



MARITIME UNIVERSITY IN SZCZECIN

ORGANIZATIONAL UNIT:
FACULTY OF NAVIGATION - DEPARTMENT OF NAVIGATION DEVICES

Instruction

Regulation of Autopilots Lab

Prepared by	M. Gucma, J. Montewka, A. Zieziula, M. Przywarty, M. Bilewski, K. Posacka, K. Drwięga
Approved	S. Jankowski
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1. Purpose of the exercise

The purpose of this exercise is to familiarize with the control parameters of autopilots. Students become familiar with the possibilities of changing the control parameters affecting the control of the ship. To do is to make adjustments to the autopilot, registration data and carry out the appropriate analysis.

Preliminary information, knowledge test and report.

For a third class, a brief knowledge check will take place.

Scope of preparation: the issues are in the introductory part, the theory of literature on the next page.

Report writing on your computer will not be accepted

The reports are written individually!

The report consists of 2 parts:

- Part A - Preliminary
- Part B - Exercise course see details below) and additionally:

Measurement Cards: signed by the teacher; own conclusions

*) On the measurement card (exercise diary) the actions are recorded - then they are rewritten purely in the report.

**) Reports of repeated applications from other students will be rejected !!!

Part A – Preliminary should include

- Purpose of the exercise;
- Description of the measuring system;
- Quality control rating indicators (for simulation with patterns);
- Principles of automatic pilot;
- Block diagram (drawings);
- Equation of PID regulator;
- Description of the PID (proportional, integral, and differential) components;

Part B - Exercise course: describe the individual steps of:

- Describe all activities performed on the exercise;
- Perform an analysis of the results obtained *
- Place charts and data tables,
- Make your own conclusions.

* Results obtained should include the steering curves, laying of the rudder, curse deviation, for all manoeuvres (on the 3 graphs)

Otrzymane wyniki powinny zawierać przebiegi krzywych sterowania (wych. steru i odchyłka kursowa) dla wszystkich przejazdów i wariantów (na 3 wykresach).

(!) At the end you have to find the conclusion - an individual report from the course of the exercise.

Requests should include: own comments on: device operation, interface comfort, presentation of data,

No conclusions - report rejected;

Conclusions borrowed - report rejected;

Complete reports must be put on the next class

The exercises include:

- 1) Presence;
- 2) positive evaluation from the test;
- 3) positive reports;

3. Description of the measurement system

Method of the steering (autopilot functions by Cetrek)

Automatic control

Press the button to turn on automatic control.



With the automatic control indicator shows the set **course**

Altering the course is done using the knobs located under the course indicator.



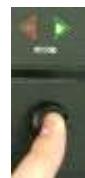
Emergency control – Dodge Function

This function is used to temporarily change the course. It is only active if automatic control is working. With automatic control, moving joystick to port/stbd side, cause the rudder follows hard to port/stbd side. When the DODGE is off, the ship returns to the set course that was entered into the autopilot, to avoid the collision

Attention! The Dodge function work only as we hold joystick!!!



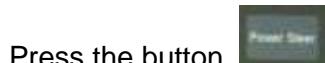
Not active Dodge



Active Dodge

Manual control

First way of the manual control



Press the button to select the manual control. The course indicator will indicate true course. Sterowanie odbywa się poprzez pokrętło umieszczone pod wskaźnikiem kursu. The steering is done by the knob located under the course indicator. We can not alter the course but only move the steering wheel!



Second way of the manual control

Press the green button in the lower right corner of the simulator above the control lever. Control is made by tilting the lever to the starboard/port side



Switching from manual to automatic control push button . The autopilot remembers the course at which automatic control is enabled.

