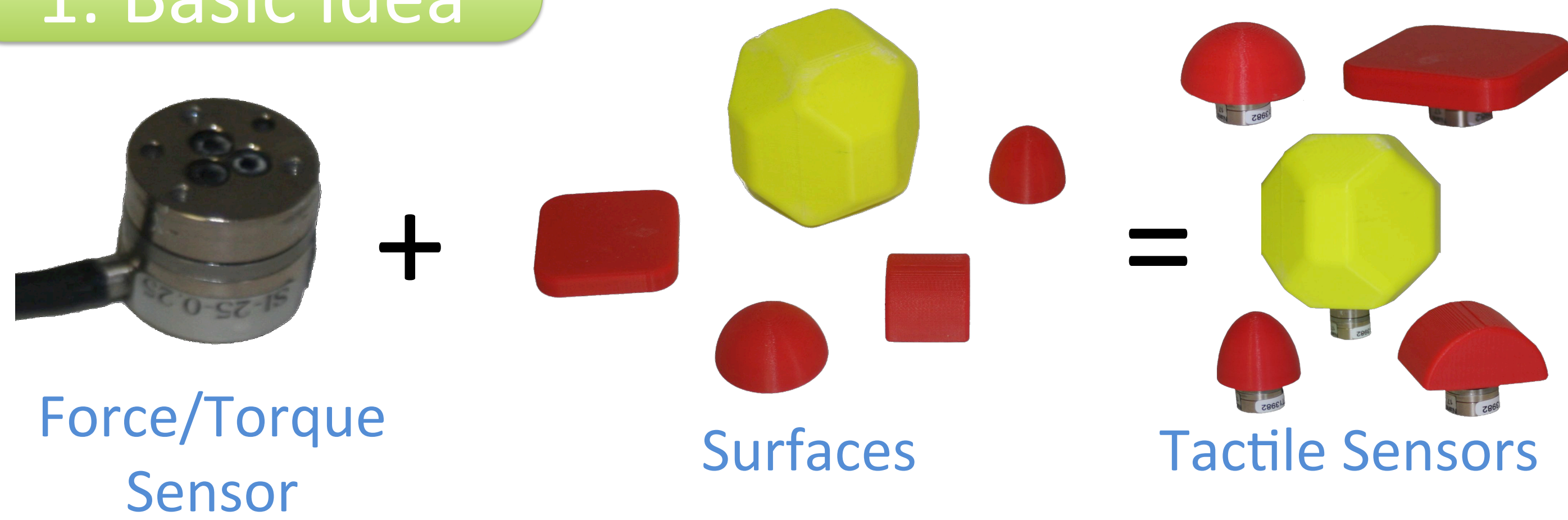
