Laser **A**ssisted **RO**botic **S**urgery of the anterior **E**ye **S**egment

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RE Restricted to a group specified by the consortium (including the Commission Services)
CO Confidential, only for members of the consortium (including the Commission Services)

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Summary

1 Executive Summary

This document reports the preliminary test carried out during the integration of all the modules in a single platform. Each module has been distinctly tested; preliminary results are described in D3.4 regarding the mechanical resolution/accuracy of the laser motorized handling system. In particular in this report preliminary results of recognition and detection of the corneal wound are given.

2 Corneal wound detection and centring

As described elsewhere, the surgeon performs a corneal cut in the patient's eye, in order to remove the diseased tissue and prepare the recipient bed to receive the donor's cornea. The corneal wound is then treated with a Indocyanine Green solution. The indocyanine solution fosters the welding requiring low energy levels provided by the laser to achieve a good closuring of the tissue.

Moreover, the colour of the indocyanine solution helps the detection of the corneal wound, or from a controller point of view, the corneal path to follow by the LA-ROSES Master system controller. In D4.1 we explained the methodology we developed to detect the contour of the cornea using an eye mock-up. Also we developed a preliminary MATLAB GUI SW controller integrating communication channel between the master PC and the robot controller to send movement commands to the robot in order to move the end-effector as to align the NIR camera center with the cornea center.

Fig. 1 and 2 show the result of this preliminary results in centring the cornea.

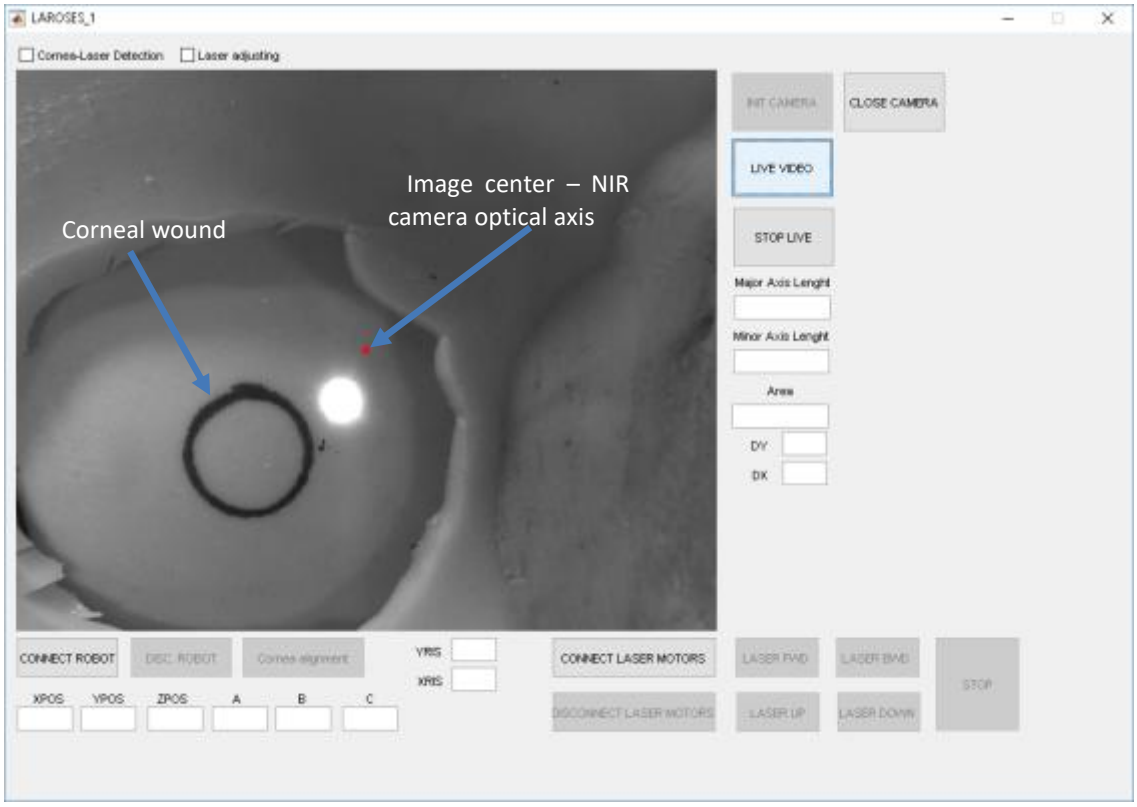

Fig. 1 – initial positioning of LA-ROSES laser system. The NIR camera centre is not aligned with the cornea center

