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3D SURFACE SCANNER
USING STRUCTURED LIGHT & INDUSTRIAL ROBOT

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DTU

Introduction

Having a detailed surface reconstruction of an object is very valuable in for example geometric modeling, to store an art piece for the future or to scan real objects to use in computer graphics such as 3D drawings, computer games etc..

The 3D surface scanner is build by mounting a structured light scanner (STL Scanner) on the arm of an Industrial Robot. The robot is controlled by a special designed interface.

Imaging Robot

The imaging robot is an industrial robot from ABB Robotics with an interface designed for performing imaging tasks. A camera, laser or STL scanner can be mounted on the robot. →
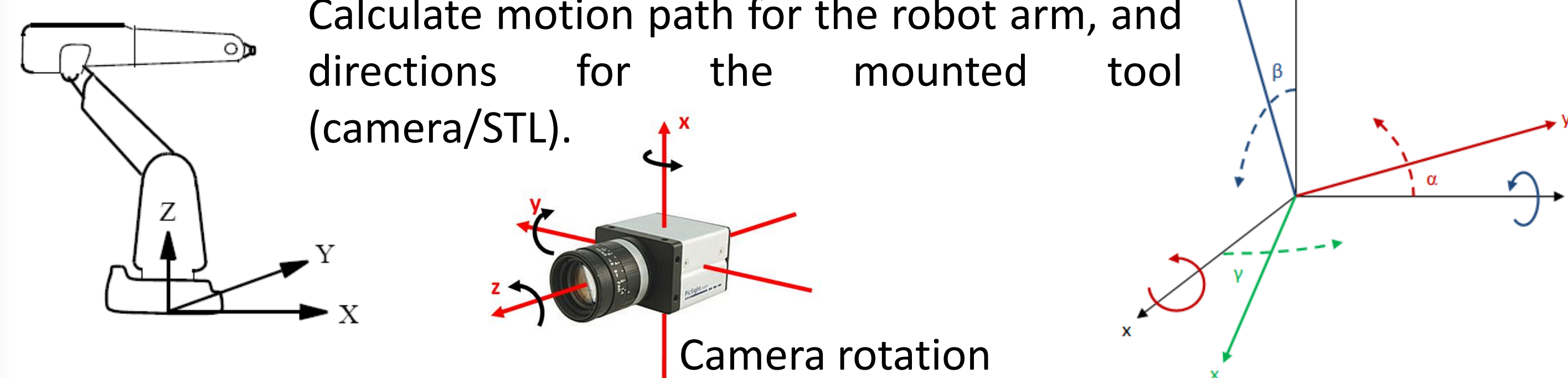
← The interface to calculate the robots motions is programmed in Matlab, and can also predict collisions with the surroundings and specified objects.
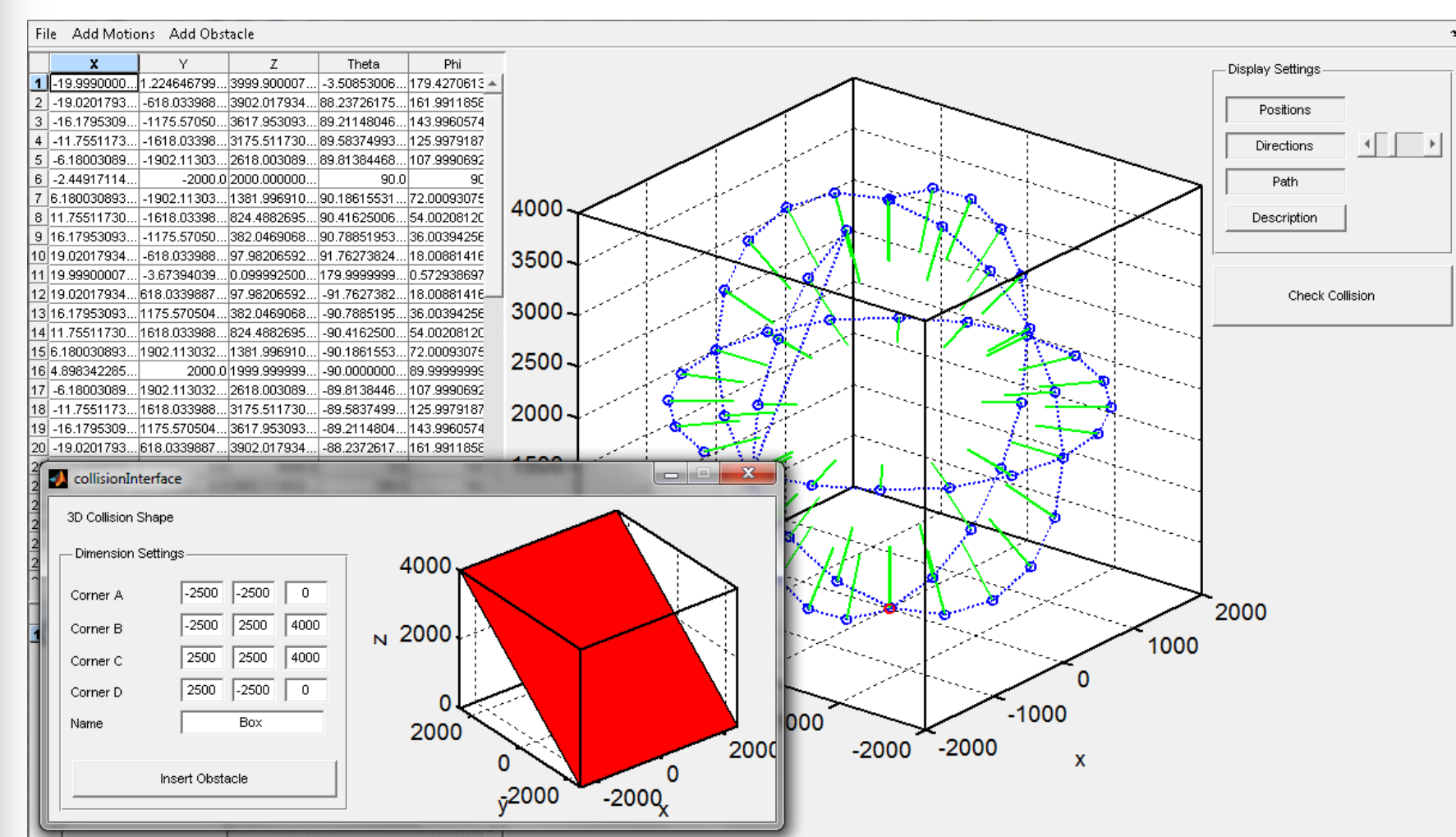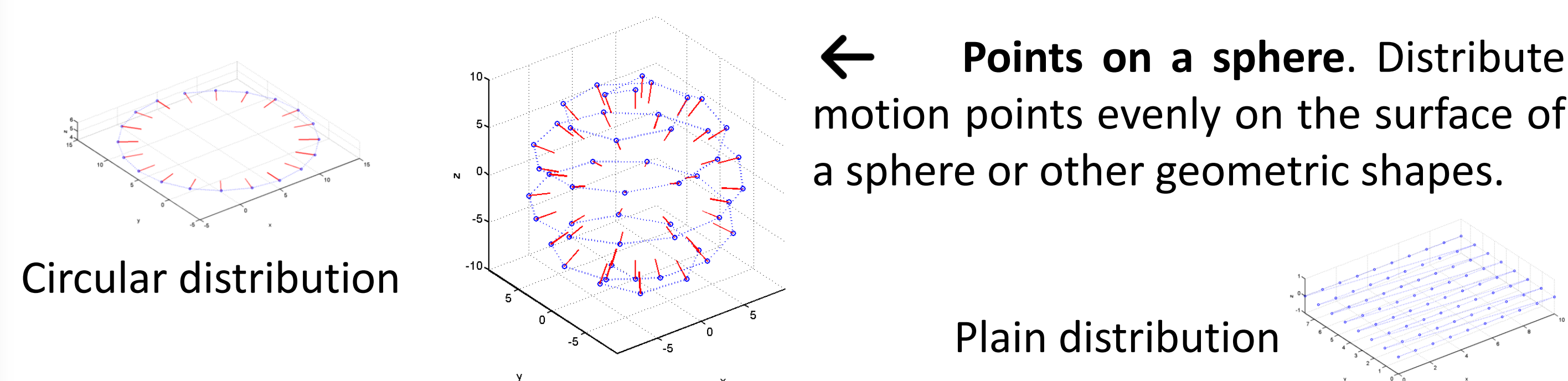
SPECIFICATION & FEATURES