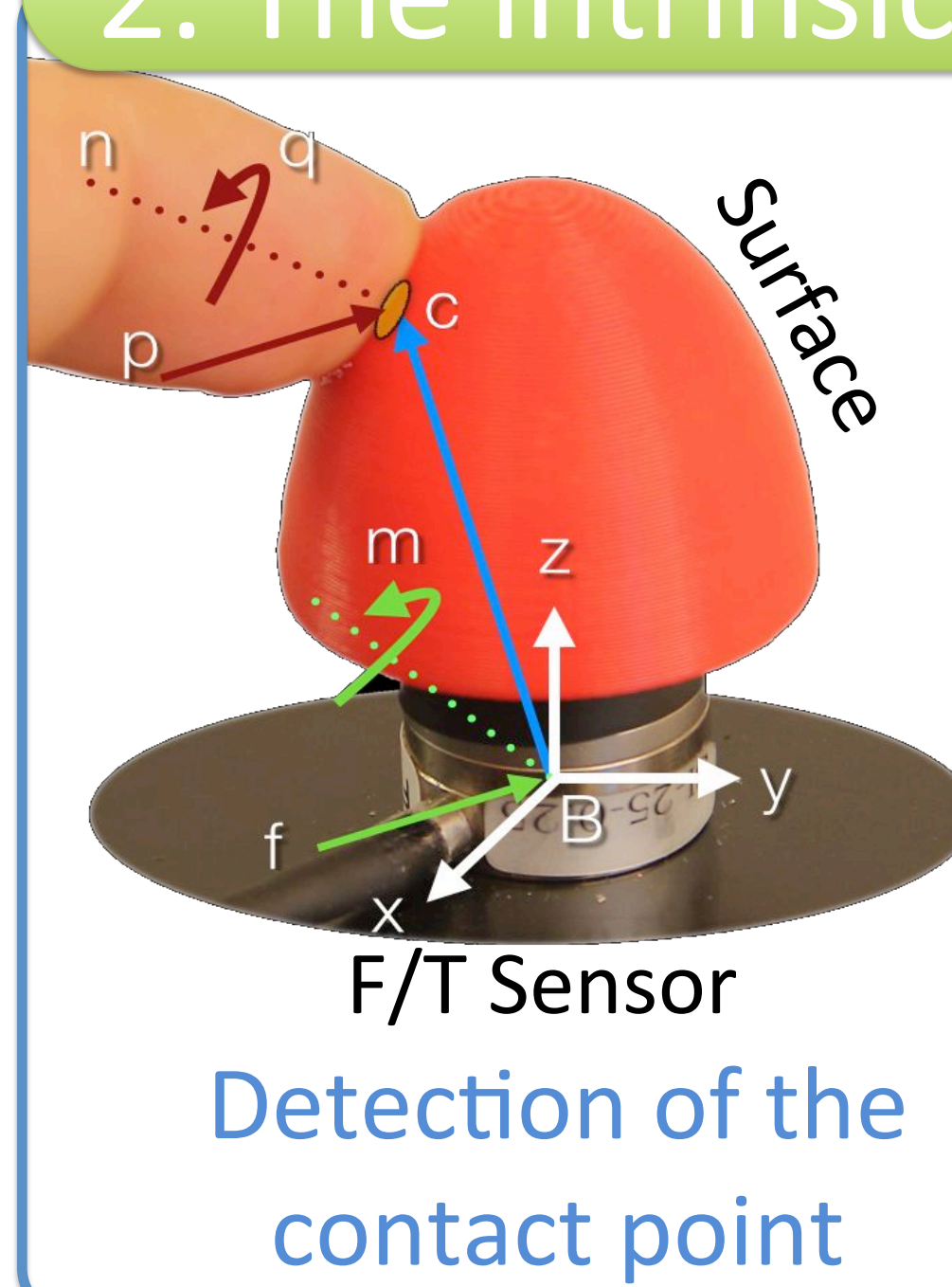


