

SOFTWARE FOR ORIENTATION SENSOR CHR6-DM

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Abstract: This article describes software solutions for specific type of orientation sensor which has a factory identification CHR6-DM. On the PCB (Printed Circuit Board) of CHR6-DM are placed chips for providing accelerometer data, gyros rates data and magnetometer data. These data are used for calculation of values for determining the Yaw, Pitch and Roll values. Data from CHR6-DM are processed by the developed software and displayed in main form of software for testing orientation and EMI (ElectroMagnetic Interference). Software will also be used for project of mobile autonomic robotic system.

Keywords: Gyroscope, Accelerometer, Magnetometer, CHR6-DM.

1. INTRODUCTION

The orientation sensor usually contains three types of sensors: gyroscope, accelerometer and magnetometer (compass).

The first of the three sub-sensors is gyroscope which was developed in 1852 by the French scientific Jean Bernard Léon Foucault. He performed the first experimental demonstration of the rotation of the Earth on its axis. This was the first step to orientation sensor - gyroscope. After many years from Foucault's first experiment with gyroscope is now his modern type used for stabilization orbital satellites, navigation for planes, ships, racket etc.

The second one is the accelerometer sensor which is using for measuring acceleration forces. These forces may be static, like the constant force of gravity or they could be dynamic - caused by moving or vibrating the accelerometer.

The third sub-sensor is a magnetometer which is usually used for measuring the strength or direction of a magnetic field either produced in the laboratory or existing in nature.

These three types of sensors are providing specific orientation data which are helpful for navigation objects or for specifying type of the environment around them.

2. SYSTEM CHR6-DM

The CHR-6DM AHRS (Attitude and Heading Reference System) is a cost-effective orientation sensor providing yaw, pitch, and roll angle outputs at up to 300 Hz. An Extended Kalman Filter (EKF) combines data from onboard accelerometers, rate gyros, and magnetic sensors to produce yaw, pitch, and roll angle estimates.

Communication with the CHR-6DM is performed over a TTL (3.3V) UART at 115200 Baud. The AHRS can be configured to transmit raw sensor in addition to angle estimates, and the transmission rate can be configured in 1 Hz increments from 20 Hz to 300 Hz. Alternatively, the CHR-6DM can operate in "silent mode," where data is transmitted only when specific requests are received over the UART. Regardless of the transmission mode and rate, internal angle estimates are maintained at over 500 Hz to ensure long-term accuracy. The CHR-6DM simplifies integration by providing a number of automatic calibration routines, including rate gyro bias calibration, magnetometer hard and soft iron calibration, and accelerometer "zeroing" to compensate for AHRS-platform misalignment. All calibration routines are triggered by sending simple commands over the serial interface.

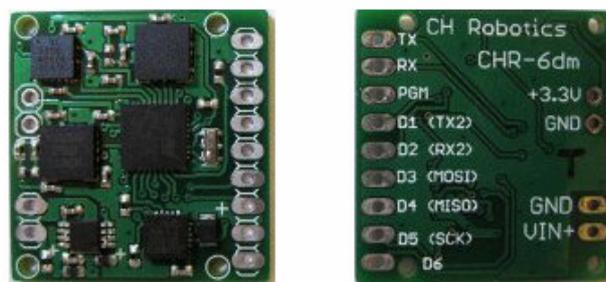


Fig. 1. CHR6-DM orientation sensor

System is used in typical application:

- Robotics
- Platform Stabilization
- Motion Tracking
- Enhanced GPS Navigation
- General Motion Sensing
- Image Stabilization

3. DATA OUTPUT FROM CHR6-DM

The CHR-6DM operates in one of two modes:

- Broadcast Mode - the CHR6-DM automatically transmits sensor data at a user-configurable frequency between 20 Hz and 300 Hz.
- Silent Mode, the CHR6-DM only transmits data when a GET_DATA packet is received over the UART.

The CHR-6dm is set to Broadcast Mode by default. The default transmission frequency is 200 Hz.

The packet which is received in Broadcast Mode contain information from all sensors Fig. 2.. Software processing is used for filtering out the start bit, data sum and other information which are required for data transfer between receiver and transmitter.

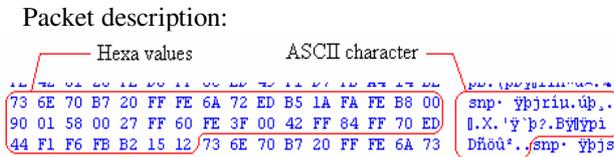


Fig. 2. Packet structure

Each packet received by the CHR6-DM must begin with the three byte sequence "snp" to signal the beginning of a new packet. The fourth byte is Packet Type indicator, which identifies the packet being received. The fifth byte is the number of bytes contained in the data section of the packet. The N-byte data section immediately follows data length byte, and the packet is finally ended with a two byte checksum, which contains the sum of all previous bytes in the packet. The values in Tab.1. are constants for calibration of sensor data which are received from CHR6-DM. Without calibration the system can be unstable.