← **Cartesian coordinates & Euler Angles.** → Calculate motion path for the robot arm, and directions for the mounted tool (camera/STL).
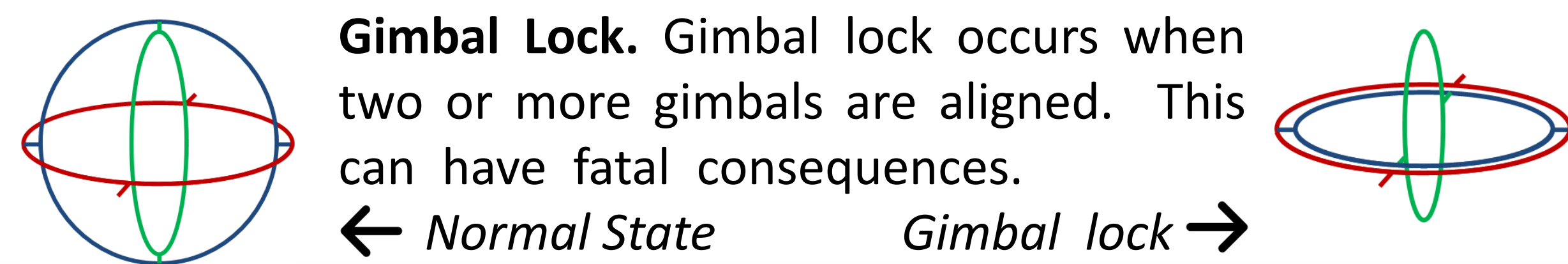
Camera rotation

← **Points on a sphere.** Distribute motion points evenly on the surface of a sphere or other geometric shapes.

Circular distribution

Plain distribution

OBSTACLE

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Gimbal Lock. Gimbal lock occurs when two or more gimbals are aligned. This can have fatal consequences.