1. Basic Idea



With a Force/Torque sensor and a surface fixed on it one can build a tactile sensor!

2. The Intrinsic Tactile Sensing Algorithm



Given the measured force and torque, and knowing the geometry of the surface, we determine the location of contact centroid, the contact force and local spin torque. From this, one can find contact position, normal and frictional components of force and detect slippage [1].

3. What Do We Do

The tactile toolbox is an open source and redistributable software implementation of the Intrinsic Tactile Sensing Algorithm.

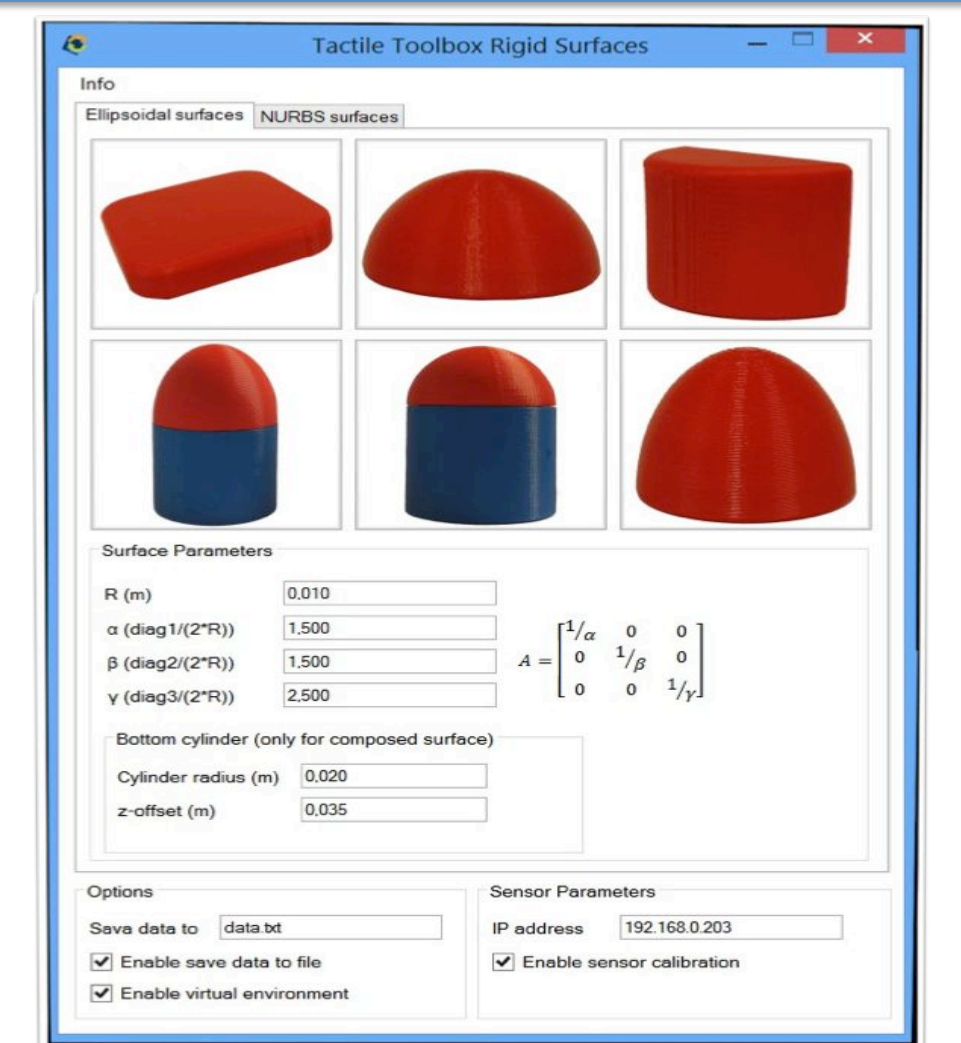
C++ (with CHAI 3D) & Matlab© Implementation

A Graphical User Interface

C++ & Matlab© driver for ATI Force/Torque Sensors

Real time visualization of the contact point and the related forces and torques on a virtual scene

