COMPACT ATTITUDE SENSOR SYSTEM USING SR-UKF

SUNFEST 2008

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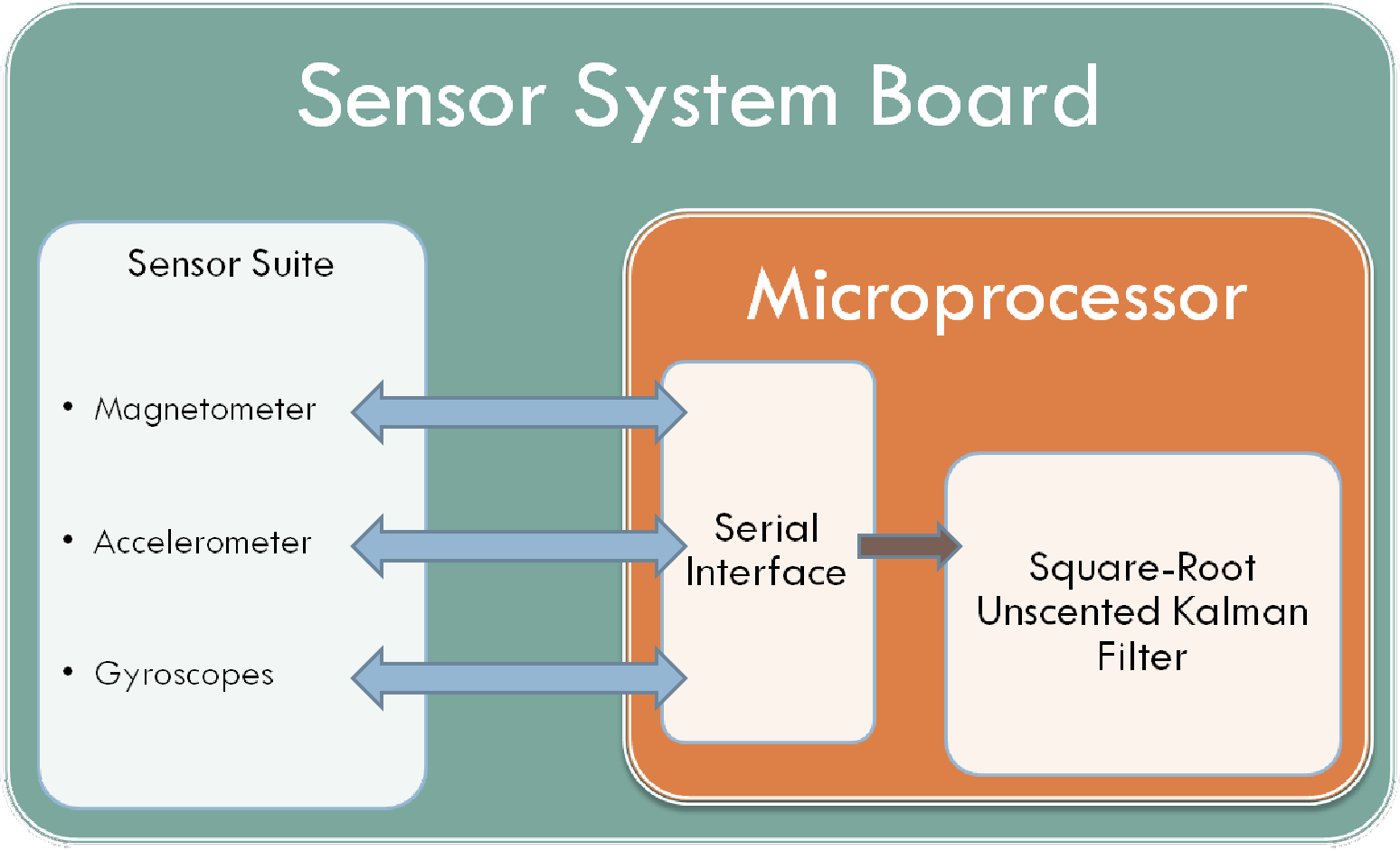
Experimental Flyer Project

- Goal: To create a simple, low-cost, highly maneuverable flyer
- Novel torque generation scheme
- Need for compact, high-speed attitude sensor system

