Custom VLSI Motor Controller

Researchers at the Computer-Integrated Surgical Systems and Technology (CISST) ERC are developing a custom VLSI motor controller that enables embedded control of high dexterity precision medical robots with demanding real-time performance and safety requirements. The initial motivation for this development was to control a small snake-like robot for laryngeal surgery, but the chip would be useful for other projects as well.

The motor controller (Fig. 1) is designed to provide accurate position, velocity, and torque feedbacks (at both high and low motor speeds) to enable precise control of small motors in space-constrained applications. When combined with a few external components, such as a power op amp and current sense resistor, it provides linear control of brush DC motors, with a high-speed serial interface to an external microprocessor (Fig. 2).

The chip provides the following features:

- Integrated design that supports brush DC motors with encoder and potentiometer feedback.
- Software-selectable control of torque or speed; speed control includes feedback of motor armature voltage to maintain desired speed under different load conditions.
- High-resolution measurement of motor current, even when the full scale is only 100 mA.
- Redundant position sensing (encoder, potentiometer) for improved safety
- Accurate estimate of motor velocity from incremental encoder feedback (Fig.2)
- In-built adaptation ensures that robotic interaction forces, as well as environmental forces, are accounted for in real time.
- Integrated design enables motor control in extremely small footprint, allowing hardware to be embedded inside multi-axis robot systems.
- The hardware is adaptive and reconfigurable with capabilities to provide broad control platforms for the design of a diverse set of medical robots.

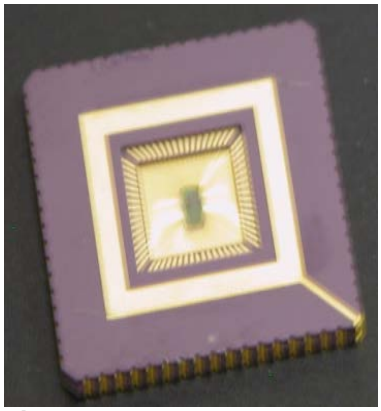

Figure 1: Prototype Motor Controller

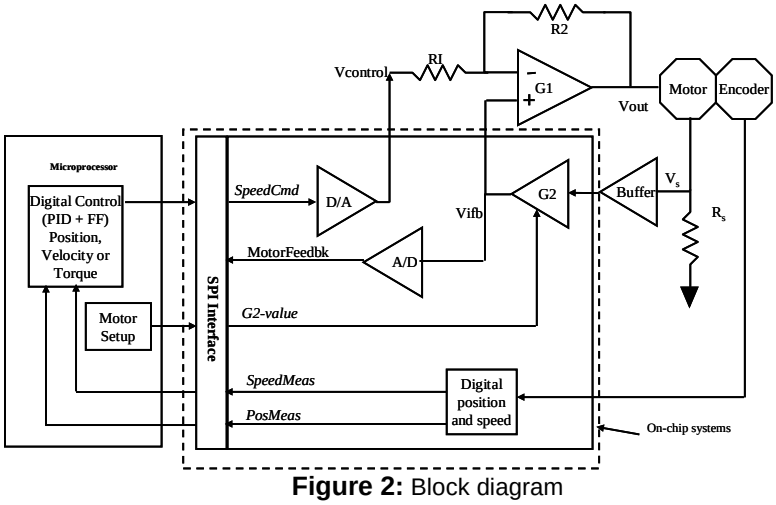

Figure 2: Block diagram