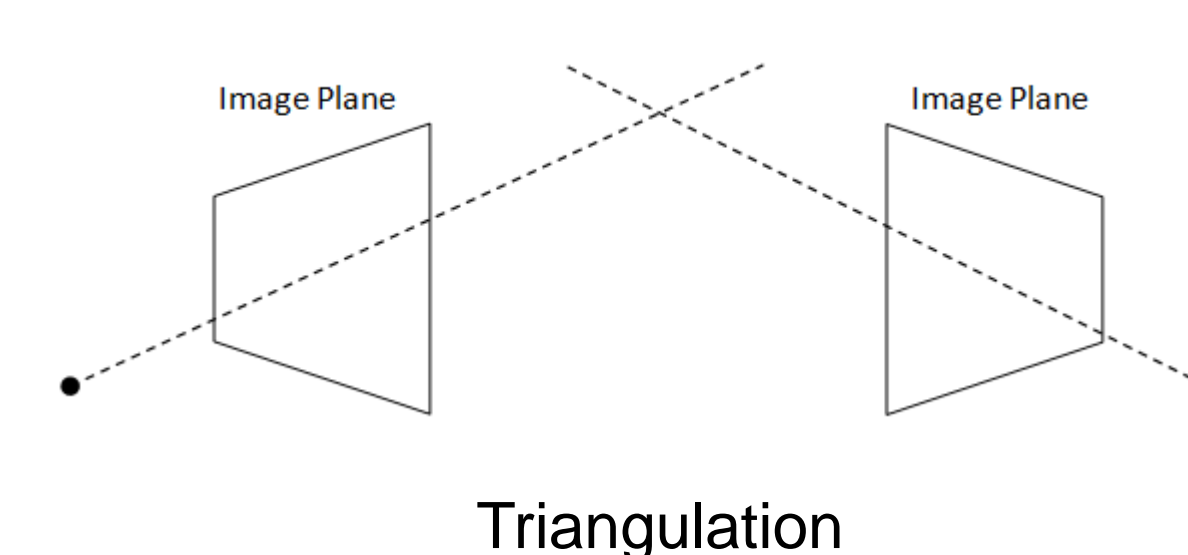← *Normal State*   *Gimbal lock* →

Structured Light Scanner

The Structured Light Scanner consists of two cameras and a projector. The setup uses two Point Grey cameras, and a pico