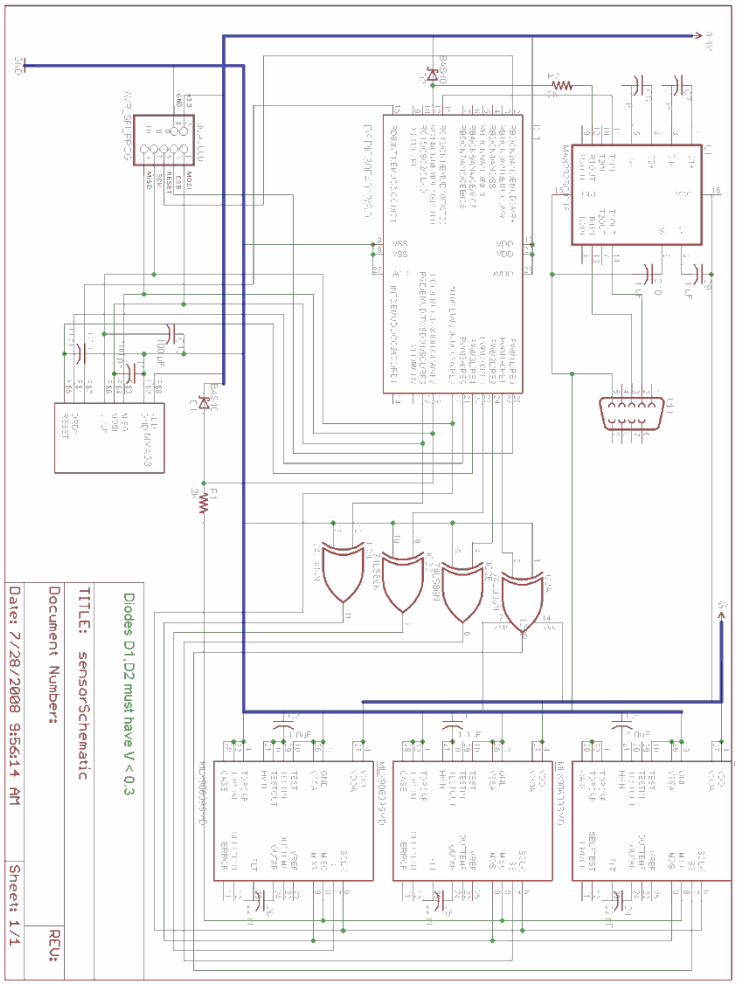
Sensor System Project

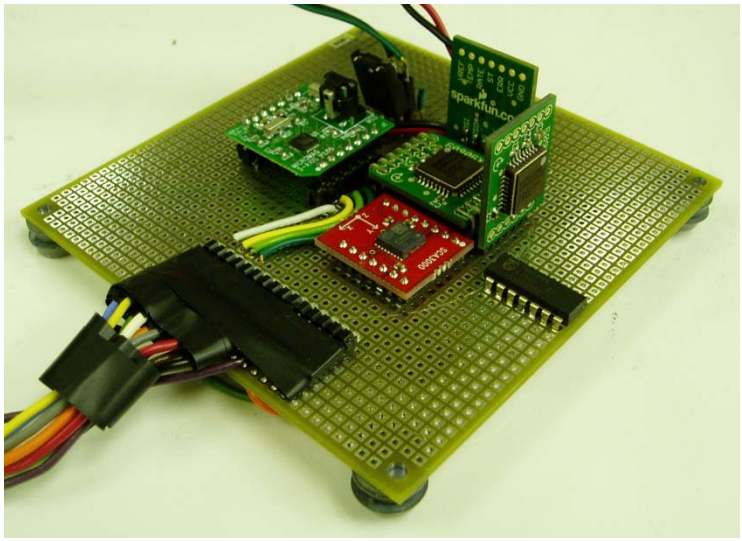


Sensor Selection

- Magnetometer: MicroMag3 (PNI Corporation)
  - 3-axis magneto-inductive sensor
- Accelerometer: SCA3000 (VTI Technologies)
  - 3-axis capacitive deflection sensor
- Gyroscopes: MLX90609 (Melexis Systems)
  - 3 one-axis capacitive Coriolis force sensor

