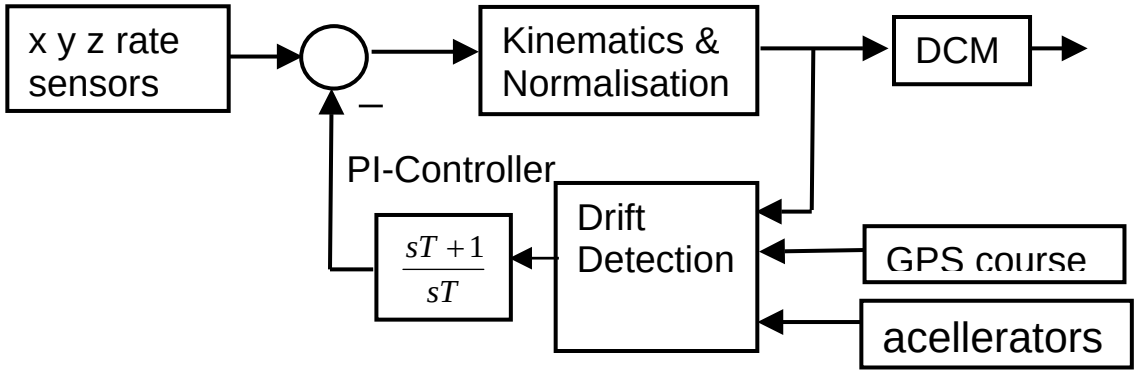
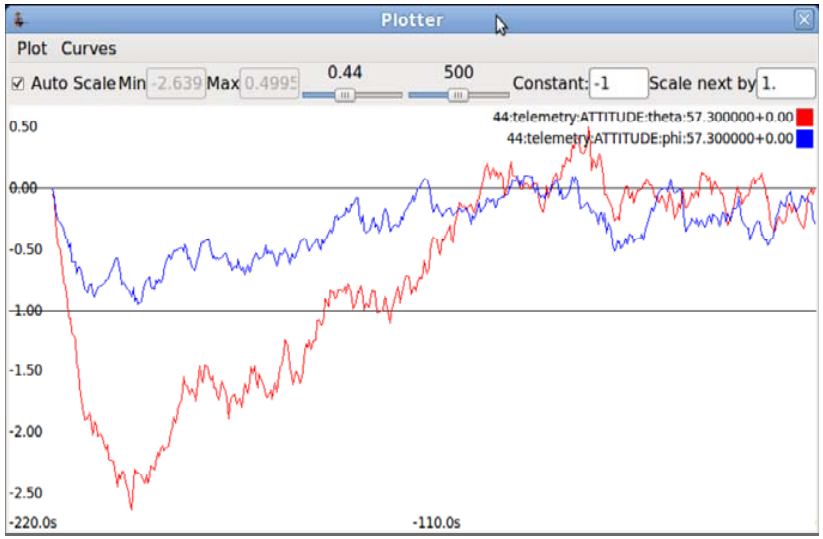
5.3 DCM algorithm with a feedback control system (proportional integral) for bias correction



- The kinematic equations are integrated in a notation of the DCM 50 times per second.
- To save orthogonality of the DCM for every integration step small adjustments of the matrix elements are applied.
- For bias and drift error correction a PI feedback contoller is used. To estimate the errors the acceleration data and the GPS ground speed.

DCM based complementary filter with PI-Controller



- This filter is very robust by low computer cost.
- The run time is only 0,59ms.
- A small disadvantage is that the controller after power up needs about same minutes to stabilize
- Automatic test flight with 400mm and 800mm deltas and Paparazzi work well and with better performance compared to the old IR-system (all weather compatibility better dynamics).
- best choice for normal plane configuration

Stabilization of rolls and pitch angle after power up

Paparazzi Tiny13 with low cost IMU

6. Conclusion

The shortcomings of the IR attitude estimations have to be eliminated to develop a free universal autopilot system for all kind of aircrafts like planes, quadrocopters and helicopters.

Our solution is the HB-Autopilot hard- and software with the following features:

- Use of powerful sensors to estimate attitude, altitude, true air speed, position, temperature
- Use of 16 bit and 24 bit ADCs
- Based on two printed boards the IMU and MCU
- free analogue inputs and SD mass storage
- the IMU can be used with most of today micro controllers

The first application was the use in quadrocopters, which use brushless controller with improved efficiency.

For the attitude estimation we will use:

- The Extended Kalman Filter with 7 state variables for quadrocopters and helicopters and
- the DCM algorithm with a feedback control system for normal plane configurations.