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A WINDOWS INTERFACE FOR MARITIME NAVIGATION TRAINING

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To Professor Silviu Sburlan, at his 60's anniversary

Abstract

This report presents a multimedia interface capable to transform a regular laboratory network of PC in a maritime navigation simulator. The research I have carried out deals with a more sophisticated simulator, capable to represent the real consoles included in an integrated bridge system, but because such a simulator may cost a couple of hundred of thousands of dollars - an amount which is not at hand for any training center, the solution presented in this report is only the economical alternative of what a real simulator means. It has the advantage that the computer network remains available and for other purposes.

In a navigation simulator, each work station represents one ship. The server, which is reserved for the trainer (instructor), may generate more ships, all under the control of the trainer. Each student attending the exercise is supposed to have a ship to control. On his radar-screen the student should see the ships of his mates as well as the fictitious ships generated by the computer of the trainer. A student has to navigate with his ship trough this crowed which may extend up to 50 ships. He has to know what the general conception of the exercise is, what his responsibility is in this exercise and what the rules of the game are.

1. Requirements for a Windows interface for maritime navigation training

An interface capable to support a navigation simulator should meet the following requirements:

- To allow the instructor to store in computers the environmental conditions of navigation (such as wind, current, waves, tides a. s. o.), the ships attending the exercise, as well as many other fictitious ships necessary to complete a real crowed or grouping of ships, of such a manner as to create a screen play that may happen in real life and requires those knowledge that are the topic of his lesson;

- To allow every student attending the exercise, to control his ship in order to apply his knowledge to solve all problems that might appear during such an exercise;

- To simulate on a monitor the console of an ARPA (Automatic Radar Plotting Aids) and eventually a console of ECDIS (Electronic Chart Display Integrated System), normally present in an integrated bridge system.

This is based on electronic charts which look like traditional maritime charts, but in fact they are graphics that can be displayed at different scales, entirely or only some parts of interest. For example, they can be displayed of such a manner that the point of the ship provided with such an equipment to be always in the center of the screen. This facility allows the navigator to look around as if he would be on a helicopter and see the neighborhood from the top. Beside this facility, the ECDIS is featuring:

- Integration of data supplied by sensors specialized in navigation parameters such as gyrocompass, rudder, loch, GPS, echo sounder, etc.;

- The voyage preparation on an electronic chart;

- Checking the quality of the selected route;

- Monitoring the ship displacement based on the selected route and on water state parameters such as: depth, currents, tide, waves, a. s. o.;

- Alarm in case that a danger of ground touching exists;

- Display of monitoring executed by ARPA system;

- Recording of the current route and later playback of the route for analysis.

- To continuously calculate two points of the ship, both based on corrections that have to be applied on the parameters of the ship moving, in order to compensate the effect of the environmental conditions (provided by the instructor):

- one based on the appropriate corrections that also are provided by instructor, and like any natural effect of the environmental conditions, they have to be estimated by navigator and if possible, to be checked from time to time, to see if his estimation is a good one. Such a point can be used in a simulator to represent the point supplied by GPS (Global positioning system) ;

- another point, based on the corrections estimated by the student while he knows the characteristics of the environmental conditions such as the direction and the speed of the wind, direction and the speed of the current, the sea state (Bofors degrees), but of course these parameters may change any time, like it happens in the real life. Once the ship commander knows the position of his ship and the parameters of ship moving, he needs to know the position and the parameters of the other ship moving, in order to anticipate possible collision possibilities or to calculate a course that may bring his ship in a certain position in respect with some other ships, position that may be required by his mission or by the rules for collision avoidance. Often such ship maneuvers are preceded by special optical or acoustic signals that the navigator has to take care of.

- To communicate both points of each ship to the master computer (the computer of the instructor) and then, the master computer has to communicate the points of all ships to all ships represented by a navigator so that their simulator interface would have all the information they normally get from their radar in order to built a radar image on the screen of the monitor. Such an image is shown bellow:

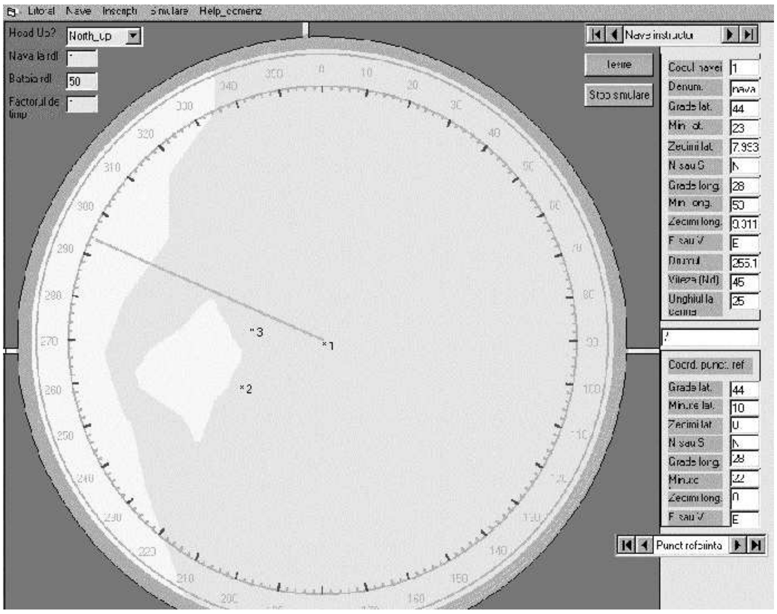

Figure 1:

The image must be superimposed on an electronic map which, as it has been mentioned above, has to be permanently placed with the real point of the ship (that supplied by GPS) in the centre of the circle generated by radar.

In order to fit this page size, this image has been developed on a display of 14” but normally it will be installed on computers with monitors of 17” or more.

The image above belongs to the ship no. 1 and here one can see the other two ships and the coast outline. If the ship (in this example ship no. 1) has the rudder placed in one side and if the navigator has set the operation mode of the radar on the ”Course-up” option, then the image inside the circle should rotate against the rotation of the ship.

On the right hand of the image all information normally available on board of the ship are displayed: course and the speed of the ship, rudder and engine lever position, log indications, environmental factors value, estimated position of the ship and GPS position. On the left side of the screen, not indicated in this image, are the buttons for options regarding the navigation log book and the use of the current voyage as a source of information for other voyages in case that a Track steering method is used to identify the points of course changing;

- In case of the master computer, the instructor may decide which ship he is watching at a given moment. For this he has to set the "ship on the radar" parameter and from that moment the radar image from his computer should look like that from the ship he has under observance, as if he would be watching the monitor of that computer (ship).

- The interface has to allow the navigator to set the parameters of the ship moving such as rudder position, the engine lever position (i. e. the speed of the ship), the current radar scale, as well as the problems to be solved as a support for his navigational decisions: for this he has to press a button (not shown in the image above), which opens a dialog box where he can specify the name of the problem and eventually some parameters required by the algorithm of such a problem. Consequently, the dialog box gets closed and a display box is opened where the navigator may watch the result of one or more problems selected by him. These problems run continuously until the navigator requires the end of running for some of them.

- Note that none of the operations mentioned above should disturb the rotation of the radar antenna, as well as the smoothness of the image evolution. The image has to be refreshed for each rotation of the radar antenna so that one can notice the move, or rotation of the landscape or of the other ships position.

- It is worth to mention that the communication between slave computers (those operated by students) and the master computer (that operated by the instructor) are automatic driven dialogs among the programs: nobody cares about these exchange of information and as a matter of fact, the students even don't have to know about it because if they would know it, this will compromise the idea of navigation simulation.

- Finally the interface should be able to analyse the action of each student and to grade his behaviour. Main data should be stored for an analysis of the entire exercise development and for criticism of each student.

2. A solution to the problem of automatic communication among programs running on each computer

This problem has been solved by mean of an activeX class capable to make the connection between a form where the radar or ECDIS image is placed and another form provided with

Winsock controls.

In order to do this job, the code of ClsSocketsDLL has declared frmHolder - an instance of the form frmWinsockDLL, by mean of WithEvents statement.

On the other hand, the form frmECDIS has declared in its code, also using the statement WithEvents an instance of the clsSocketsDLL, called Sockets-DLL.

It is well known that objects declared with statement WithEvents allow the use of their events by the object which had declared them. Also these last mentioned objects may change the properties of object declared by them with statement WithEvents. A condition to transfer events from one object to another, is that the events to be transferred must be declared in the master object as public events. Once these conditions being fulfilled, these objects may operate according to the diagram bellow:

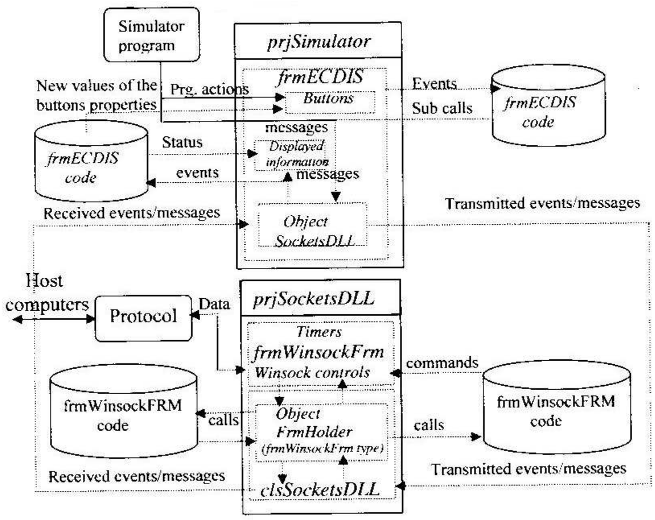

Figure 2:

3. Using the simulator interface

On a large scale, the purpose of this research is to simulate the displacement of a ship from one place to another, but in details, this means to simulate the phases of the navigation process, infinitely repeated during a voyage. The purpose of this repeated process is a safe maneuvering and control of the ship, in spite of some complex conditions imposed by the maritime traffic.

This simulator interface generates a number of ships the instructor can avail of. It is his business to decide how to use them in an exercise and it is the business of each student to navigate in the environment resulted from the screen play conceived by his instructor.

In detail this means that the navigator (the student) has to identify different special situations that might appear, to analyze these situations by comparison with his experience and the rules regarding to each type of situation and to decide what his actions should be.

He can apply collision avoidance rules, can make specific calculations to identify any possible danger, can consult the appropriate documentation or can deliver specific acoustic or visual signals.

The interface is provided with a menu that allows the instructor to set up all important data such as the initial position on the globe of each ship, the characteristics of the environmental factors, the coast outline or the electronic map to be used for the current area of navigation. Later the instructor can control the fictitious ships and can survey how each student operates his own ship. He can simulate some troubles such as GPS out of order and can decide what criteria of appreciation of the student actions will be used during the current exercise.

The student simulation interface is slightly different from that of the trainer, as they still have the possibility to control their ship, to visualize the main data about their own ship and some data about some other ships, the characteristics of the environmental factors, the estimated position of the ship and, if the trainer decided the GPS to be available, the position supplied by GPS. About other ships the students may have data that normally are supplied by radar such as the distance and the bearing to a ship, but they may ask the interface to do more than that: for instance they may ask the interface to calculate the course and the speed of a ship they are interested in, or even more, to determine if that ship is running on a dangerous course, i. e. one that might lead to a collision. Sometimes they may be interested to find out what course should take to meet a ship, or to hit a ship with an object such as a torpedo or a missile. In that case the problem will be solved for a speed specific to that torpedo or missile.

They also can run programs that are designated to solve current problems as a support for some decisions the student should make. For instance what is next point the course of the ship has to be changed, or what is the time of arrival at the ship destination.

The interface is provided with a user's guide, where instructions and pictures of different dialog boxes are presented.

It is important to emphasize that usually all the dialog boxes give a break to the program that has activated such a box, but in case of this interface such breaks were not allowed because they would disturb the radar simulation. All dialogs with this interface take place as if the radar is an analogous part of the simulator and has nothing to do with the interface.

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