FUNCTION OF THE KNOBS



Rudder - to set the rudder gain factor



Yaw - to set yawing zone



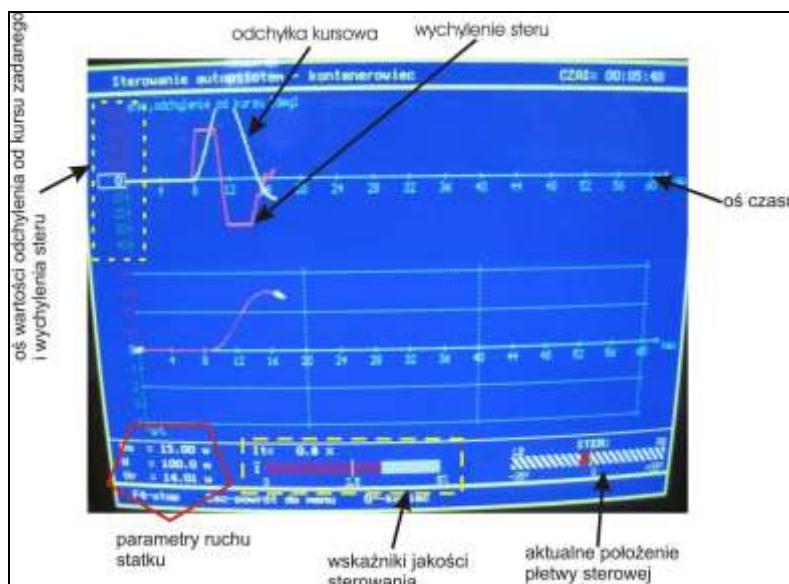
Trim – to adjust the automatic constant rudder



Course Selector – to alter the course

4) Performing exercises

Screen simulation:



yellow curve - course deviation ($K_z - K_{z_0}$) difference between the set course and the gyro course [°]

red curve – deflection of the rudder [°]

Quality indicator of the steering is expressed as function of the speed ship:

$$(1 - V_0 [K_k(\Delta \Psi) - K_{k_0}] + K_r(\Delta R)] 100\%)^2 \cdot$$

$$I_t = \frac{V_0}{n} \sum_{t=1}^n I_{t,n}$$

It	- temporary quality indicator of the automatic control [%],
I	- average quality control of the autopilot during the entire duration of the trial, [%],
V0	- initial speed of the vessel, [m/s],
delPsi	- deviation from the set course, [°],
delR	- current rudder angle, [°],
KK	- współczynnik korekcyjny dla odchyłki od kursu,
kR	- Correction factor for rudder angle,
tn	- duration of the whole trial.

The smaller the value of the It or I, the better the quality of the control

EXCERCISES 1

4.1 IMPACT OF THE RUDDER GAIN FACTOR FOR THE STEERING OF THE AUTOPILOT (WWA)

Insert the following autopilot settings:

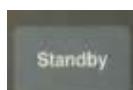
Wariant	Rudder	Yaw	Trim
1	0	0	0
2	10	0	0
3	20	0	0

You receive 3 time runs on the one graph (where we change only the Rudder gain factor)

Change only rudder!

1) Run the 'autopilot simulator' program:

- a) Select: AUTOPILOT CONTROL;
- b) Select: CONTAINER SHIP (**KONTENEROWIEC**) and press **F5**;
- c) Enter the following data and confirm ENTER



Now press **Standby** on the autopilot desktop

- głębokość wody (water depth) 100 [m]
- zadany kurs statku (course) 0 [deg]
- początkowy kurs statku course on the begining of the trial 0 [deg]
- prędkość wiatru [m/s] wind speed 0 [m/s]

- stan morza [°B] sea state 0 [°B]
- obliczenia w czasie rzeczywistym real-time calculations [T/N] N
- co który wynik zapisać every 100 results 100
- nazwa zbioru wyników filename ww

- d) Start the autopilot for automatic control (PILOT key).
- 2) For 10 seconds, observe the movement of the controlled ship automatically, course deviation and rudder angle should be zero.
 - 3) We introduce pulse interference – lay the rudder **DODGE** to starboard side and hold until yellow line reach the value around **30°** on the Y axis, and set the joystick to zero.
 - 4) As a result of the introduced interference (lay the rudder) the vessel get off the course. When the interference stops the ship will return to a preset course.
 - 5) **Always confirm the alarms activated with the ALARM button.**
 - 6) **The course itself will stabilize after some time (the course deviation will be around zero)** yellow line reaches the value of 20 on the X axis), set RUDDER to 10.
 - 7) When the yellow line 40 reaches the X axis RUDDER set to a value of 20 by using the dial indicator.
 - 8) Again DODGE joystick move to the stbd, hold until the yellow line reaches approximately 30 ° to the Y-axis at this time set the joystick to the zero position.
 - 9) **When the yellow line reaches about 56 on the X axis, press the F4 key on the keyboard (once!).**
 - 10) When the simulator program is stopped, reset the RUDDER setting, press OFF on the autopilot desktop, and two times ESC on the keyboard.