Channel	Scale factor	Units
Yaw	0.0109863	°/LSB
Pitch	0.0109863	°/LSB
Roll	0.0109863	°/LSB
Yaw rate	0.0137329	°/s/LSB
Pitch rate	0.0137329	°/s/LSB
Roll rate	0.0137329	°/s/LSB
Mag x	0.061035	mGauss/LSB
Mag y	0.061035	mGauss/LSB
Mag z	0.061035	mGauss/LSB
Gyro x	0.01812	°/s/LSB
Gyro y	0.01812	°/s/LSB
Gyro z	0.01812	°/s/LSB
Accel x	0.106812	mg/LSB
Accel y	0.106812	mg/LSB
Accel z	0.106812	mg/LSB

Tab. 1.Data output scale factors

Every value from Channel column have to be multiplied by the constant which is on same row but in column with name Scale factor.

4. SOFTWARE SOLUTION

The software for the CHR6-DM is made in the C# and the entire communication is incorporated to the software

solution. In the start-up menu, by selecting the RS232 port a link between the computer and the USB converter to the RS 232 with a handshake is created. Received values from the orientation sensors are displayed in the text boxes and then plotted to the graphs. Values from CHR6-DM are converted to the decimal values for better understanding. These values are stored in decimal array with size for 10 values. Software uses algorithm for finding same decimal values in the array. This algorithm is used for reduction of errors from measuring CHR6-DM with combination of multiplying by the Tab. 1. (Data output scale factor). After application methods mentioned above the graphs are plotted.

Description of Main form1:

Fig. 3. shows first two graphs (1,2) for displaying values of rotation and rotation rate. The CHR6-DM has three axis of movement. They are known as the YAW, PITCH and ROLL and their values are displayed in first graph. The second graph on same figure is used for rotation rate (Yaw Rate, Pitch Rate and Roll Rate).

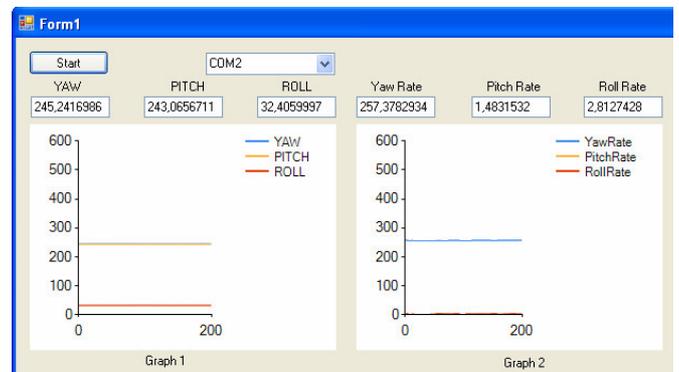


Fig.3. First two graphs in Software for CHR6-DM

Fig. 4. shows second two graphs (3,4) for displaying values from Gyroscope and Accelerometer. Graph 3 - gyroscope shows measuring or maintaining orientation, based on the principles of conservation of angular momentum. Graph 4 – is used for displaying accelerometer data which are measured in three axes.

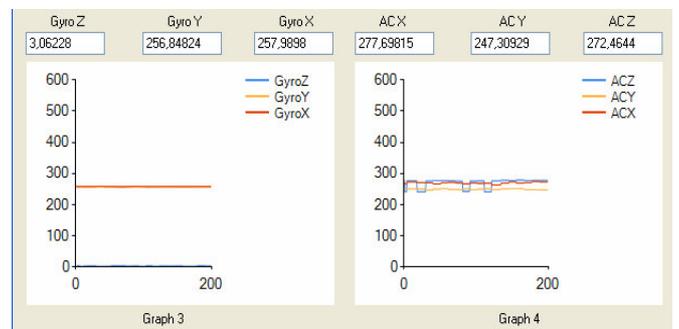


Fig. 4. Second two graphs in Software for CHR6-DM.

Fig. 5. shows last graph with values from Magnetometer and 3D Cube. The cube was used for clearly understanding of movement which is provided by the data from CHR6-DM.

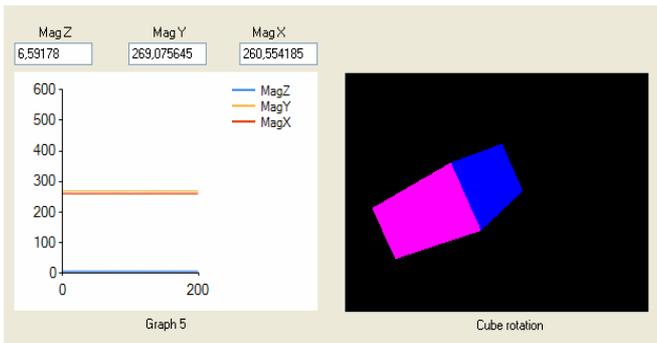


Fig. 5. Last graph with 3D Cube in Software for CHR6-DM.

5. CONCLUSION

The reason for programming the new software for CHR-6DM was fully understanding orientation sensors and testing their properties. Data from orientation sensor are necessary for correct navigation of autonomic system which will be made just with CHR6-DM. From CHR6-DM is expected providing navigation and mapping areas which will be associated with the project of Mobile Autonomic Robotic System.

6. ACKNOWLEDGEMENTS

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