



SCADA FOR SAILING BOAT AUTOPILOT

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Introduction

The goal of the project is to build a SCADA (shortcut from "Supervisory Control And Data Acquisition"). It was predicted to use demo version of program AVEVA InTouch HMI (with some limitations: 2 hours of constant use and only 32 user tags).

Frontend should properly represent and animate parameters of sailing the boat.

Backend should assure making animations work great.

Main goals of working application:

- Maintaining the course of sailing using rudder
- Software should maintain selected course without overshooting
- Alarm defined for the situation of critically low level of battery voltage
- Triggering the state of engine needs to authenticate
- Visualization and animation of current, past, and set course
- Autopilot needs to be turned on to maintain course

Description

Application simulates changing course of sailing boat by moving the rudder. User can set needed course on HMI panel. If given value is different than actual course the angle of rudder changes. Hence the boat pivots until reaching right direction.

Tags used in application:

- *course* – course set for autopilot by user
- *course_act* – actual course of boat
- *counter, course1, course2, ..., course5* – supporting variables used for visualisation
- *ap_on* – indicates whether the autopilot is turned on
- *engine_on* - indicates whether the engine is turned on
- *rudder* – value of rudder angle
- *speed* – value of current speed
- *temp* - temperature of engine coolant
- *voltage* – battery voltage

We also used the following system tags:

- *\$OperatorEntered* - name of user
- *\$PasswordEntered* - password entered to login
- *\$AccessLevel* – manage users permissions

The autopilot works only if user turn it on. Otherwise, no matter what value of needed course is given, the boat continues to sail with actual course without changing direction. When user turns on the autopilot on HMI panel program calculates difference between actual and set course. According to calculated value the rudder moves, and boat change its direction. The smaller difference between courses is, the smaller value of rudder angle to avoid overshooting.

Visualisation

The project includes gauges:

- Rudder Angle- shows the current inclination of rudder in degrees, where 0 is straight rudder
- Engine Temperature – shows the current temperature of coolant of Diesel engine in Celsius degrees(°C)
- Speedometer- shows the current boat speed in knots(kts)
- Battery Voltage- shows the battery voltage in Volts(V)
- Autopilot display- shows the set course in degrees
- Autopilot state- shows if autopilot is taking control of boat
- Course set and current- red arrow shows the current course, green- set course
- Clock- current time
- Bird eye view of course from the last 5 seconds
- Alarm display- displays alarm when battery voltage drops below 10.8V or is higher than 14.4V

The project includes also steering elements:

- Engine switch(keys)- allow to charge the battery, control the speed and the temperature of engine
- Autopilot course setter (buttons)- upper buttons change the set course by 10 degrees, lower by 1 degree
- Autopilot main switch (I/O buttons)- when autopilot is switched off, rudder maintain 0-degree angle, boat should sail straight ahead