projector which makes is so small that its mountable on the Imaging Robot arm. →
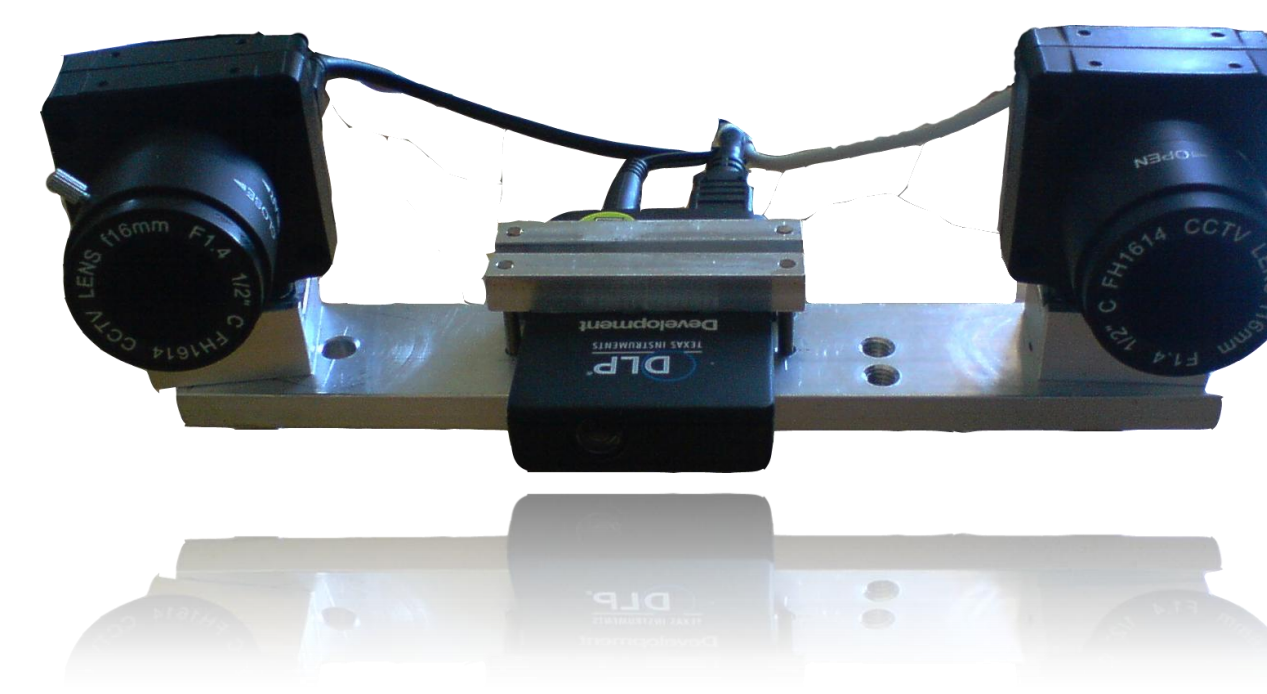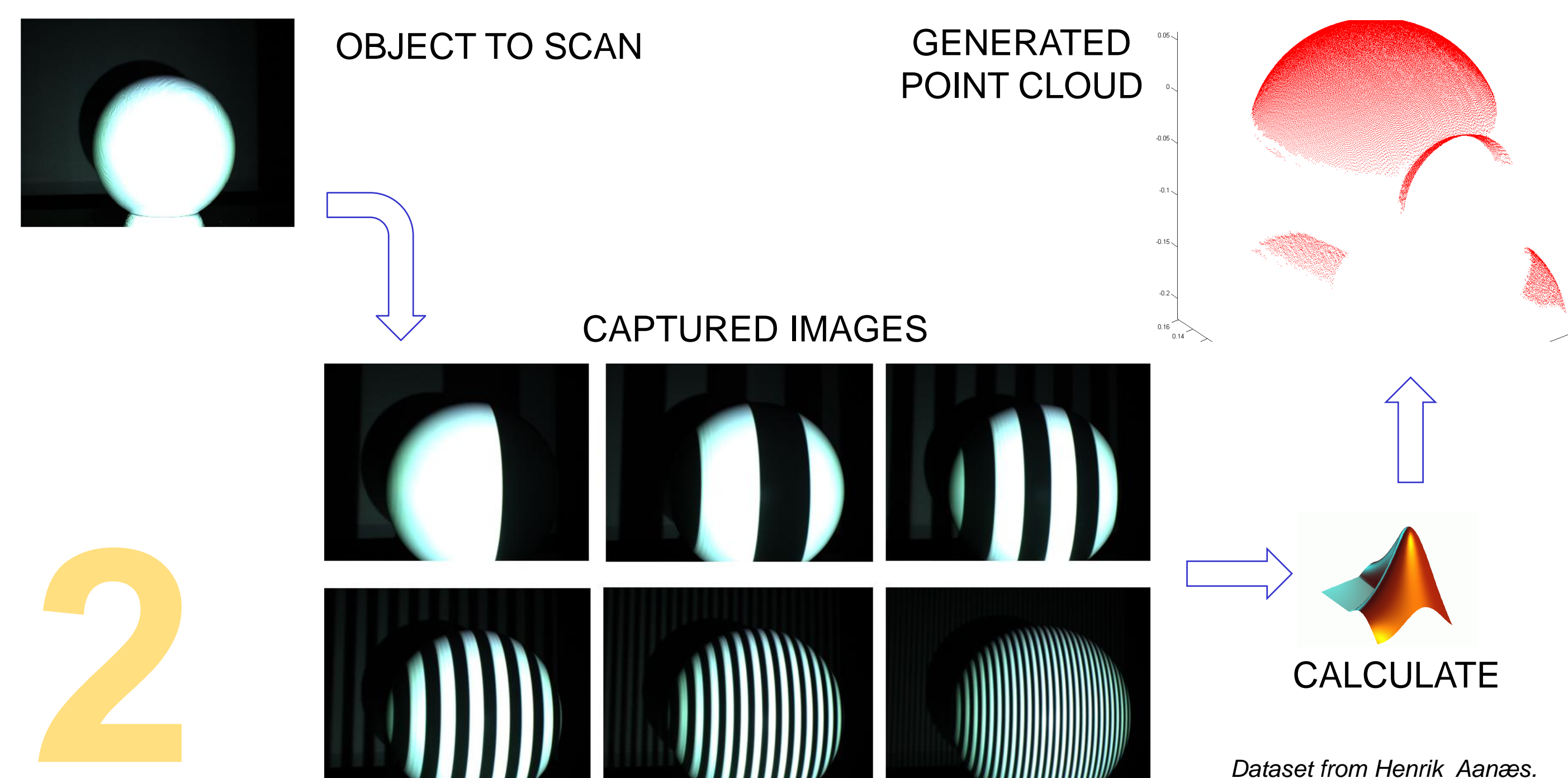
HOW IT WORKS
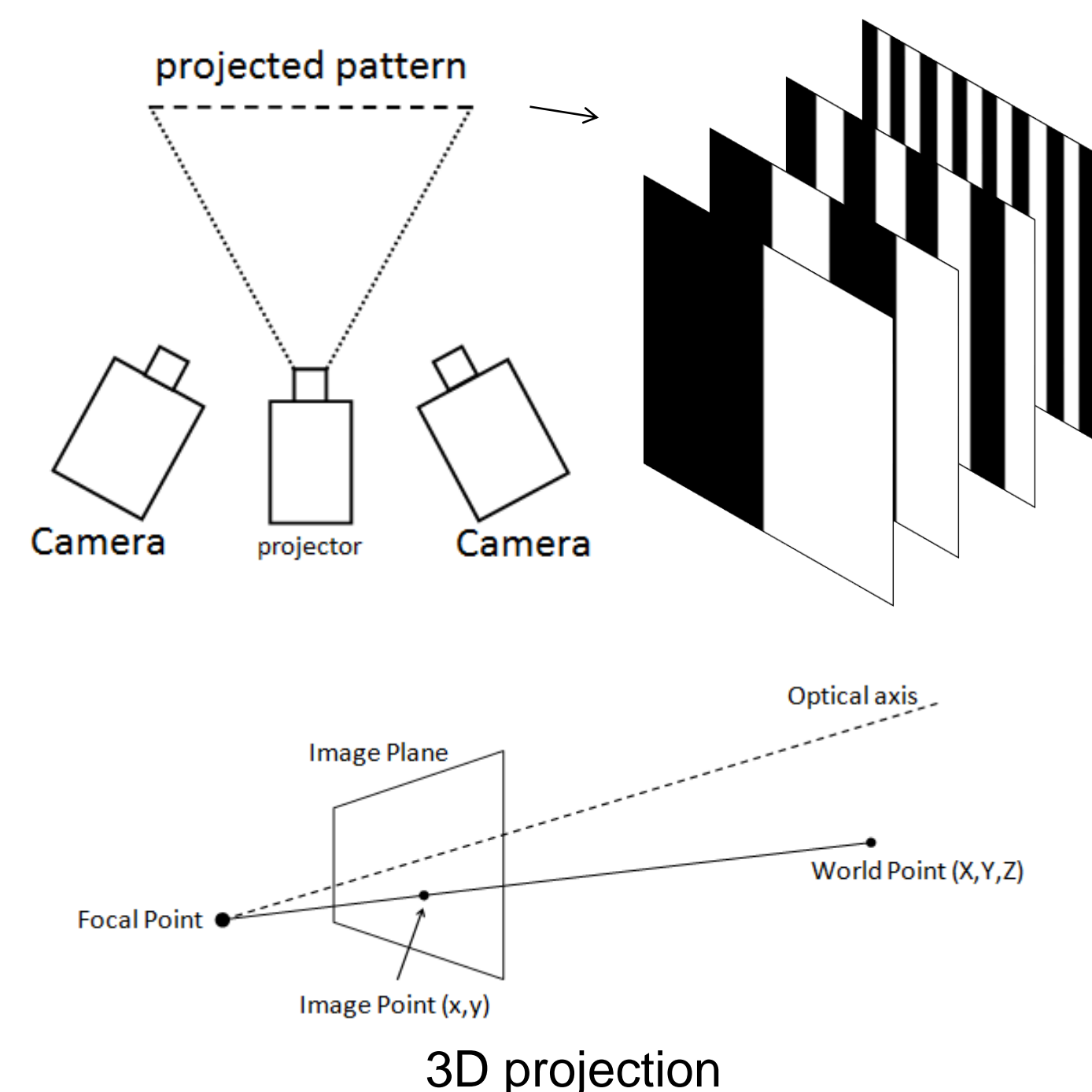
← The projector projects a binary coded pattern on to the object. The cameras captures the result for every projected pattern, and by using triangulation, its possible to construct a point cloud representing the scanned object.

