microcontroller for considering muscle resistance as the time progresses
* Collaborating with the DCM interface using serial communication
* Improve the pacing efficiency to conserve battery life

# Likely Design Decision Changes

* Separate mathematical calculations into subsystems
* Use a solid LED to show when the hardware is connected to the DCM
* Rename any internal variables used in calculation to the format *k\_name*
  + This will separate variables programmed by the DCM and variables used in calculations

# Hardware Hiding Modulation

The Hardware Hiding subsystem allows for decomposition into modular structure. This separate subsystem allows for independent debugging and hardware-replacement, if required. The system consists of operations, inputs and outputs which may be modified without disturbing the performance of the FSM subsystem in Simulink.

# Pin Mapping

Variables in the Pacemaker FSM use the pins on the microcontroller to read or write certain values at designated pins.

## Inputs to the Hardware Hiding Subsystem

The connection between the Pacemaker FSM and Hardware Hiding subsystems is given below. The FSM feeds information to the microcontroller (and shield) to be written to the specified pins:

|  |  |  |
| --- | --- | --- |
| Controlled Variable of Pacemaker FSM Subsystem | Pin Number | Description |
| c\_atrPaceCtrl | D8 | Acts as a switch between C22 and the chamber. Turn ON to allow for pacing in atrium. |
| c\_ventPaceCtrl | D9 | Acts as a switch between C22 and the chamber. Turn ON to allow for pacing in ventricular. |
| c\_pacingRefPWM | D5 | Main power supply to the primary capacitor (C22). The value is an integer between 0-100 and represents the duty cycle. |
| c\_paceChargeCtrl | D2 | Connects the power supply with C22 capacitor |
| c\_paceGNDCtrl | D10 | Permits charging/discharging of the blocking capacitor (acts as a switch). |
| c\_atrGNDCtrl | D11 | Enables GND terminal in the atrium chamber to drain unwanted charge. |
| c\_ventGNDCtrl | D12 | Enables GND terminal in the ventricle chamber to drain unwanted charge. |
| c\_zAtrCtrl | D4 | Used to monitor the impedance of the atrium chamber. Impedance can be measured at Z\_signal pin A2 (analog pin). |
| c\_zVentCtrl | D7 | Used to monitor the impedance of the ventricle chamber. Impedance can be measured at Z\_signal pin A2 (analog pin). |
| c\_frontEndCtrl | D13 | Deployed in activating the sensing modes. This variable stays OFF unless sensing of the heartbeat is required. |
| c\_atrCMPRefPWM | D6 | Used to set a threshold voltage for sensing in the atrium chamber. The value is an integer between 0-100 and represents the duty cycle. |
| c\_ventCMPRefPWM | D3 | Used to set a threshold voltage for sensing in the ventricle chamber. The value is an integer between 0-100 and represents the duty cycle. |
| c\_blueLED | Blue LED | Received as a Boolean and blue LED is turned ON for an instant when the FSM goes through the atrium pacing state. |
| c\_redLED | Red LED | Received as a Boolean and red LED is turned ON for an instant when the FSM goes through the ventricle pacing state. |

## Outputs from the Hardware Hiding Subsystem

The connection between the Pacemaker FSM and Hardware Hiding subsystems is given below. Data is read from the specified pins and is sent to the Pacemaker FSM as input.

Any variables that do not have a pin number are parameters that are to be read from the DCM module at a latter point in time. Currently, these variables are statically defined in the hardware hiding subsystem for testing purposes.

|  |  |  |
| --- | --- | --- |
| Outputs | Pin Number | Description |
| p\_pacingMode | - | A constant value is assigned to select one of the four implemented modes.  0 – AOO  1 – VOO  2 – AAI  3 – VVI |
| p\_atrPulseAmplitude | - | Calculates the amplitude for the atrium chamber pulse by controlling the duty cycle.  e.g. the divide block is used to calculate duty cycle: |
| p\_ventPulseAmplitude | - | Calculates the amplitude for the ventricle chamber pulse by controlling the duty cycle.  e.g. the divide block is used to calculate duty cycle: |
| p\_atrPaceDelay | - | Combination of division and multiplication blocks are utilized to compute the delay time after an atrium pace. The block-operations are explained below:  To achieve a heart rate of 60 beats/min, the heart needs to pulse once every second.  1000 ms/beat = total time allocated for a beat;  1000 – 2 = 998 ms/beat (subtract the atrium pulse-width time) |

|  |  |  |
| --- | --- | --- |
| Outputs | Pin Number | Description |
| p\_atrPulseWidth | - | A constant value which determines the atrium pulse width. Set for 2 milli-seconds. |
| p\_ventPaceDelay | - | Combination of division and multiplication blocks are utilized to compute the delay time after a ventricle pace. The block-operations are explained below:  To achieve a heart rate of 60 beats/min, the heart needs to pulse once every second.  1000 ms/beat = total time allocated for a beat;  1000 – 2 = 998 ms/beat (subtract the ventricle pulse-width time) |
| p\_ventPulseWidth | - | A constant value which determines the ventricle pulse width. Set for 2 milli-seconds. |
| m\_atrCMPDetect | D0 | Compares the natural signal with the threshold value and sets ON if signal is higher than threshold |
| m\_ventCMPDetect | D1 | Compares the natural signal with the threshold value and sets ON if signal is higher than threshold |
| p\_atrThreshold | - | A constant value of 80, which describes 80% of 3.3V i.e., 0.8 \* 3.3 = 2.64V |
| p\_ventThreshold | - | A constant value of 80, which describes 80% of 3.3V i.e., 0.8 \* 3.3 = 2.64V |
| m\_pushButton | SW2 | Sends a signal to the FSM when the push button on the board is pressed |
| p\_arpDelay | - | Stores the value of the atrium refractory period. Currently, programmed to 250ms |
| p\_vrpDelay | - | Stores the value of the ventricle refractory period. Currently, programmed to 250ms |