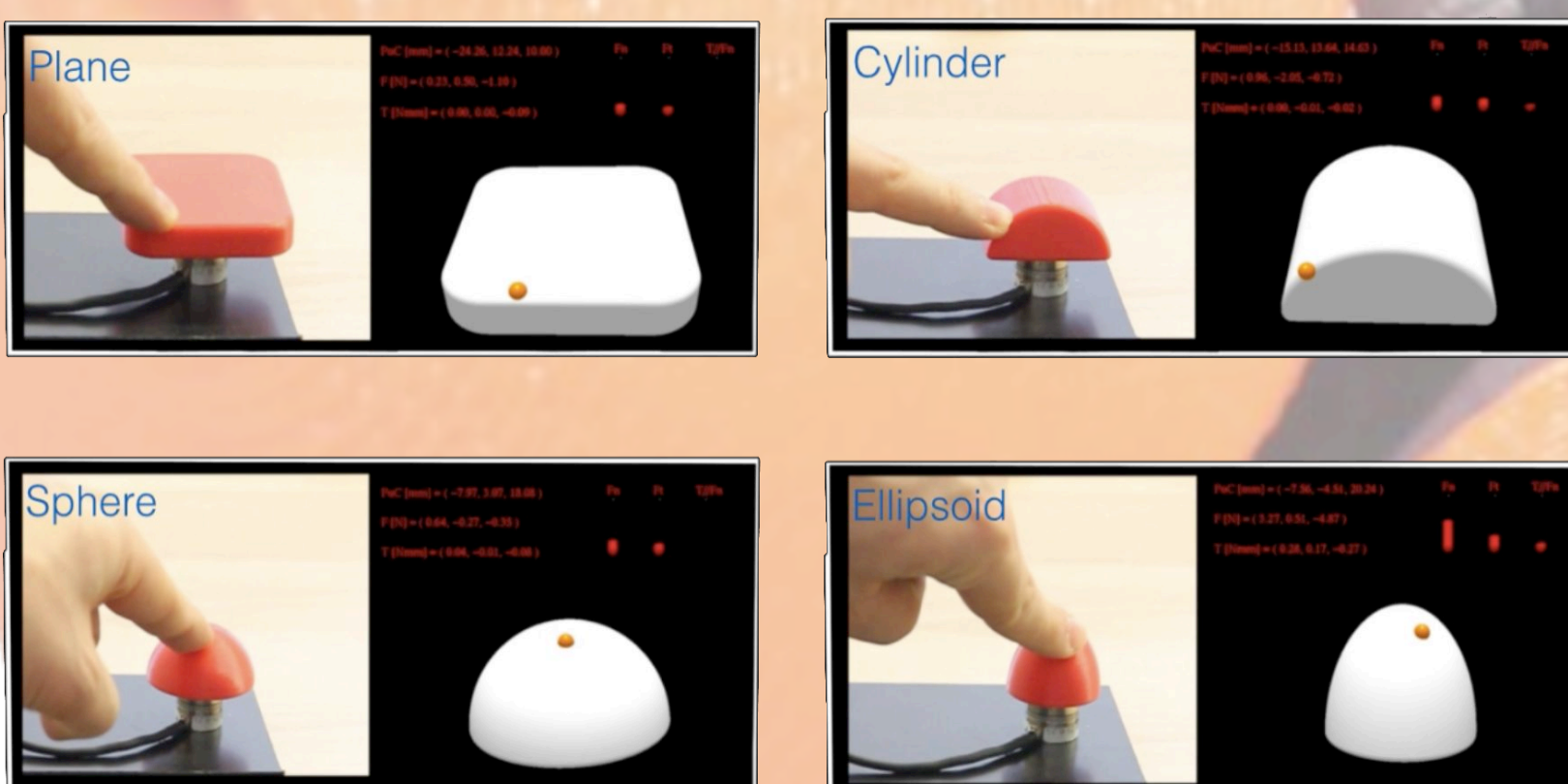
Main Features



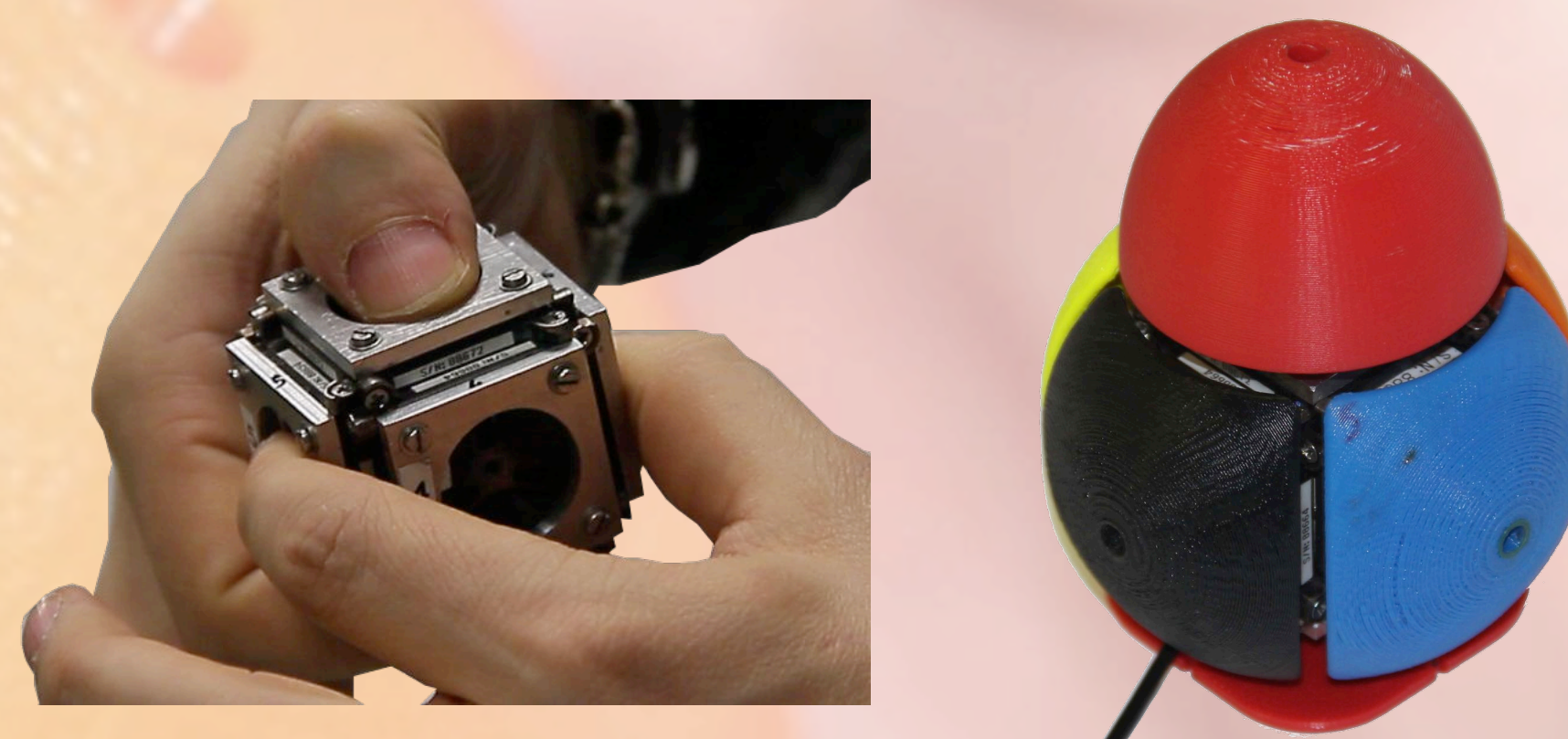
The Tactile Toolbox GUI

4. Ellipsoidal Surface

If the surface fixed on the Torque/Force sensor is plane or a cylinder or a sphere or an ellipsoid the contact centroid problem has a closed form solution, thus simple tactile sensors can be built.



