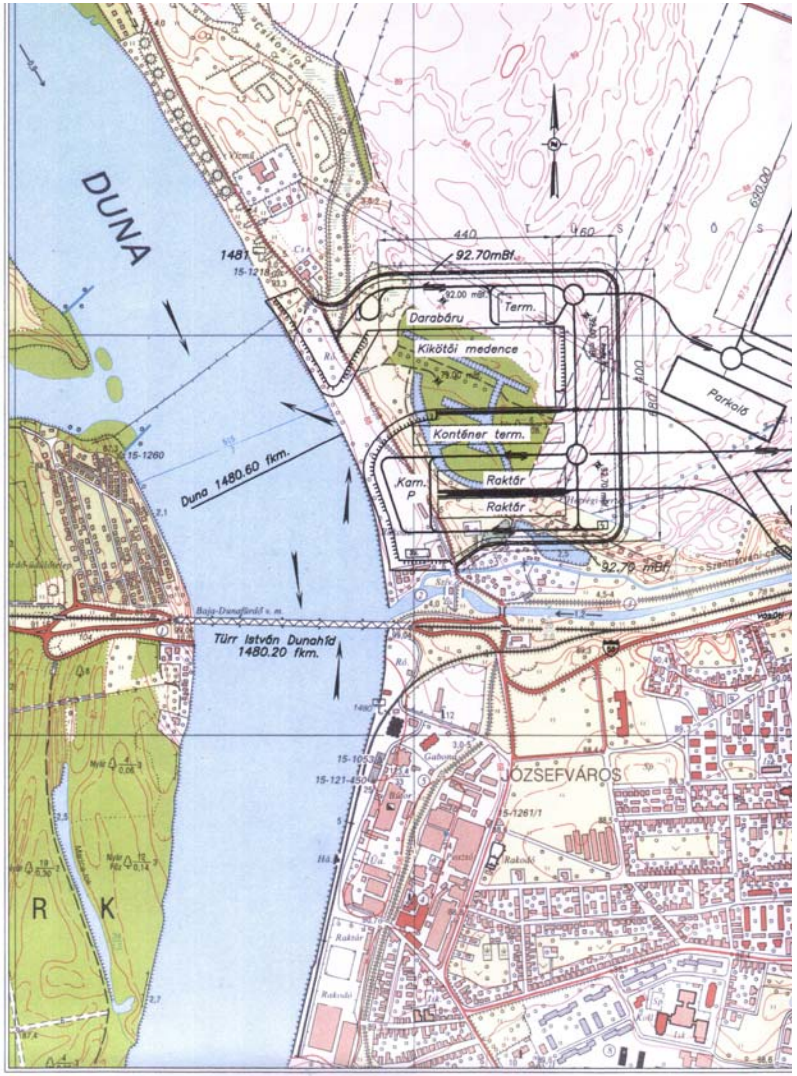
Department of Aircraft and Ships

2D Simulation of inland vessel manoeuvrings

MAIIF 5. Conference, Budapest

MAIIF



By:

Budapest University of Technology and Economics

Department of Aircraft and Ships

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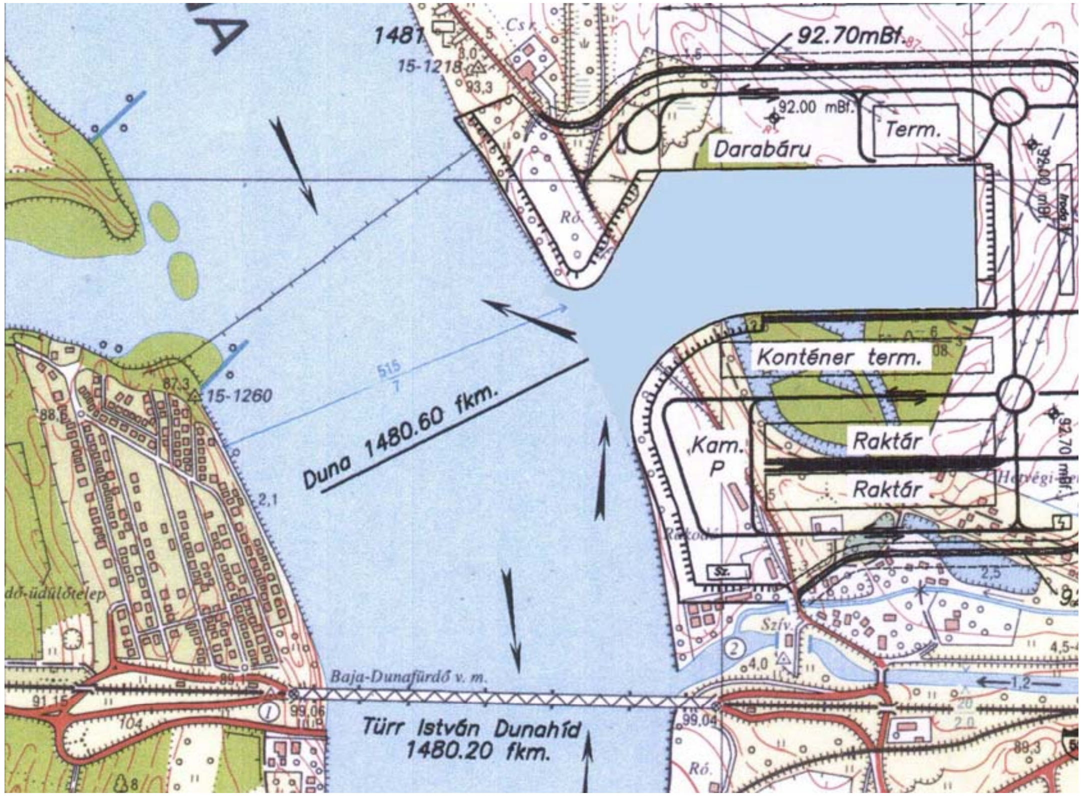
92.70mBf.
92.00 mBf.
Term.
Darabáru
Konténer term.
Raktár
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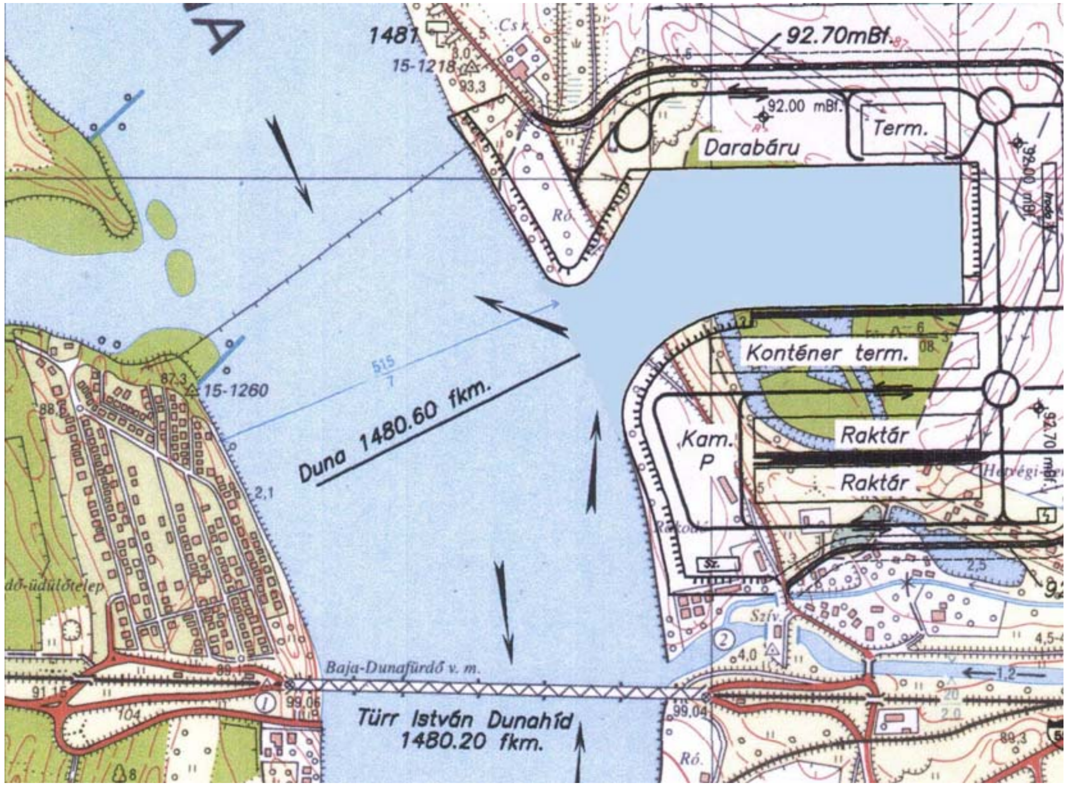
P
Duna 1480.60 fkm.
15-1260
Baja-Dunafürdő v. m.
Türr István Dunahíd
1480.20 fkm.

1. Objective

Research on the navigability of newly-designed basin of Baja International Port



The problem:

Main stream seems to be too close to the basin opening

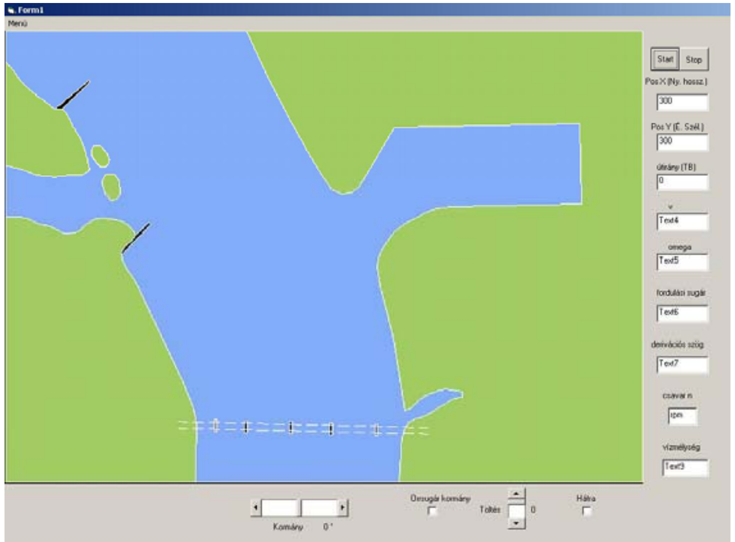
2. Metodology

Research possibilities:

Model testing

- Ship and river test together
- Ship and river test separately

2D Computer simulation



3. Selection of test ship

General Inspectorate of Transport: representative ship with a minimum dimensions of

Length:	110m
Breadth:	11.4m
Draft:	2.5m

No available detailed design documentation for such a vessel

Theoretical test vessel design

3. Selection of test ship

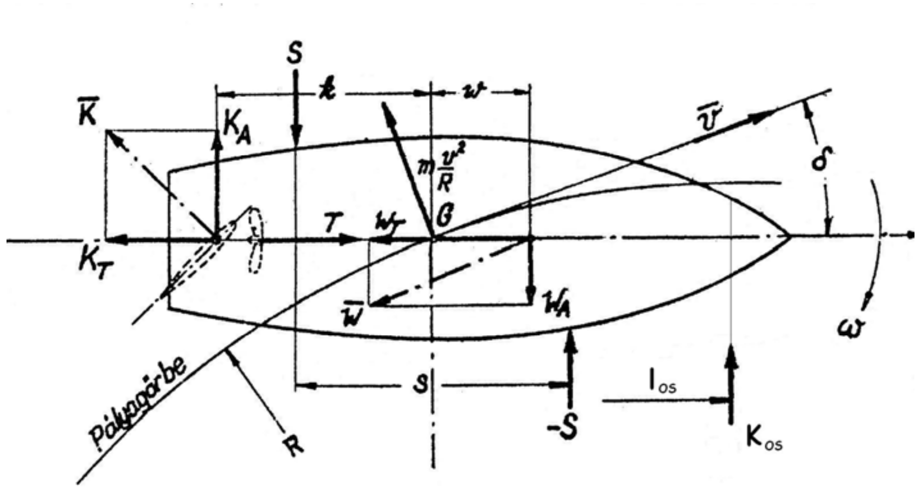
Main dimensions of the accredited, fictive self propelled single screw vessel:

Length between perpendiculars:	110,00 m
Breadth:	11,4 m
Depth:	2,90 m
Max. draft:	2,50 m
Min. draft:	0,80 m
Displacement by 2,50 m draft:	2853 t
Displacement by 0,80 m draft:	847 t
Dead weight capacity:	1800 t
Main engine:	MTU 12 V 4000 M60
power:	1320 kW
nominal speed:	1800 1/min
Rudder:	three blade Jenckel rudder + bow thruster

4. Motion equations

Simplification by inland vessels:

- No pitch
- No dipping
- No heeling



Motion equations:

$$m\frac{dv_x}{dt} + m\varpi_z v_y = \Sigma F_x$$

$$m\frac{dv_y}{dt} - m\varpi_z v_x = \Sigma F_y$$

$$\theta_z \frac{d\varpi_z}{dt} = \Sigma M_z$$

$$m\frac{av_x}{dt} = -m\frac{a\delta}{dt} v_y + T - K_x - R_x + W_x$$

$$m\frac{dv_y}{dt} = m\frac{d\delta}{dt} v_x + K_y - R_y + W_y + K_{OS}$$

$$\theta_z \frac{d^2\delta}{dt^2} = -K_y \cdot k + R_y \cdot r - W_y \cdot w - K_{OS} \cdot l_{OS}$$

4. Motion equations

Forces acting on the ship:

$$T = c_T^* \frac{\rho_{víz}}{2}\left[\left((1-w)v\right)^2 + (0{,}7D\pi\cdot n)^2\right]\frac{\pi}{4}D^2$$

$$K_x = c_{Kx}(\alpha)\frac{\rho_{víz}}{2}\left((1-w)v\cdot\sqrt{1+\frac{T}{\frac{\rho_{víz}}{2}\frac{D^2\pi}{4}(1-w)v}}\right)^2 A_{korm}$$

$$K_y = c_{Ky}(\alpha)\frac{\rho_{víz}}{2}\left((1-w)v\cdot\sqrt{1+\frac{T}{\frac{\rho_{víz}}{2}\frac{D^2\pi}{4}(1-w)v}}\right)^2 A_{korm}$$

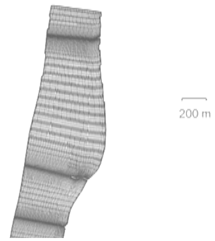
$$W_x = c_{Szx}\frac{\rho_{levegő}}{2}v_{szél}^2\cdot A_{szélx}$$

$$W_y = c_{Szy}\frac{\rho_{levegő}}{2}v_{szél}^2\cdot A_{szély}$$

$$R_x = \frac{R_t}{1-t}$$

$$R_y = \frac{\rho_{víz}}{2}c_{lat}\int_0^{L_{wl}}\left[v_y + (x-x_g)\frac{d\delta}{dt}\right]^2 A_{lat}(x)\cdot dx$$