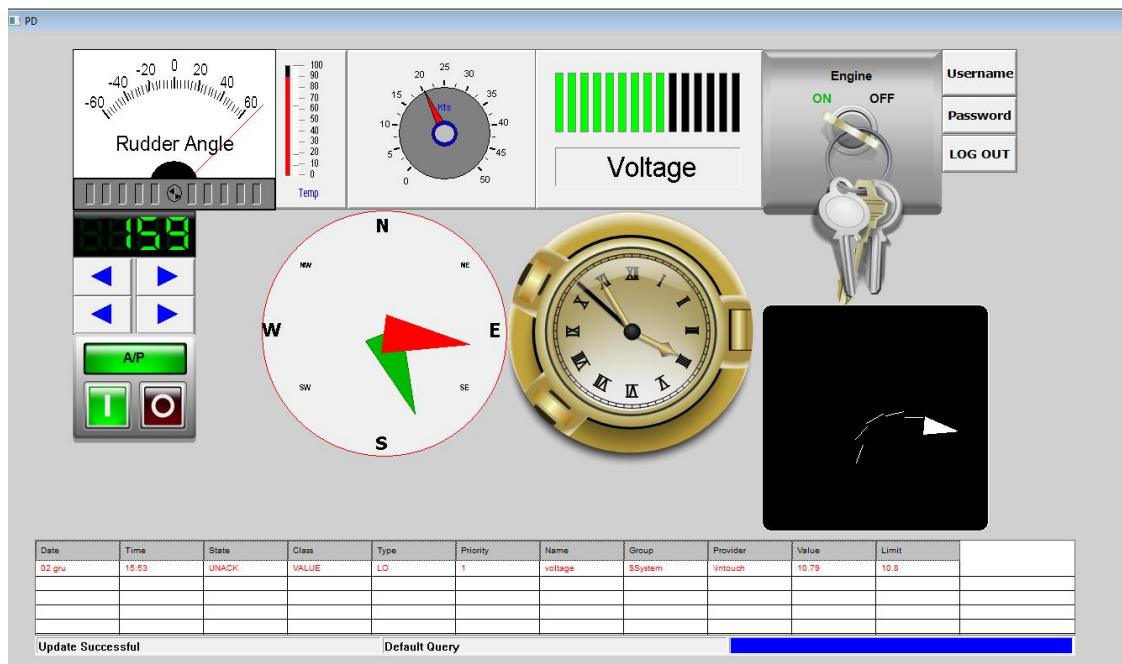


Fig 1 Main screen

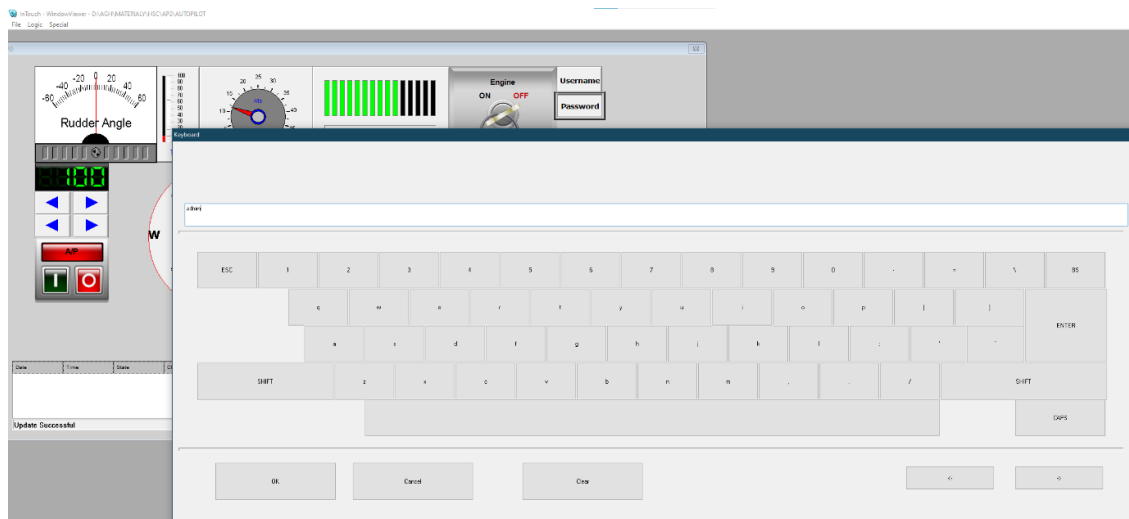


Fig 2 Login Panel

Turning the engine on or off needs to put correct username (default admin) and password (default admin)

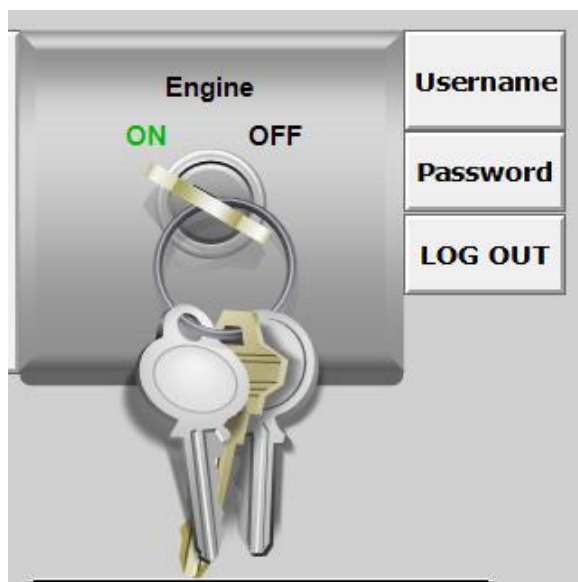


Fig 3 Engine Panel

Granting the proper access level allows to trigger the state of engine.

Date	Time	State	Class	Type	Priority	Name	Group	Provider	Value	Limit
02 gru	17:06	UNACK	VALUE	LO	1	voltage	\$System	\intouch	10.79	10.8
Update Successful				Default Query						

Fig 4 Alarm Panel

Too low or too high voltage of battery generate alarm, which is automatically deleted, when battery is at proper voltage level (so between 10,8V and 14.4V).

