Embedded Development for Spaceflight Radiation Detectors

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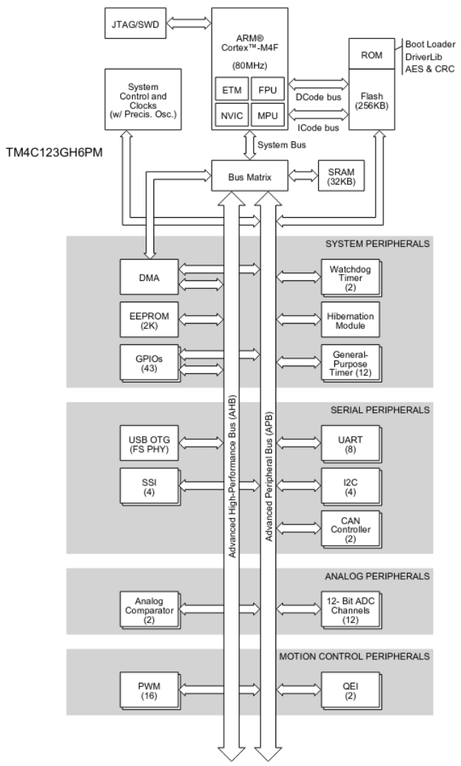
Abstract

Understanding the radiation environment inside a spacecraft is essential for safe long-term human occupation of space. Currently, detectors capable of tracking the highly energetic, massive particles encountered in cosmic rays are designed for ground-based operation, and present data in ways optimized for analysis by researchers. In this poster, efforts are showcased to develop an iOS-based interface with ADVACAM's Timepix detectors that allows for easy and user-friendly presentation of key information of medical interest, without compromising the quality of data gathered. Specifically, the resolution of challenges faced in embedded development of a communications channel between the Timepix output and Apple's proprietary iAP2 protocol are detailed. The development targets Texas Instruments Tiva C microcontrollers based on the ARM Cortex M4 architecture, and implements I2C, USB, and UART communication. Also presented is work on user interface design and low-bandwidth remote data transfer over iCloud, the integration of which is a major advantage of the design.

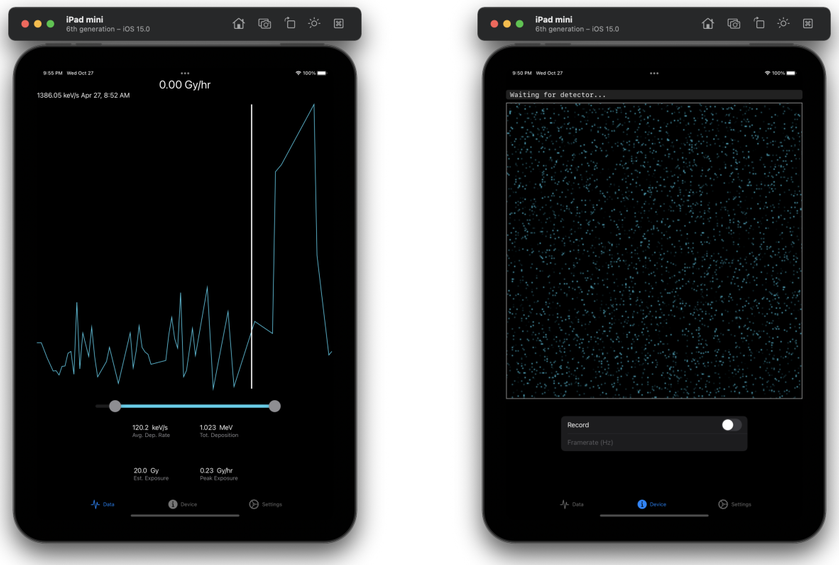
The TM4C123

Ample timers, peripherals, clock modes, and bytes of flash memory led us to choose this implementation.



Ergz iPad Application

The new iPad mini, with a 96 W output rating, gets around the peak current problems with all other Apple devices and enables untethered operation. The interface allows quick reading of several relevant medical factors: instantaneous dose rate, total dose over selected time range, average dose rate over selected time range, and peak instantaneous dose.



(a) Medical Information

(b) Detector Information

iCloud Integration

Ergz is able to back up its recorded data to the Apple iCloud. This enables remote interaction with data as it's collected. As an example of the value that provides, the following zsh script skeleton could be used on a stationary Mac server to produce a Web-exposed directory that can, for example, be accessed on-demand by higher caliber analysis tools such as CERN ROOT.

```
#!/bin/zsh

# Run this every 30min on a cron daemon.

cd ~/Library/Mobile Documents/com~apple~CloudDocs/

rsync -ta *.csv path/to/Web/dir/.
```

Approximation Graphs

Conclusion

The method presented are for first-order differential equations; however, this method can be applied to a variety of problems, including systems of nonlinear ordinary differential equations and nonlinear partial differential equations. Although the arguments presented here are heuristic, in the future we will investigate some appropriate conditions under which these results can be proven rigorously.

Acknowledgments

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References

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