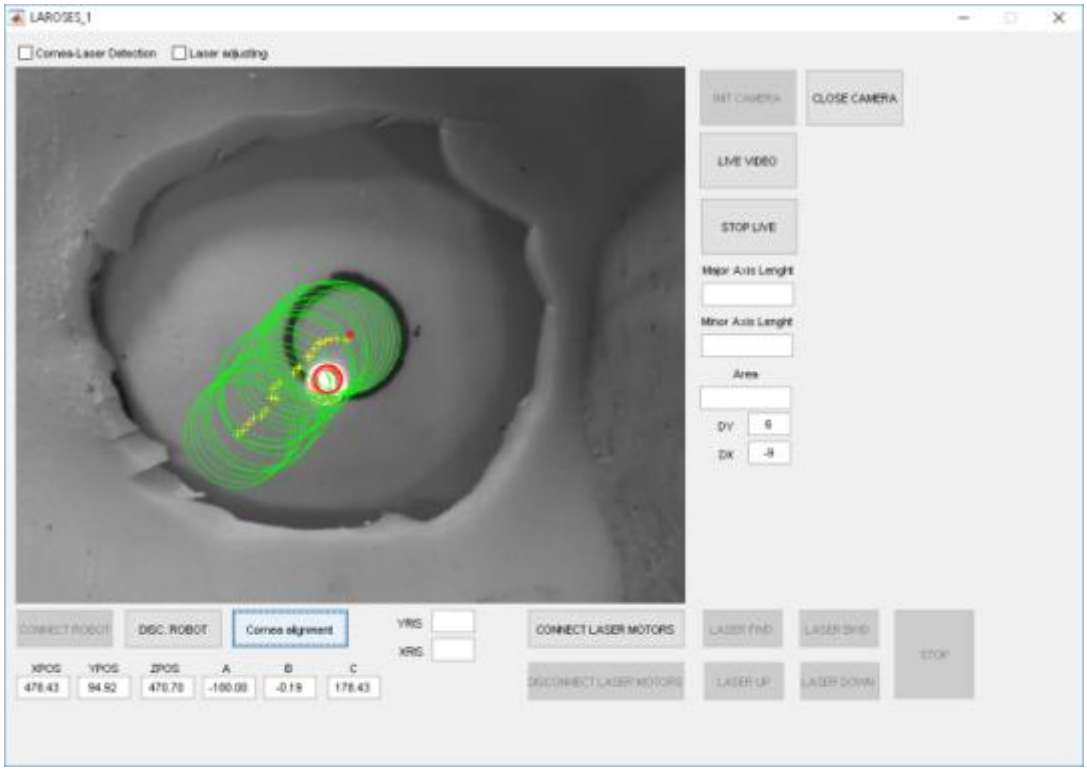

Fig. 2 - Preliminary LA-ROSES visual servoing control scheme implementation

As depicted in fig. 1 a gross initial positioning at the correct distance above the patient eye is performed by the system. The initial height positioning can be automated because of the height of the operating bed is known. What is necessary to be automatized is the alignment on the X-Y plane. This can be realized applying a simple VS method: the measured error on the image reference system, i.e. the error distance measured in pixel units between the image center (NIR camera optical axis – centre of the laser handling system) and the center of the cornea is directly used by the robot controller to drive accordingly movements of the arm as to reduce this distance error. Fig. 2 shows the path travelled by the robot arm to align the camera with the cornea center. Also the laser spot is detected applying the method described in D4.1. The system stops the robot as the Euclidean distance between the image center and the cornea center falls under a specified threshold.

The robot controller program is very simple. It waits for a movement commands and update X and Y positioning tool variables relative to the robot base world frame taking into account the Euclidean distance measured in pixel units. If this distance is greater than a threshold value named D1 the X and Y variables are updated with motor displacement error value of about 2mm. As the distance decreases below a short threshold D2 the robot moves towards the cornea center updating its tool coordinates of 0.05mm (the robot accuracy). At the end of this procedure the laser handling unit is aligned along the perpendicular of the cornea center.