Process of Device Communication and Hardware-Software Integration

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Background

Currently, children affected by lower-limb disabilities such as Cerebral Palsy, Spinal Cord Injury, and Spina Bifida are an underrepresented population in robotics research, and a lightweight exoskeleton designed to help them establish mobility would significantly improve their quality of life.

Fig. 1: Pediatric exoskeleton with individual joint level sensors for proper condition indications. [1]

Methodology

Developing a modular, lightweight exoskeleton that will enhance the level of pediatric rehabilitation requires state machine embedded code to:

1. Emulate the transitions of gait patterns (sit, stand, walk, etc.)
2. Respond to user commands and intent
3. Communicate between devices
4. Establish error handling sequences.

Design and Approach

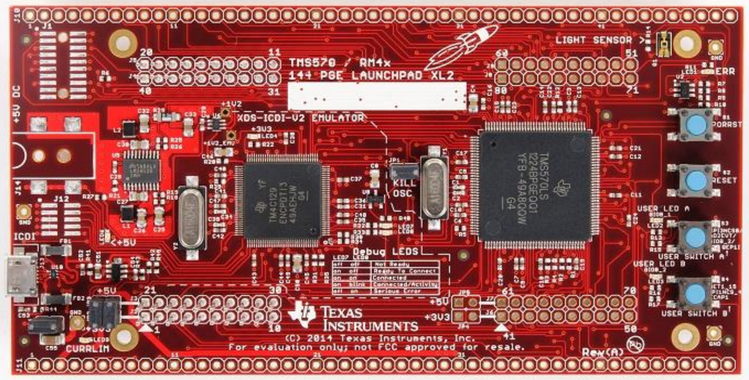
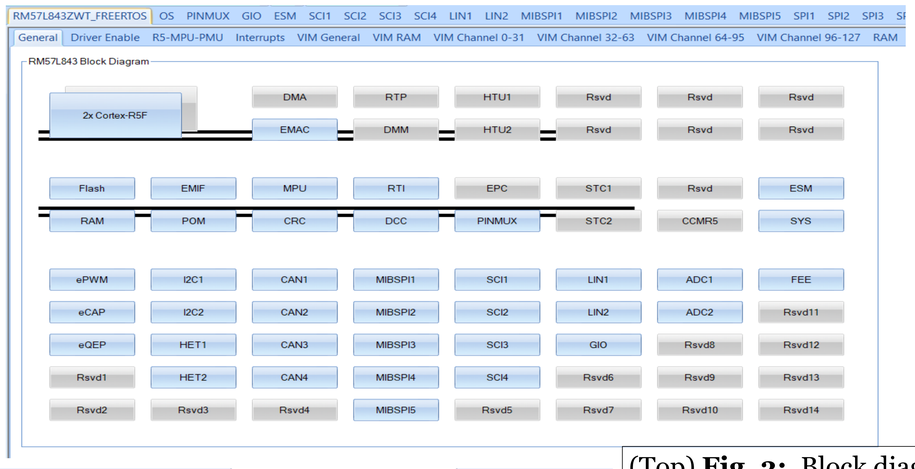
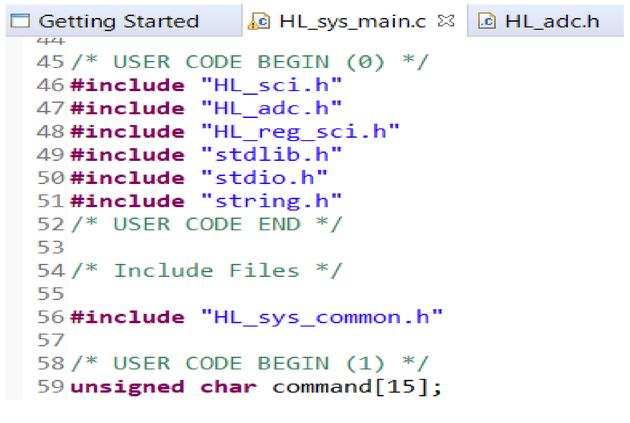


Fig. 2 Main high-level Hercules TMS570LS31 controller that drives state and error handling sequences, joint movements, and user interface communication. [2]

Steps to Develop Device Communication

1. Open microcontroller pin ports communication via HALCoGen
2. Develop C functions to be called to for different transition states via Code Composer Studio and Visual Studio Code
3. Create state machine script to incorporate different gait pattern transitions and produce visual and audial feedback with the sensors





```
45 /* USER CODE BEGIN (0) */
46 #include "HL_sci.h"
47 #include "HL_adc.h"
48 #include "HL_reg_sci.h"
49 #include "stdlib.h"
50 #include "stdio.h"
51 #include "string.h"
52 /* USER CODE END */
53
54 /* Include Files */
55
56 #include "HL_sys_common.h"
57
58 /* USER CODE BEGIN (1) */
59 unsigned char command[15];
```

(Top) **Fig. 3:** Block diagram of port configuration options for the main microcontroller that are used to establish communication with each port and pin on the microcontroller.

(Left) **Fig. 4: S**ample of files generated by HALCoGen that are referenced and coded to trigger external sensors using embedded state machine functions.

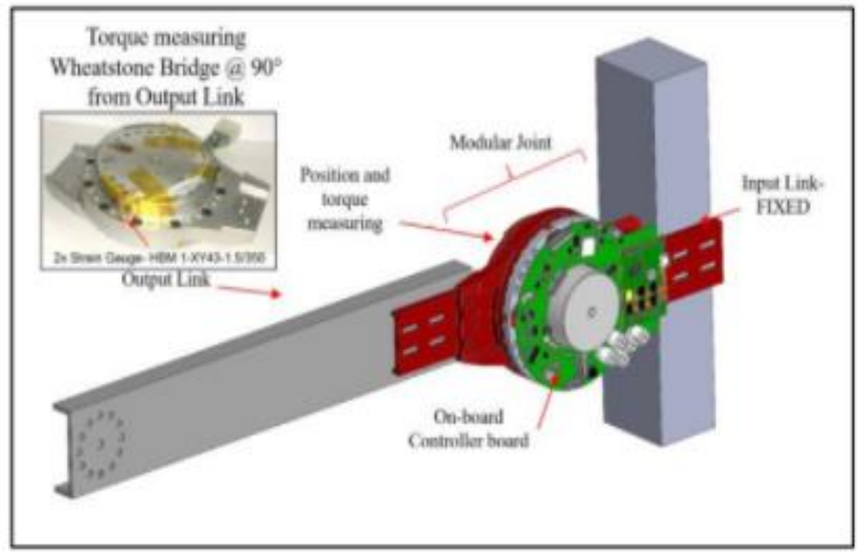


Fig. 5: Modular joint model to be regulated by main controller through embedded trajectories and CAN communication.[1]

Conclusions and Future Work

The next stage of this process would be to:

1. Establish CAN Bus communication from main controller to individual joints
2. Incorporate more versatile and predictive code for extraneous situations
3. Designing and producing a PCB that allows power flow to all individual sensors

References

[1] Eguren, David, et al. "Design of a customizable, modular pediatric exoskeleton for rehabilitation and mobility." *2019 IEEE International Conference on Systems, Man and Cybernetics (SMC)*. IEEE, 2019.
[2] https://www.ti.com/tool/LAUNCHXL2-TMS57012

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