Examples of the tactile toolbox for ellipsoidal surfaces

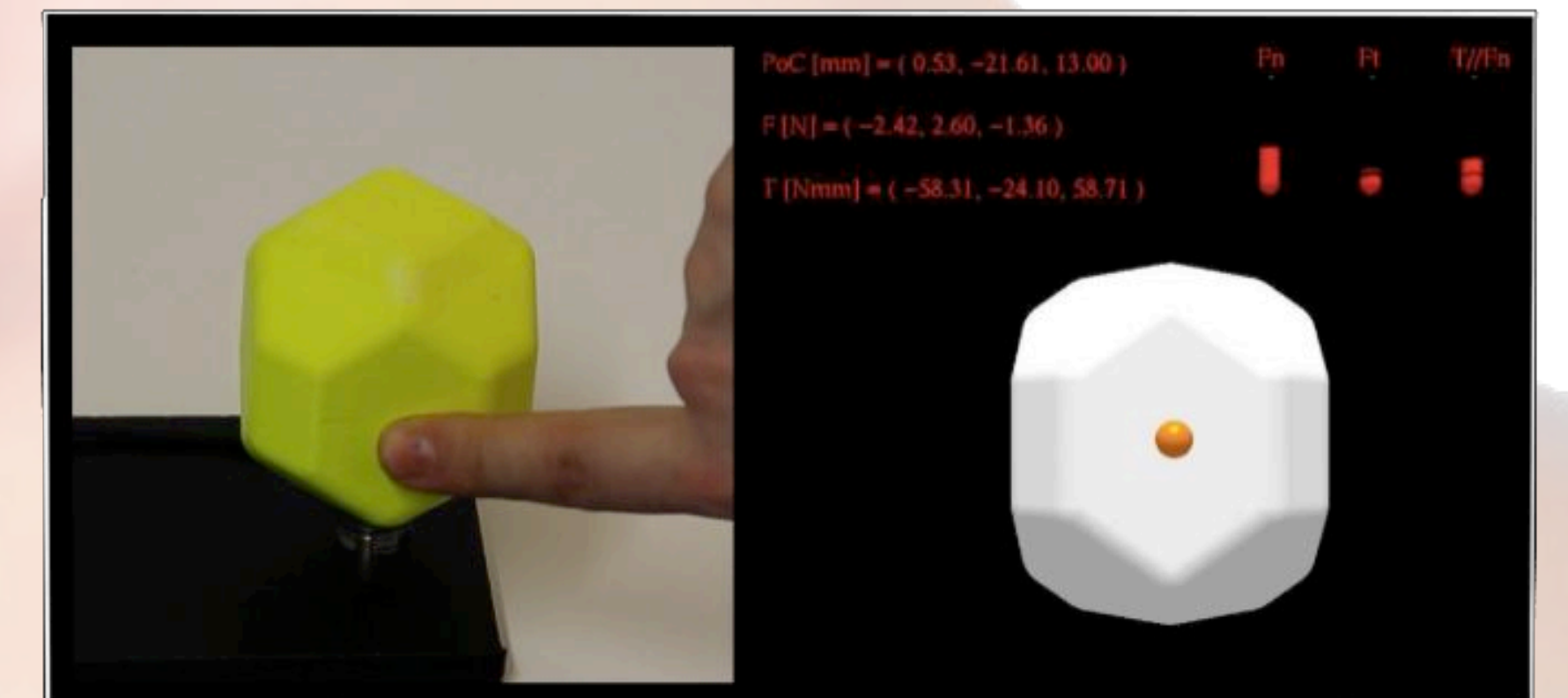


The Patched Intrinsic Tactile Object

Every surface can be used for building a tactile sensor!

5. NURBS

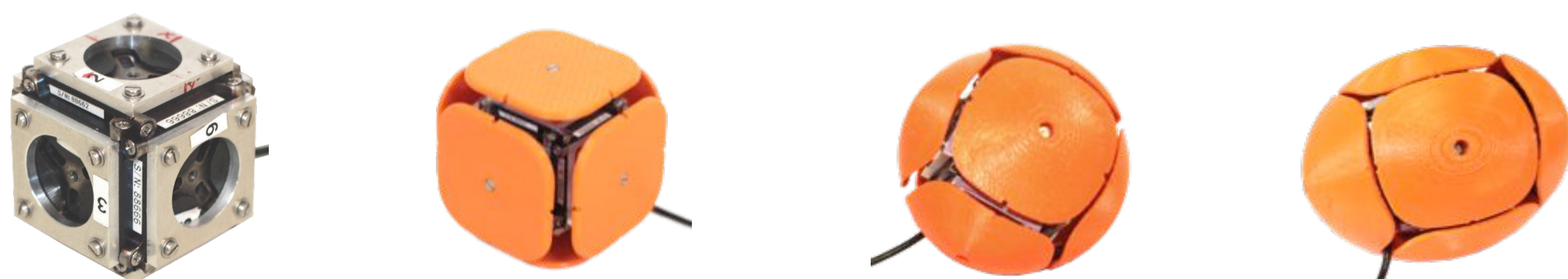
If the surface considered is not ellipsoidal one can use the NURBS (Non Uniform Rational B-Splines) for parametrizing this surface. In this case the Intrinsic Tactile Sensing Algorithm has an efficient iterative solution.



