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1 Description of functions

1.1 Security functions

The board automatically emerges the boat, if a problem is detected. By flashing of the status LEDs, which can be connected to the Switch outputs 1 and 2, the type of Problem will be determined.

- No reception signal is recognized (1 x flashing)
- The battery is discharged (2 x flashing)
- The board has detected a hardware problem (3 x flashing)

1.2 Nick angle keeping and depth control

1.2.1 Nick angle keeping control

The nick angle keeping control ensures that the boat is level in the water. This means that the boat is also controllable at faster drive and runs straightly through the water without "dolphin movements".

1.2.1.1 Dynamic angle keeping control

The nick angle keeping control keeps the boat level in the water. As a result, it reacts sluggishly to controls in the pitch axis. In the case of fast boats, it may be desirable that the boat also jumps out of the water once. Such maneuvers are more or less prevented by a static angle keeping controller.

Therefore you can activate a so-called dynamic angle keeping control. This causes the effect of the angle keeping control depends on the elevator stick position. I.e. if the control stick for the pitch axis is in the middle position, the angle keeping control works normally. The more you pull or push on the pitch stick, the angle keeping control becomes weaker and weaker. So even extreme maneuvers are possible easily.

1.2.2 Roll control

Boats, where the center of gravity is fairly in the middle, with respect to the roll axis, react sensitive to rolling moments, such as generated by the drivetrain. That can, in extreme cases, result in spinning the boat uncontrollably through the water, when accelerating. This Behavior, is compensated by the roll control.

1.2.3 Depth control

As the name suggests, submarines often go underwater. Depending on how clean the water is, it might be difficult to see, how deep the boat is going. In this case, the depth control should help, because it automatically keeps the boat at the specified target depth. This can be set to a value between 0 and 125cm.

1.2.4 Automatic depth control calibration

The depth regulator works with the help of an absolute pressure sensor. The air pressure, outside of the Water, represents the diving depth of 0cm. But it is depending from the actual weather and the current altitude above sea level. So it is important that the pressure sensor is calibrated. This happens automatically every time druring startup of the device.

1.2.5 Controller calibration while driving

1.2.5.1 A little bit of control theory

So-called PD control algorithms are used in the board to set the position of pitch and roll axis. The depth control uses a P control algorythm. "KP" and "KD" are control parameters that ensure that the control function is optimal.

The KP parameter sets the response of the controller to deviations from the setpoint. I.e. the boat is supposed to dive 50cm deep, but in reality it is 60cm deep. The deviation of 10cm too deep, causes to steer the boat up. The larger you choose the parameter KP, the stronger the effect.

The KD parameter sets the reaction to changes in the position. E.g. if the boat tilts down around the pitch axis, this is counteracted by steering the boat to up. Here, too, the following applies: the larger the parameter KD, the stronger the effect.

Now you might get the idea to set the controller parameters as large as possible in order to achieve the best possible control performance. Unfortunately that would lead to so-called "Control oscillations". You can imagine it like this: the boat is too deep. That is noticed by the control and it tries to counteract this as much as possible. The boat goes up and comes closer to the surface. As soon as it has reached the target depth, the controller notices this again and sets the elevator to straight position. The position of the boat is directed upwards, so the Boat continues to rise. The controller notices this again and takes countermeasures. The consequence is that the Boat shuttles up and down like a dolphin.

The trick is to find the best possible values for the control parameters.

1.2.5.2 Finding of good control parameters

In our case, the controller parameters can be found out experimentally. To achieve this, special "Calibration modes" can be activated. When any calibration mode is activated, the control parameters can be tuned by the transmitter, while driving. So you can try different control parameters until the boat runs straight ahead .