EXCERCISES 2

4.2 IMPACT OF THE YAW (SM) FOR THE STEERING OF THE AUTOPILOT

These trial change the yaw zone while maintaining the remaining parameters.

Insert the following autopilot settings:

Wariant	Rudder	Yaw	Trim
1	0	0	0
2	0	10	0
3	0	20	0

You receive 3 time runs on the one graph (where we change only the **Yaw** factor)

Change only Yaw!

1) Run the 'autopilot simulator' program:

- Select: AUTOPILOT CONTROL;
- Select: CONTAINER SHIP (**KONTENEROWIEC**) and press **F5**;
- Enter the following data and confirm ENTER



Now press **Standby** on the autopilot desktop

- głębokość wody (water depth) 100 [m]
- zadany kurs statku (course) 0 [deg]
- początkowy kurs statku course on the begining of the trial 0 [deg]
- prędkość wiatru [m/s] wind speed 0 [m/s]
- stan morza [°B] sea state 0 [°B]
- obliczenia w czasie rzeczywistym real-time calculations [T/N] N
- co który wynik zapisać every 100 results 100
- nazwa zbioru wyników filename ww

- Start the autopilot for automatic control (PILOT key).
- For 10 seconds, observe the movement of the controlled ship automatically, course deviation and rudder angle should be zero.
- Przez 10 sekund obserwować ruch statku sterowanego automatycznie, odchyłka kursowa i kąt wychylenia steru powinna wynosić zero.

- 4) We introduce pulse interference – lay the rudder **DODGE** to starboard side and hold until yellow line reach the value around **30°** on the X axis na, set the joystick to zero.
- 5) As a result of the introduced interference (lay the rudder) the vessel get off the course statek zejdzie z zadanego kursu. When the interference stops the ship will be try to return to a preset course.
- 6) **Always confirm the alarms activated with the ALARM button.**
- 7) **The course itself will stabilize after some time (the course deviation will be around zero)** yellow line reaches the value of 20 on the X axis), set YAW to 10.
- 8) Again DODGE joystick move to the stbd, hold until the yellow line reaches approximately 30 ° to the Y-axis at this time set the joystick to the zero position.
- 9) **When the yellow line reaches about 56 on the X axis, press the F4 key on the keyboard (once!).**
- 10) When the simulator program is stopped, reset the YAW setting, press OFF on the autopilot desktop, and two times ESC on the keyboard.

EXCERCISES 3

4.3 IMPACT TEST OF THE INTEGRAL COEFFICIENT (WI) FOR THE STEERING OF THE AUTOPILOT.

The best example is during bad wather condition srong wind, high sea state. Change TRIM from 0 to 20 diuring all trial.

DO NOT TOUCH Dodge!!!

Insert the following autopilot settings:

Wariant	Rudder	Yaw	Trim
1	10	0	0
2	10	0	10
3	10	0	20

You recive 3 time runs on the one graph (where we change only the **TRIM** factor)

1) Run the 'autopilot simulator' program:

- Select: AUTOPILOT CONTROL;
- Select: CONTAINER SHIP (**KONTENEROWIEC**) and press **F5**;
- Enter the following data and confirm ENTER



Now press **Standby** on the autopilot desktop

- głębokość wody (water depth) 100 [m]
- zadany kurs statku (course) 0 [deg]
- początkowy kurs statku course on the begining of the trial 0 [deg]
- prędkość wiatru [m/s] wind speed 40 [m/s]
- kierunek wiatru wind direction 45 [deg]
- stan morza [°B] sea state 6 [°B]
- kierunek fali wave direction 60 [deg]
- obliczenia w czasie rzeczywistym real-time calculations [T/N] N
- co który wynik zapisać every 100 results 100
- nazwa zbioru wyników filename WW

- Start the autopilot for automatic control (PILOT key).

- 2) **Set RUDDER to 10**
- 3) For 10 seconds, observe the movement of the controlled ship automatically, course deviation and rudder angle should start to change. Due to of wind and wave the vessel should sheer.
- 4) When yellow line reach the value 20° on the X axis, set TRIM to 10
- 5) When yellow line reach the value 40° on the X axis, set TRIM to 20
- 6) **When the yellow line reaches about 56 on the X axis, press the F4 key on the keyboard (once!).**
- 7) When the simulator program is stopped, reset the all setting, press OFF on the autopilot desktop, and two times ESC on the keyboard.