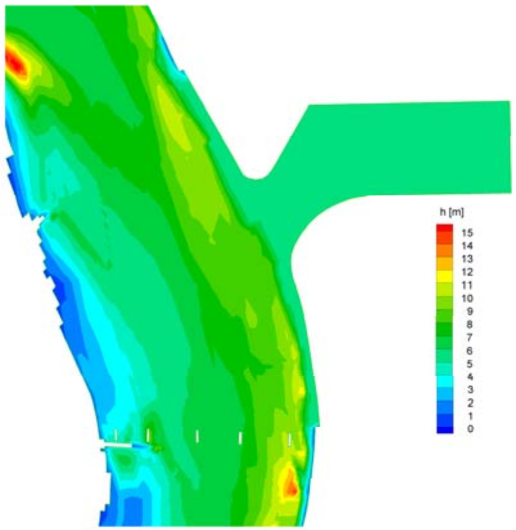
5. Environmental conditions



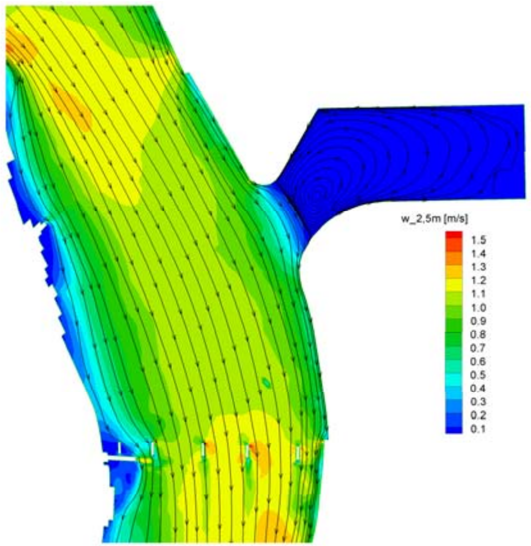
Wind → as wind force on ship, see before

Stream of Danube → as stream data net (v_x, v_y, depth)

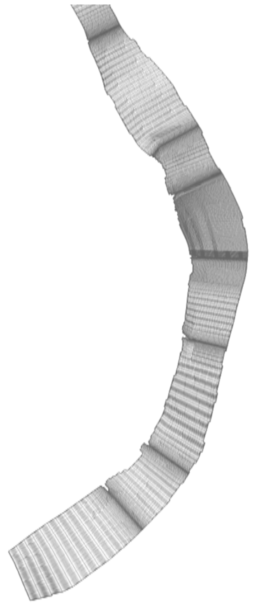
Department of Hydraulic and Water Resources Engineering



Water depth

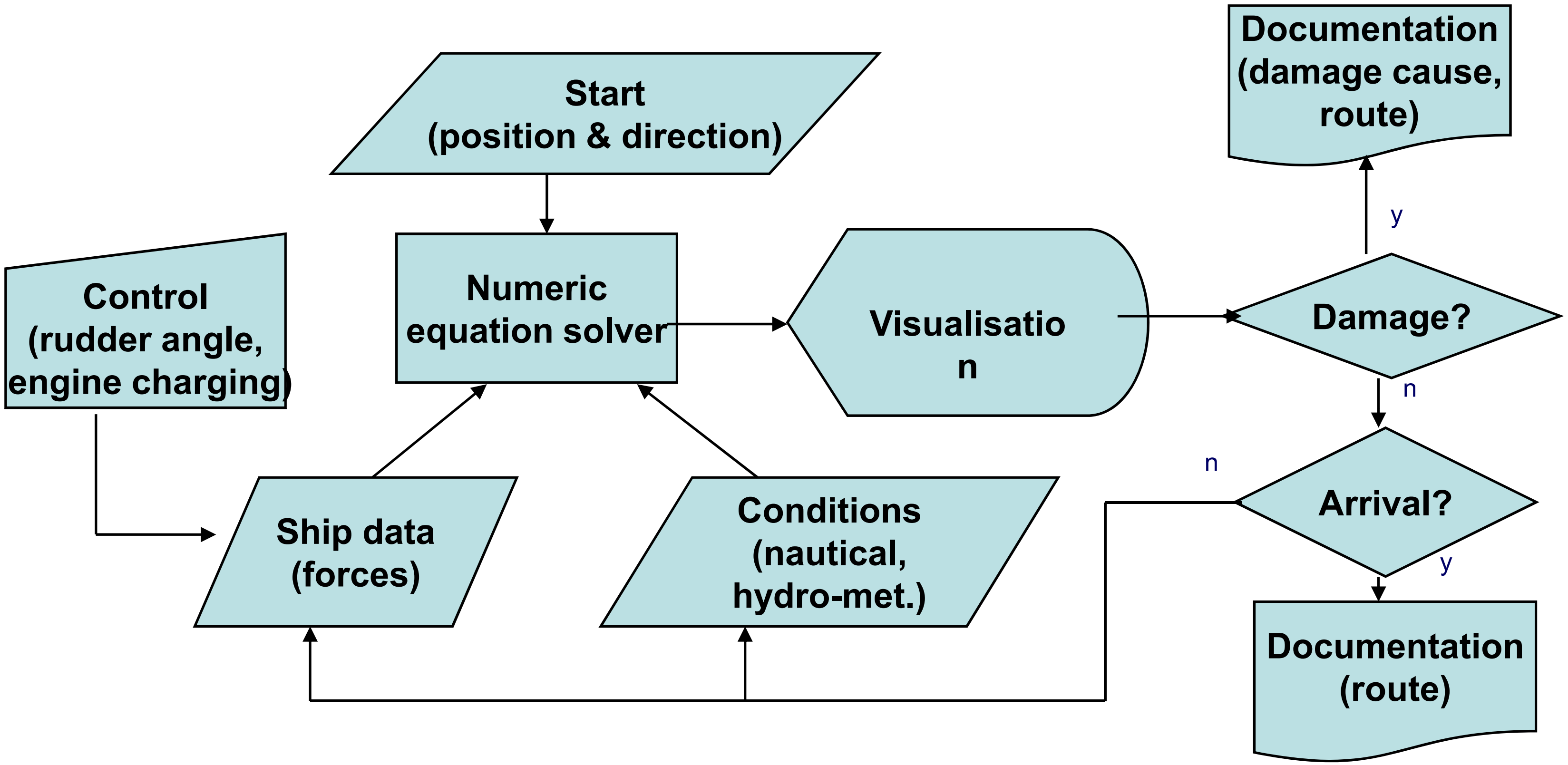


Flow speed



6. Program structure

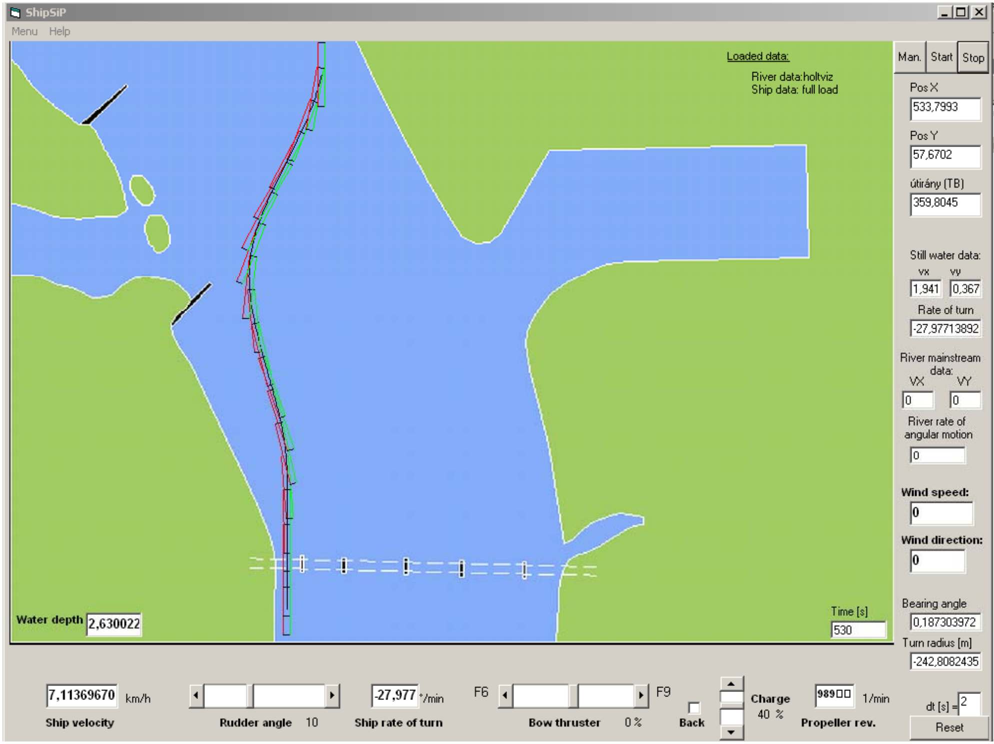
Flow chart of the program:



7. Validation

by zig-zag test results

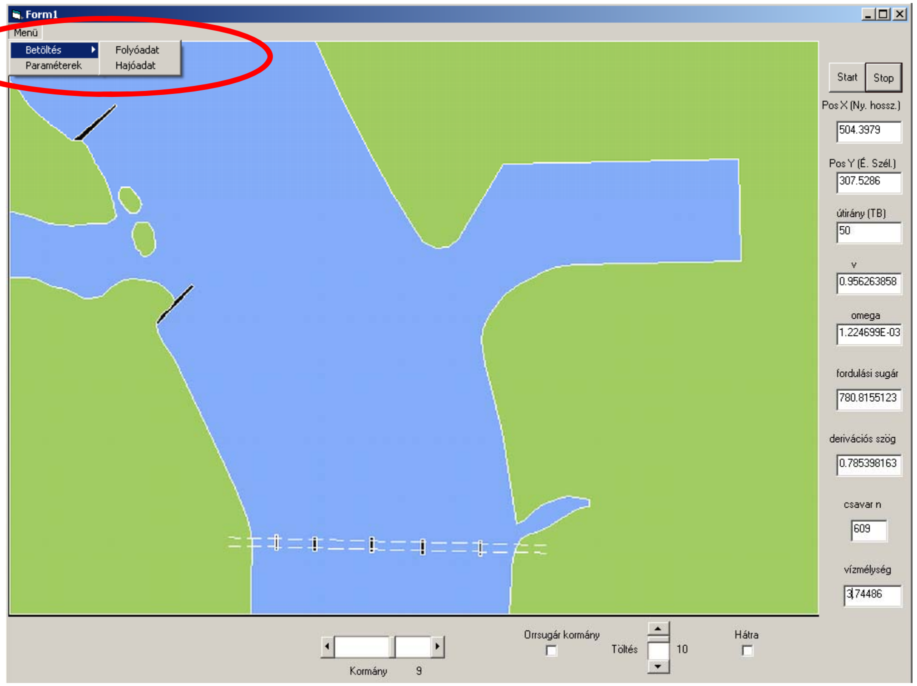
by nautical experts and captains

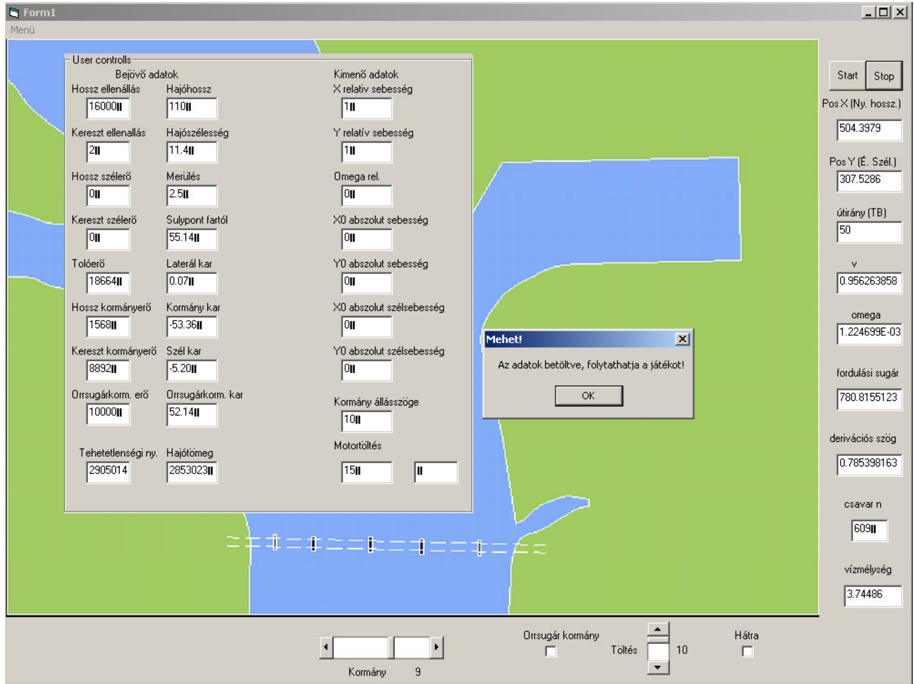


	Ship speed [km/h]	Rudder angle [°]	Course angle [°]	Max.turning speed [°/min]	Overshoot angle [°]	Course max. side distance [m]
Same length caravan test results	7.2	20	10	30	6	50
2D ship model	7.19	20	10	34	9	78