Circuit Design and Implementation

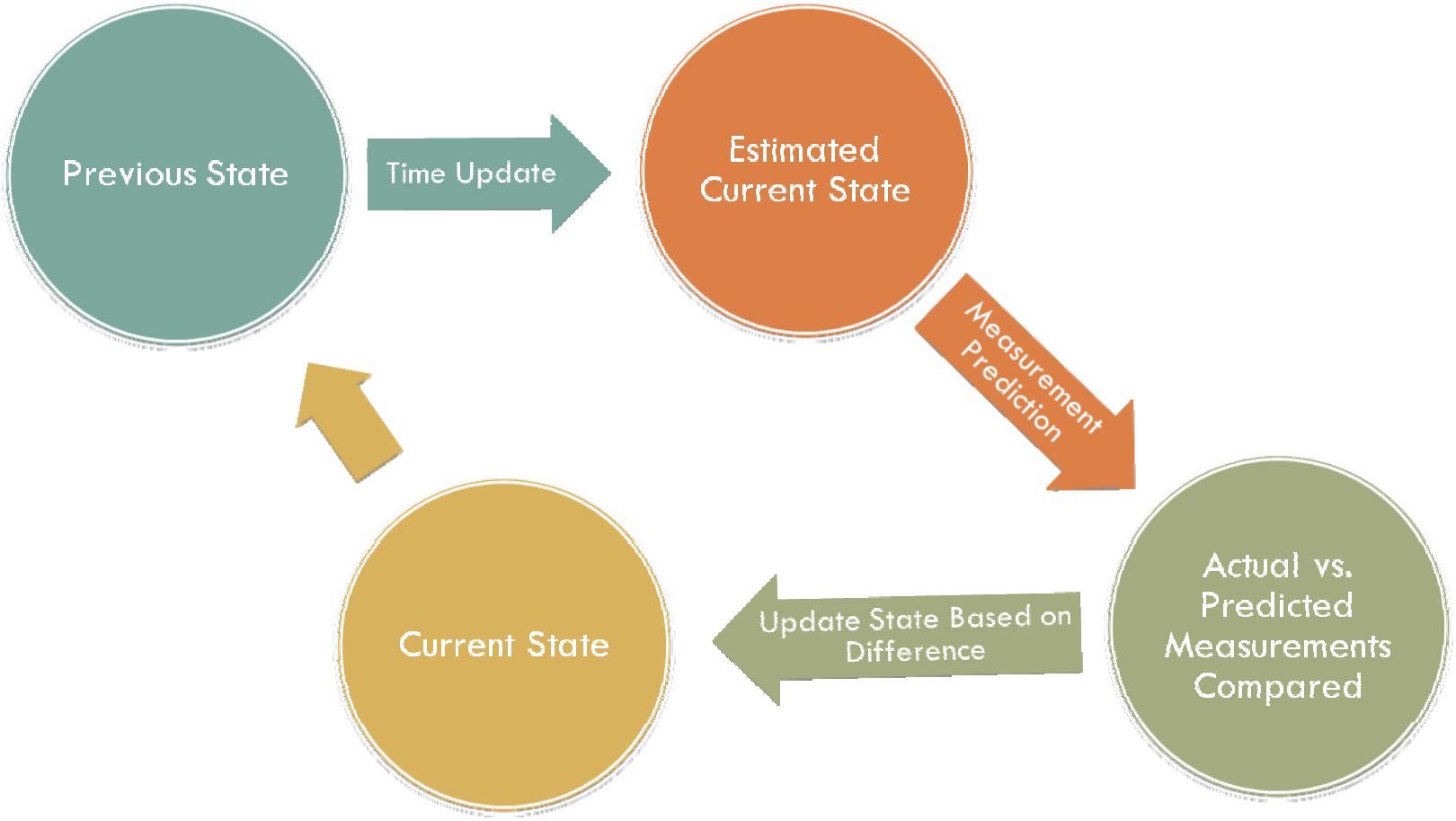




SR-UKF

- Square-Root Unscented Kalman Filter
  - Kalman Filter
    - Tracks a state based on noisy, indirect measurements
  - Unscented Kalman Filter
    - Allows for nonlinear process and measurement models
  - Square-Root Unscented Kalman Filter
    - Mathematical formulation that prevents numerical instability

SR-UKF Cycle


Previous State
Time Update
Estimated Current State
Measurement Prediction
Actual vs. Predicted Measurements Compared
Update State Based on Difference
Current State

MATLAB GUI

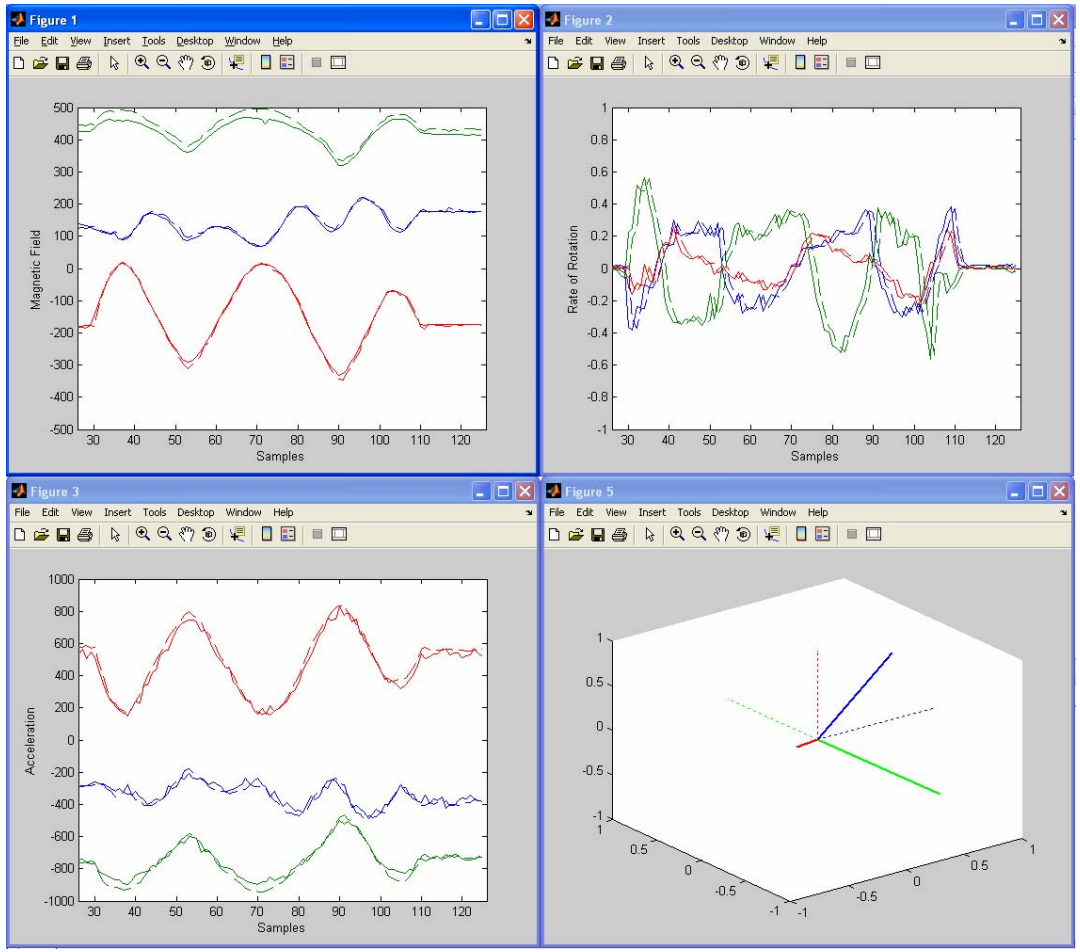
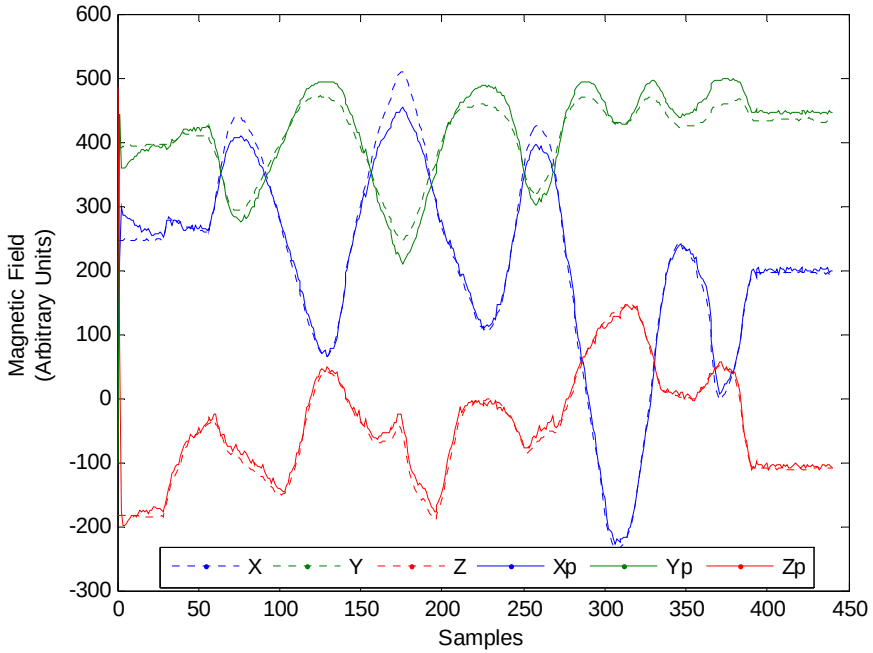