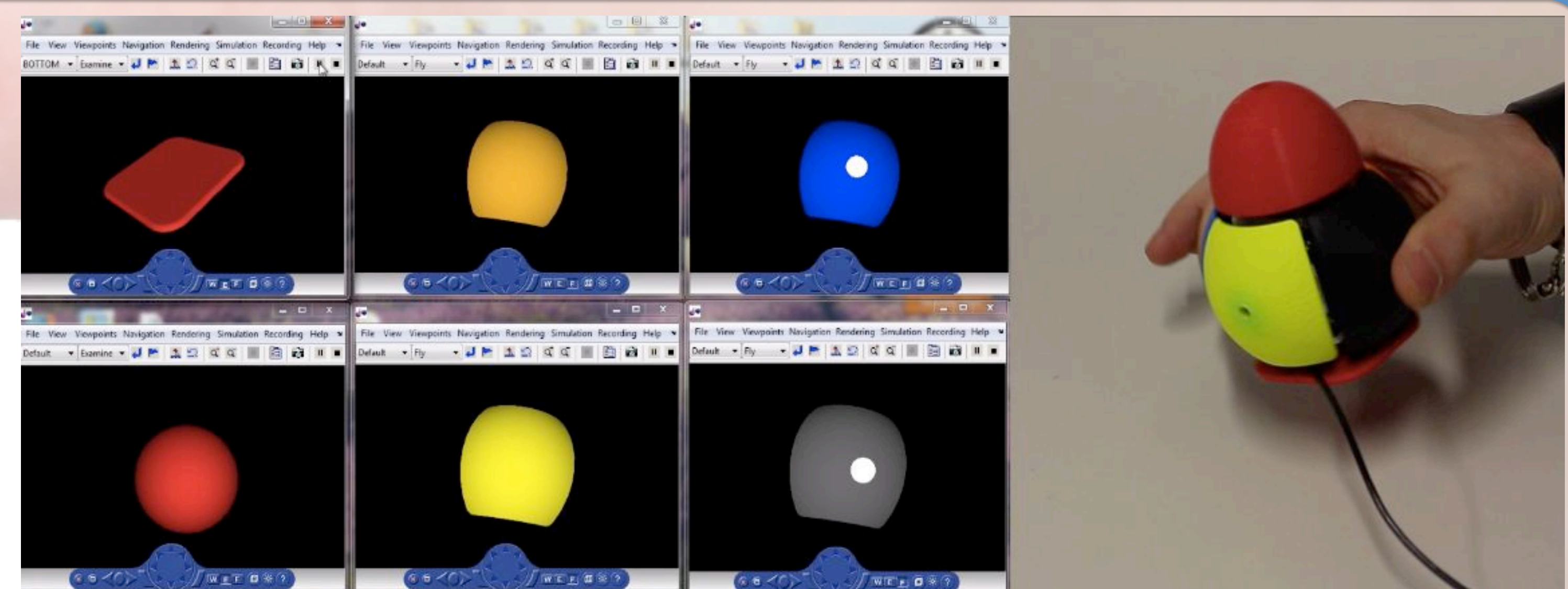
NURBS example

6. The Patched Intrinsic Tactile Object

The Patched Intrinsic Tactile Object is a sensorized object capable of multi-touch detection. The sensor is composed of six 6-axis F/T sensors spatially organized on the faces of a cube. Thanks to the modular design and the possibility to cover the sensitive faces with surface patches a variety of sensorized objects with different shapes can be realized.



From left to right: the core of the Patched Intrinsic Tactile Object, the cubical, spherical and ellipsoidal arrangement, respectively



An example of the Patched Intrinsic Tactile Object during a grasp

The peculiar feature that all the components of the contact wrench can be measured on each face with high accuracy, renders the Patched Intrinsic Tactile Object a unique tool in the study of grasp force distribution in humans and robots.

Essential Reference

[1] Bicchi, J. K. Salisbury, and D. L. Brock. Contact Sensing from Force and Torque Measurements. *The Int. J. of Robotics Research*, 12(3):249-262, 1993

Acknowledgements

This work is supported by the European Research under:

