Intelligent Machine Design Lab
Sensor Report

Daedalus Project

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Abstract

To provide vehicle stability on a small aerial vehicle, an inertial measurement unit consisting of gyros and accelerometers is vital. The Daedalus platform accomplishes this using an orientation sensor from MicroStrain that is gyro-stabilized. This report covers the specifications of the 3DM-G unit from MicroStrain and the method of integration to the system.

Introduction

The primary goal of the Daedalus project is to demonstrate autonomous flight and vehicle control of a small four-post flying vehicle. This vehicle configuration is inherently unstable. However, monitoring system dynamics and correcting the actuators using a computing system can achieve stability. Thus it was vital that the Daedalus project include the ability to sense the vehicle's angular rate of motion along all three axes, pitch, roll and yaw. Also important to vehicle control was the ability to sense vehicle accelerations along all three axes.

To achieve these goals, the 3DM-G orientation sensor from MicroStrain was selected. This particular device was picked after efforts to custom design a similar system met with enormous difficulties. The 3DM-G device consists of three single-axis rate gyros, two dual-axis accelerometers and a three-axis magnetometer. The rate gyros are used by the onboard microprocessor unit to stabilize the output data from the device. The stabilized data is accurate to +/- degrees for an arbitrary angular orientation. The rate gyro and accelerometer data is essential to the control system onboard the Daedalus platform while the magnetometer data gives vehicle orientation with respect to the earth's magnetic field. Currently, magnetometer data has been read but not employed. Figure 1 shows a picture of a 3DMG.

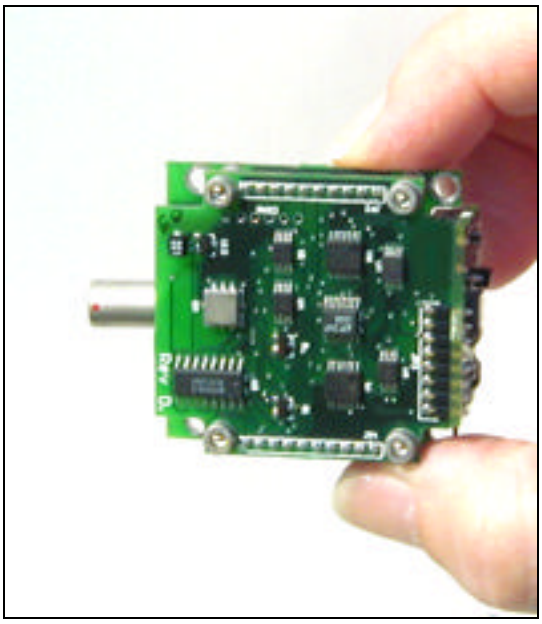

Figure 1 - 3DM-G Package

Communications

Using the 3DM-G is quite simple as it supports RS-232 and RS-485 communication protocols. For the Daedalus project an RS-232 interface was used running at a maximum baud rate of 115,200 bps. Communication with the unit is done through a binary stream. Using the Rabbit RCM3200 processor, character bytes were written to and read from the 3DM-G individually. A small portion of code for the reading and parsing of an Orientation Vector message is shown below:

```
for(i=0;i<23;i++)
{
        while(serBpeek() == -1);
        vectors.input[i] = serBgetc();
}
if(vectors.input[0] != STAB_VECTORS){return -1;}
vectors.MagField[0] = (vectors.input[1]<<8) + vectors.input[2];
vectors.MagField[1] = (vectors.input[3]<<8) + vectors.input[4];
vectors.MagField[2] = (vectors.input[5]<<8) + vectors.input[6];
vectors.Accel[0] = (vectors.input[7]<<8) + vectors.input[8];
vectors.Accel[1] = (vectors.input[9]<<8) + vectors.input[10];
vectors.Accel[2] = (vectors.input[11]<<8) + vectors.input[12];
```

```
vectors.AngRate[0] = (vectors.input[13]<<8) + vectors.input[14];
vectors.AngRate[1] = (vectors.input[15]<<8) + vectors.input[16];
vectors.AngRate[2] = (vectors.input[17]<<8) + vectors.input[18];
vectors.checksum = (vectors.input[21]<<8) + vectors.input[22];
```

Other messages, including orientation matrix and euler angles are available and follow this basic format. The 3DM-G can be run in either polled or continuous mode. Also allowed is a mixed mode of continuous data output with polled responses. Currently the Daedalus system is reading and processing both the velocity vectors and Euler angle message at a rate of approximately 30 Hz each.

Drawbacks and Future Recommendations

The 3DM-G is very powerful for both its price and weight range. However it does offer some drawbacks. First and foremost in a project of this nature is the weight. Advertised as 18 grams outside its plastic enclosure, the 3DM-G actually weighs in at approximately 25g. I believe a large portion of this is due to a rather large and overly robust connector for the system. It is a small 4-pin LEMO style connector with a long metal barrel. The corresponding male connector for this connection weighs a hefty 4 grams, so one can only imagine what the female jack weighs.

The 3DM-G is also expensive, especially in a IMDL project such as this. I was fortunate to have an advisor kind enough to help fund my project and these sensors were being purchased to be used on other projects. The start-up kit with software and a power/data cable is 1295.00 from MicroStrain.

Overall, for this project's needs and financial capability, the 3DM-G provided an ideal solution to my sensor task.