8. The simulation program

Loading of data for wind, water level, and ship's load cases

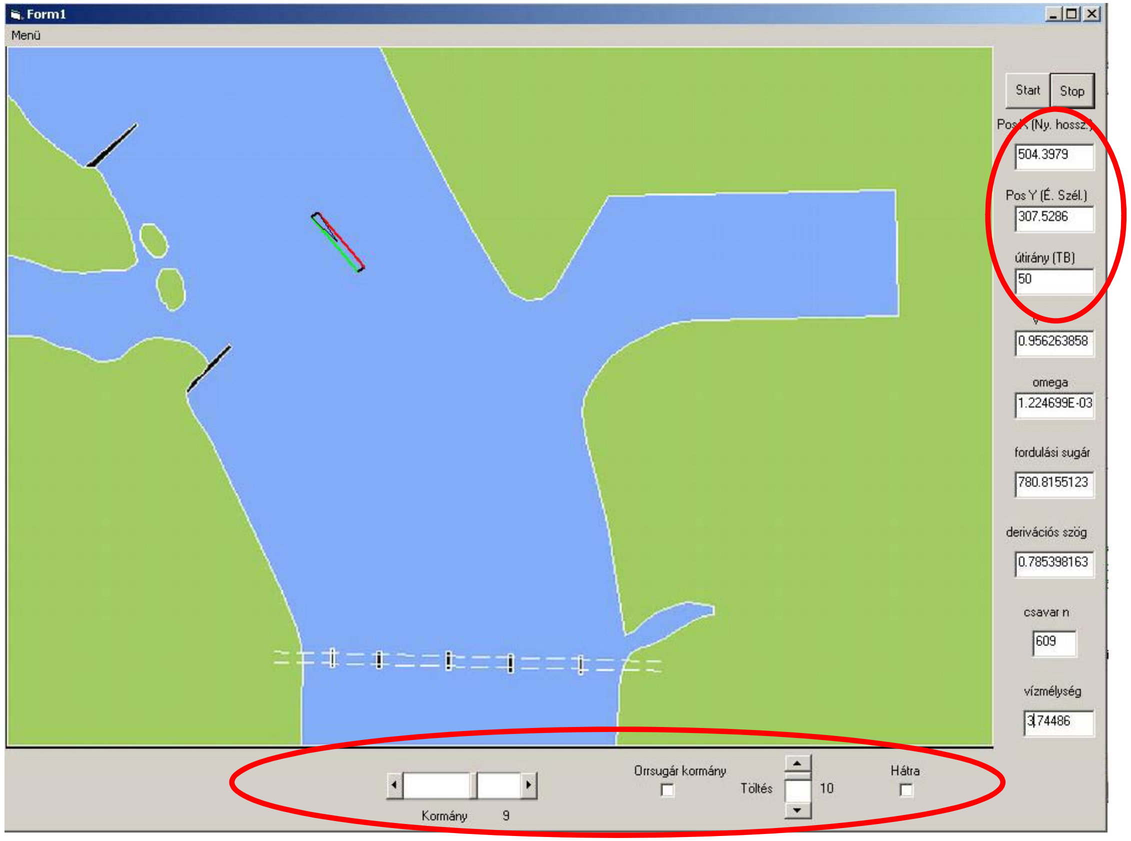




8. The simulation program

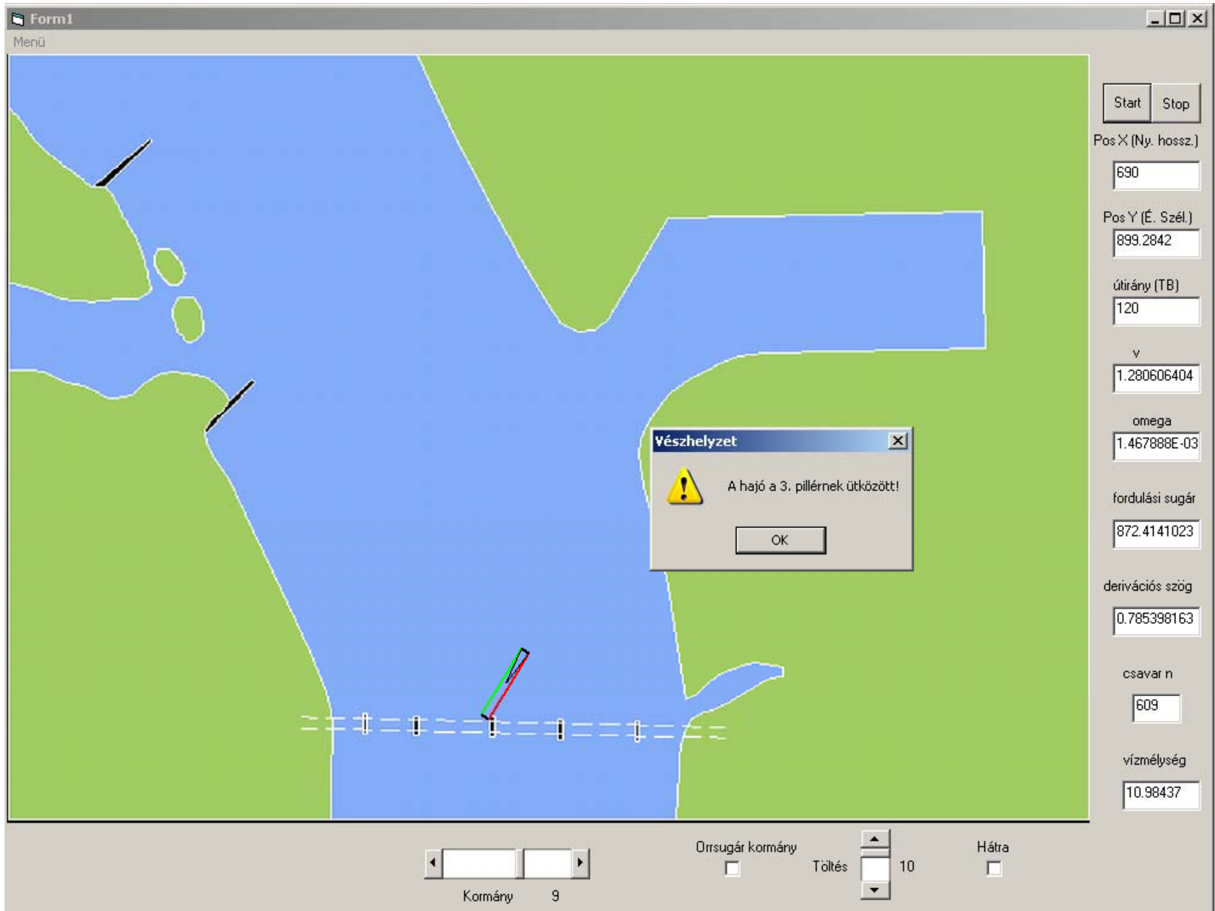
Starting position

Controll of the ship



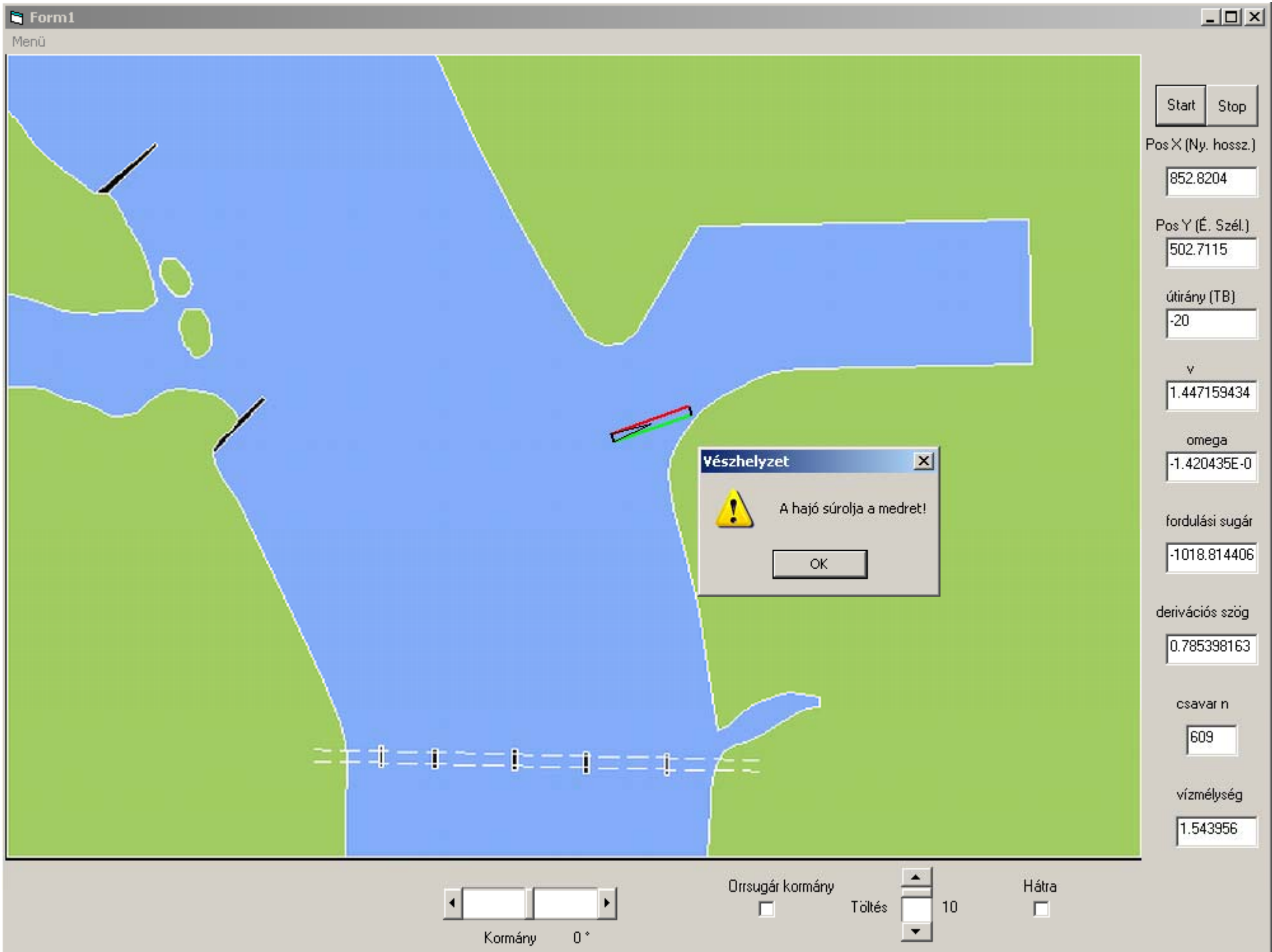
8. The simulation program

Collision with the bridge

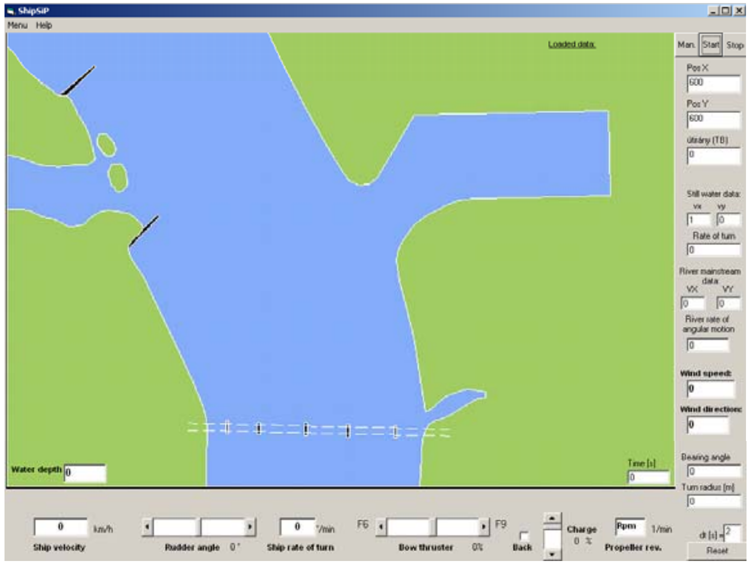


8. The simulation program

Grounding



9. Summary



Application of the simulation program:

- The new Baja port navigability can be examined by different port arrangements

- The program can be applied for different ships and nautical environments
    - Accident simulation up to the collision
    - Crew training
    - Different navigation situation study

Thank You for Your Attention

Dániel HADHÁZI, Csaba L. HARGITAI, Győző SIMONGÁTI

Budapest University of Technology and Economics,
Department of Aircraft and Ships,
H-1111, Budapest, Stoczek u. 6.
Phone: (36-1) 463-1922
Fax: (36-1) 463-3080
E-mail:
hadhazi@rht.bme.hu
hargitai@rht.bme.hu
gyozo@rht.bme.hu