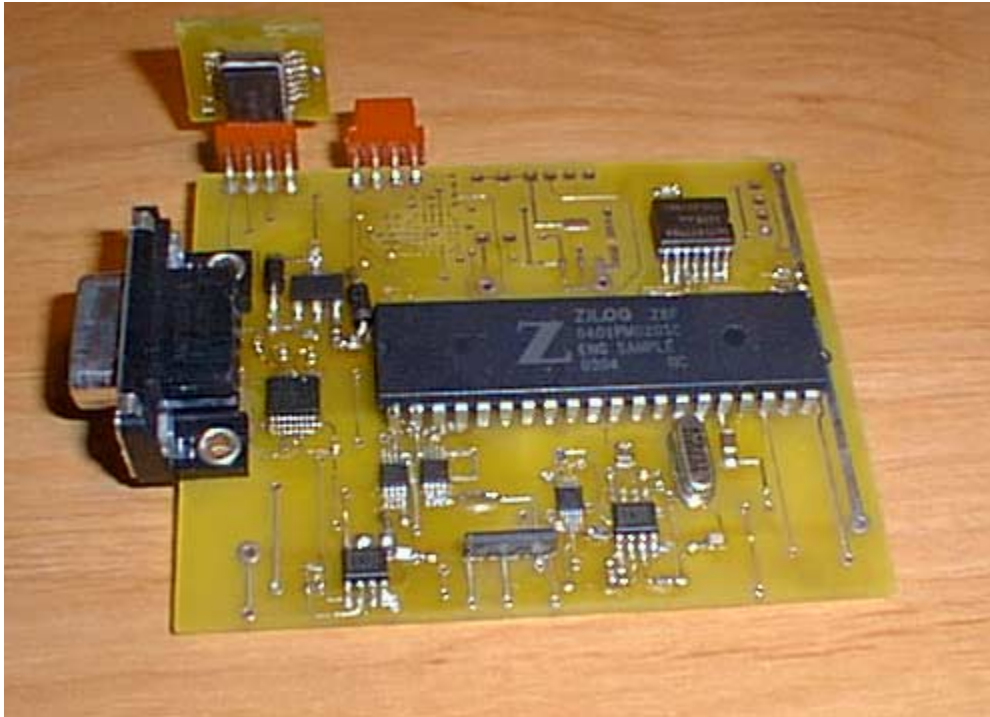


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Z8F6401 Orientation Tracker



Abstract

Thanks to the last decade's recent MEMS technological advances, accelerometers, magnetometers, and gyroscopes have become increasingly smaller, faster, more accurate, and best of all inexpensive. These advances have opened up a wealth of new opportunities for engineers to create cool gadgets like six degree of freedom computer mice, inertial pedometers, virtual reality head trackers, inertial navigation systems for cars and other vehicles, motion-capture suits, and many other motion / rotation sensing applications. This project focused on the simple task of interfacing accelerometers and magnetometers to a Z8F6401 microcontroller. By measuring the direction of the Earth's gravity vector and the Earth's magnetic field relative to the board, it was possible to figure out how the board was oriented globally. The Z8F6401 sent out a serial stream of comma-delimited ASCII data that listed the x,y,z components of the magnetic and gravity vectors, as well as a timestamp for each sample. A simple OpenGL based PC program was created to graph these vectors, calculate Euler angles to describe the rotation, and draw a graphical representation of the board to illustrate how it was moving around.

ADXL202AQC accelerometers from Analog Devices were chosen for this project because of their fast response, low cost, small size, and the fact that they have digital outputs for their sensing axes. They also have separate analog outputs, but three of the eight ADC lines of the Z8F6401 were occupied by the magnetometers, and it was necessary to leave at least four lines open so that three ADXRS300 gyroscope IC's and a temperature sensor (integrated inside

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one of the gyroscopes) could be added at some point in the future. The four accelerometers were connected to port C[3:0] of the Z8F6401, since these pins had the option of enabling edge-detection interrupts for accurate pulse timing. Using one of the Z8F6401's 16-bit timers also offered better data resolution than what could be achieved using the 10-bit ADC.

The output signals from a dual-axis magnetometer (HMC1052) and a single-axis magnetometer (HMC1051Z) were amplified through low voltage op-amps (LMV358) before being connected to the first three lines of the 10-bit analog to digital converter onboard the Z8F6401. Two digital outputs from the Z8F6401 were also used to send "reset" pulses to the magnetometers. These pulses were necessary to re-align the film magnetic domains of the magnetometers.

The Z8F6401 was programmed to execute a simple loop (see sample code below) that checked UART0 for input commands from the host PC, sent reset pulses to the magnetometers and collected the magnetometer and accelerometer data before sending it out UART0. OpenGL graphics software was used to graph the data from the microcontroller and drive a simple graphic representing the orientation of the board in the world coordinate system.

The graphical representation of the board on the host PC rotated accurately in concert with the real board, through the full range of possible 3D rotations. The Z8F6401 Orientation Tracker used a fairly straightforward approach to accomplish this means, and should prove to be a very useful, low-cost sensor for capturing rotational movement.

Software Code Sample

```
/*
*****
**   main function
inputs: none
outputs: 0 (never reached)
remarks: Sets up timers, configures digital I/O lines, sets up the
ADC and UART0. Also outputs an ASCII header out UART0. The while loop
runs continuously checking UART0 for commands from the PC and
executing the necessary functions for getting and outputting sample
data.
*****/
int main() {
    int i=0;
    for (i=0;i<10;i++) inbuffer[i]=0; //initialize input buffer
    setupClocktimers(); //sets up TIMER0 (for sample timestamps) and
                          //TIMER1 (for timing accelerometer data)
    setupDigitalPorts(); //sets up port C[3:0] as digital inputs for the
                          //accelerometers
    setupADC(); //sets up the ADC to use the first 3 channels
                //continuously
    init_uart(_UART0,CLOCK_FREQ,BAUD_RATE); //initializes UART0 at 115.2
                //kbps
}
```

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```
rom_to_data_copy(fmt,projectnumber); //output ASCII header
outputstring(fmt);
rom_to_data_copy(fmt,devicename);
outputstring(fmt);
while (1) {
    check_uart(); //check UART0 to see if any command data has
                //arrived
    if(mode==STREAM_MODE) { //check to see if we should be streaming
                //data
        resetMagnetometers();//send reset pulse to re-align
                //magneto-resistive sensors
        getADCdata(); //get ADC data (i.e. magnetometer data)
        getAcceldata(); //get accelerometer data
        outputData(); //output data to UART0 at 115.2 kbps
    }
}
return 0;
}
```

Block Diagram

