Proposal for Project Option 2: Heart Monitor

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Project Topic

An embedded system consisting of the Black Pill (STM32F103C8) microcontroller and the AD8232 electrocardiogram (ECG) is implemented. The system is driven by a PC application running over python. The PC connects to the microcontroller via the USART serial interface. The microcontroller takes in the ECG analog input and processes it using the on-board ADC.

There are three types of commands that can be sent from the PC application to the microcontroller. The first is to request a data stream of ECG samples for one minute. The sampling rate for this command is set via a separate sampling rate command. The third command returns the current heart rate (in beats per minute, or bpm).

Project Architecture

Figure 1 is the current proposed architecture of the system.

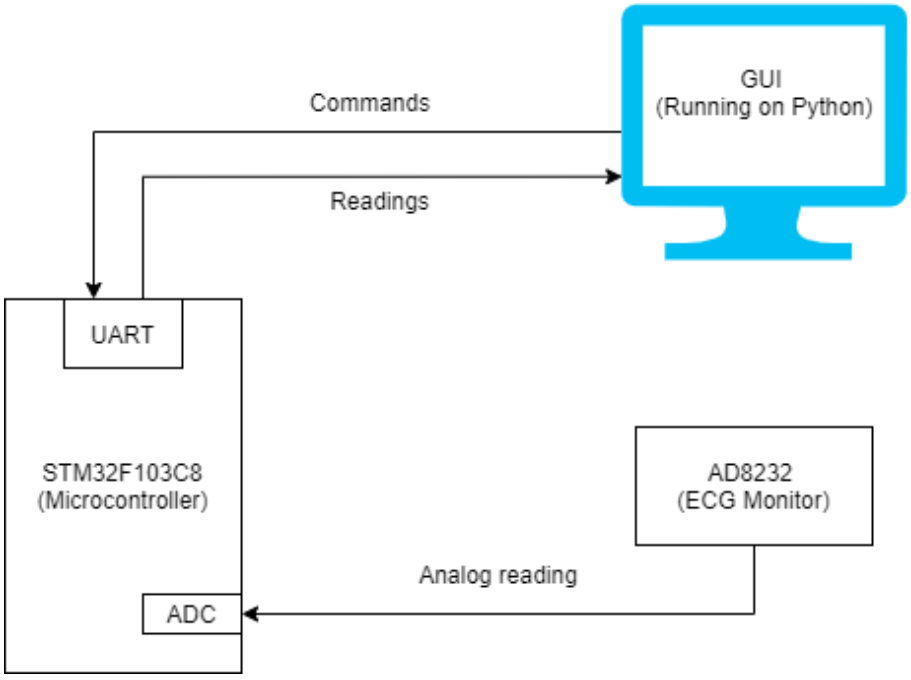

Figure 1: System Architecture

Plan

There are two main development steps: developing the PC Application and programming the microcontroller.

For the PC application, I plan to use Python with the tkinter GUI library to display two windows: a connection window for the end user to choose the serial port and baud rate, and a main window where the user can issue commands and see results. Serial connection will be using pySerial. Plotting will be using matplotlib.

For the microcontroller, the initial step would be to configure the UART to communicate with the PC app. Next, the ADC will be configured using a general-purpose timer. The timer would be configurable by incoming serial commands adjusting the sampling rate. Upon receiving a command of reporting for 1 minute, the microcontroller will convert and report serially analog data using the specified sampling rate. Finally, the heart-rate command will be satisfied via sending 5 seconds of data to the PC app, which will compute the average heart rate from the given data.

Current Progress

The Python app initial screen is completed and tested. It can open serial connections with any microcontroller via UART and communicate with it. Only the skeleton of the second screen is completed (a blank screen with three buttons issuing the commands). The continuous plotting is yet to be implemented. The protocol for sending commands is completed.

The ADC is configured, but the execution of the three commands is yet to be implemented. The hardware architecture is finalized and tested.

Next Steps

For development purposes, I plan to simulate ECG output using python on the PC app while developing its end. This is because it is inconvenient to develop using real time data from the ECG as it requires tricky placement on a patient's body, which is not easily available during development.

With that completed, I will complete the PC app side, including the continuous plotting and bpm calculation using 5 seconds of data. Next, I will configure the microcontroller timer to initiate conversion, transmit results on completion, and to accept sampling rate commands. Finally, I will configure the 1-minute and heart rate commands by converting and transmitting 60 seconds and 5 seconds of readings, respectively.