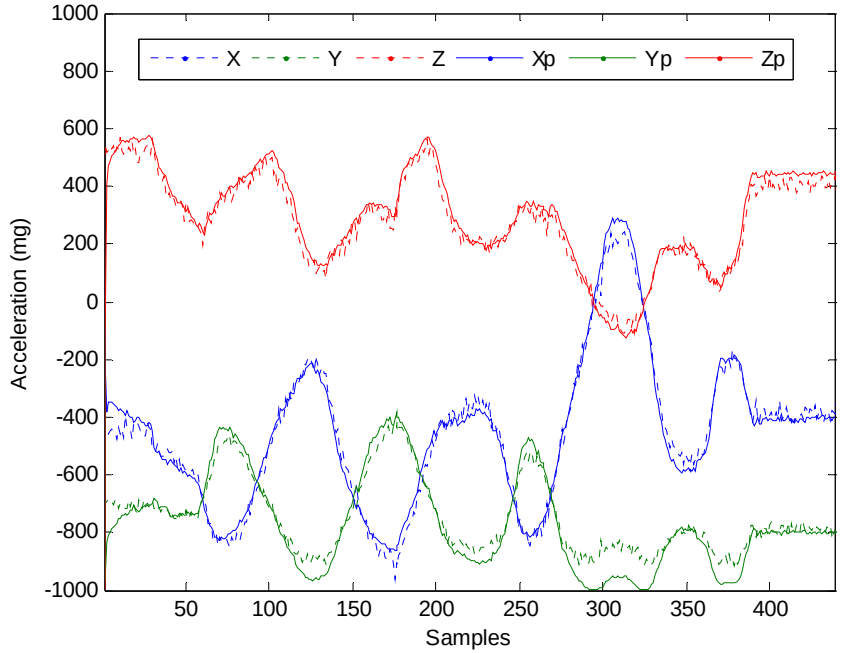
Figure 1
File Edit View Insert Tools Desktop Window Help
Magnetic Field
Samples
Figure 2
File Edit View Insert Tools Desktop Window Help
Rate of Rotation
Samples
Figure 3
File Edit View Insert Tools Desktop Window Help
Acceleration
Samples
Figure 5
File Edit View Insert Tools Desktop Window Help

Actual vs. Predicted Measurements

Magnetometer



Accelerometer



Microcontroller Feasibility Analysis

- MATLAB code converted to C using Embedded MATLAB coder (EMLC)
- Minimum RAM requirements
  - EMLC (no dynamic allocation): 3452 bytes
  - Custom coding with dynamic allocation: 2052 bytes
  - dsPIC30F4012 RAM: 2048 bytes
- Other microcontroller options
  - Questions of processing power

Next Steps

- Implementation on more powerful microprocessor
- Sensor behavior onboard the flyer
  - Magnetic effects from motors
  - Accelerometer reliability during flight
- Adding flyer control system outputs to the time update step of the SR-UKF

Thank You!

Dr. Mark Yim

Bill Mather

Dr. Jan Van der Spiegel and SUNFEST staff

National Science Foundation