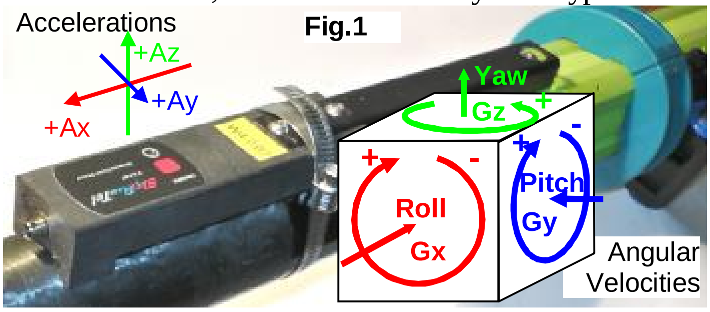
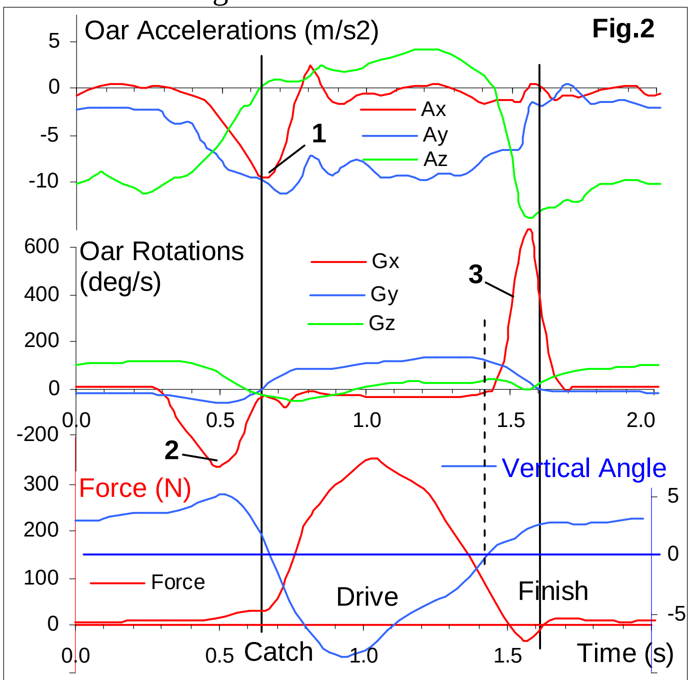
Rotational motions of the oar.

In October we have obtained the first data of the rotational motions of the oar measured with a new ***BioRow 7D*** wireless sensor. The sensor was mounted on the inboard near the button (Fig.1) and was capable of measuring the handle force (in similar way with the standard wired handle force sensor) as well as 3D accelerations and 3D oar rotations. The data through BlueTooth is transmitted to the Master unit of ***BioRowTel*** system, which can handle up to 8 sensors at the same time, so it works with any boat type.

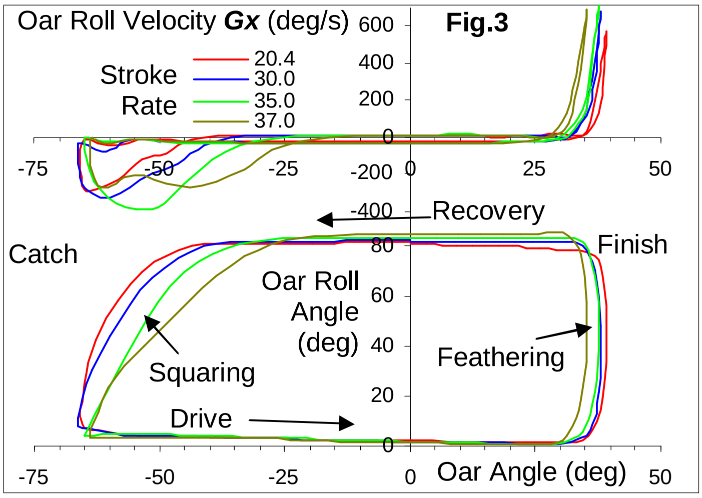


The frame of reference was set similarly to the boat motions analysis (RBN 2012/03) and the axes directions were defined by the design of the sensor. Fig.2 shows the oar accelerations and angular velocities together with the handle force and oar vertical angle obtained from the right oar in M1x at 30 str/min:



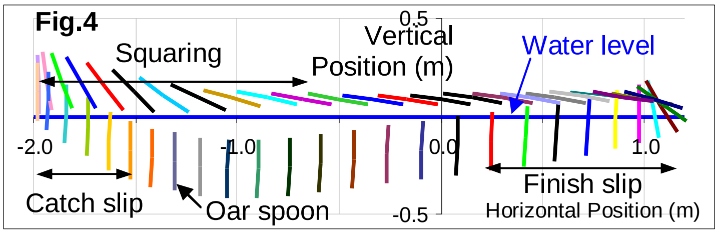
During the drive, the sensor is positioned underneath the oar upside down compared to the position on Fig.1, so ***Ay*** and ***Gy*** (pitch) are related to the vertical movements of the oar and ***Az*** and ***Gz*** (yaw) – to the horizontal ones. During recovery, the oar is rolled 90^o (feathered), so ***Ay*** and ***Gy*** became horizontal measures and ***Az*** and ***Gz*** – vertical ones. Also, the sensor rotates with the oar in horizontal plane for more than 100^o. At the catch, its ***X*** axis is positioned at about 30^o to the boat axis, so ***Ax*** measures the boat acceleration (Fig.2, 1). At the middle of the drive, the ***X*** axis of the sensor is close to the perpendicular to the boat, so ***Ax*** became very close to zero.

The most understandable and informative measured variable appeared to be the roll ***Gx***, which is clearly related to the squaring-feathering of the oar. Fig.2 shows (2) that the squaring takes about 0.35s and completed at the catch, when the oar change direction, but the blade is still in the air. The feathering in this sculler began, when the centre of the blade crosses the water level (3) and completed in about 0.25s – faster than squaring. Fig.3 shows the oar roll in the same M1x at various stroke rates:



At low rate, the squaring of the blade before catch takes about 15^o of horizontal movement of the oar. At the high rate, the squaring takes about the same time, but twice longer distance up to 40^o, because of much faster horizontal movement of the oar. The feathering distance at the finish is independent on the stroke rate.

The oar roll data in conjunction with horizontal and vertical oar angles allows ***BioRowTel*** software a full reconstruction of the oar movements relative to the water level. Fig.4 shows this reconstruction of the same M1x at the stroke rate 37 str/min:



In this sculler, **<u>the blade moves nearly half the distance of the recovery in a semi-squared position, which significantly increases losses on the aerodynamic drag resistance</u>** (RBN 2006/04).

More efforts required to build a mathematical model, which will combine complex data and allows explaining other measured variables. Normative values will be available after enough statistical data gathered. Using **<u>*BioRow 7D* wireless sensor brings very valuable information about oar handling skills in rowing and sculling</u>**.