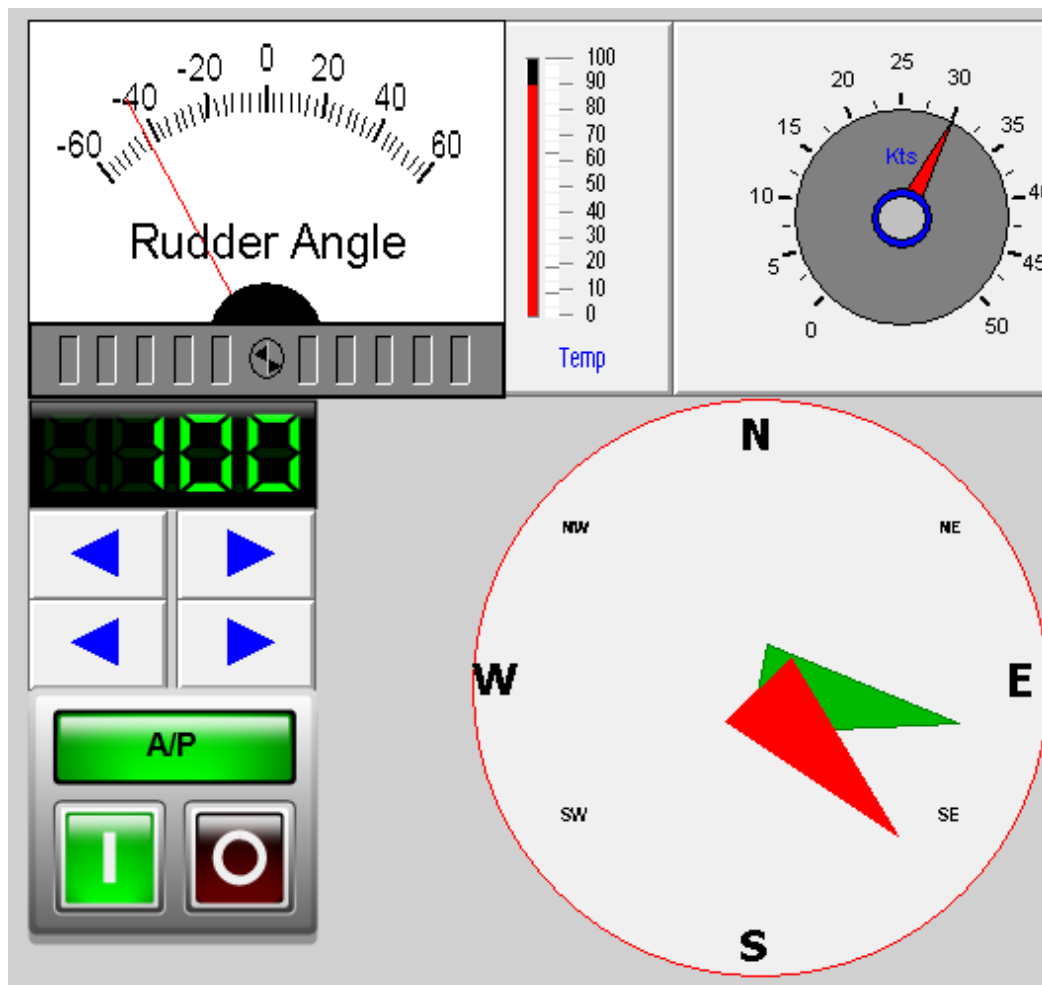


Fig 5 Autopilot Panel

Buttons allows to change the set course. Autopilot is allowed to steer the boat, only when switch is in ON state(green). Rudder angle gauge shows the current inclination of rudder.

Temperature and speed relate to the state of engine. When the engine is on temperature should not increase over 90 Celsius degrees. The maximum speed of the boat is 30 kts.

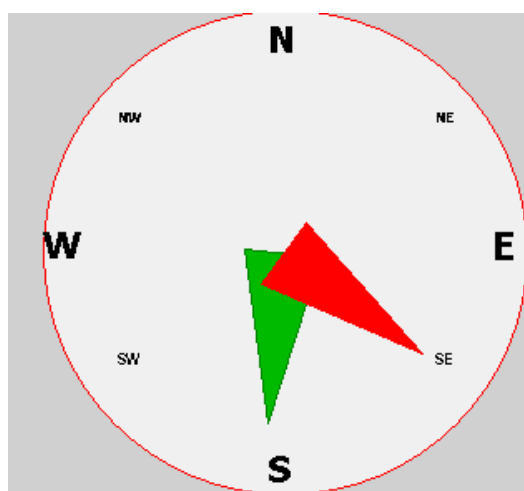


Fig 6 Course Panel

Red arrow shows set course, when the green one shows current.

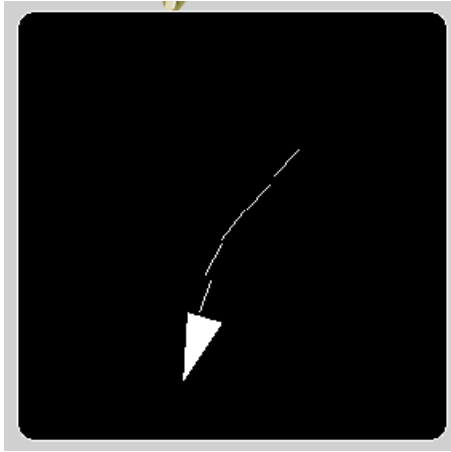


Fig 7 Historic course panel

Panel shows the history of boat turning. It refreshes every second. The last indicator shows the course, that was 5 seconds ago, and the arrow indicates the current course.

Conclusions

SCADA application makes it possible to manage complex process in a simple way. Using AVEA InTouch HMI was intuitive and easy to learn. Program gives many possibilities to visualise any needed in our application element. Even when program library lacks some graphical components to represent feature, we can make our own graphics with advanced animation. We used that option in our application to depict compass and historic course panel.

Program also allows managing alarm for every variable what means you can implement it for any emergency. Access level for users provides security and safety as only users with proper level can make some actions. It requires authorisation using for example password.

Our application meets all the assumed expectations for autopilot and has some additional features which visualise other elements of sailing boat.

Bibliography

Image from the first page:

https://photos.croatia-yacht-charter.com/Beneteau-Oceanis-60-3567_0b.jpg