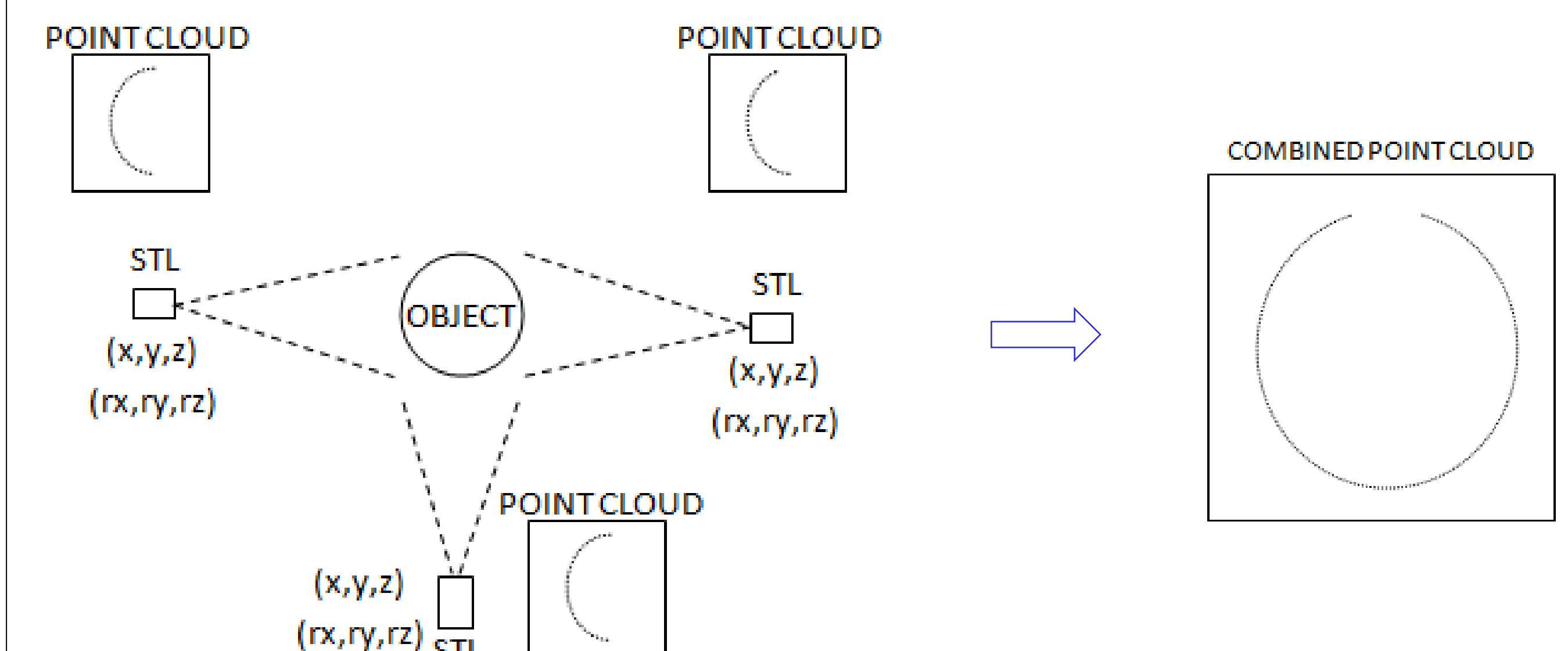Camera   projector   Camera

Optical axis

Image Plane

Focal Point

World Point (X,Y,Z)

Image Point (x,y)

3D projection

Image Plane   Image Plane

Triangulation

EXAMPLE

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OBJECT TO SCAN

GENERATED POINT CLOUD

CAPTURED IMAGES

CALCULATE

Dataset from Henrik Aanæs.

3D Surface Scanner

Mounting the STL scanner on the robot gives the potential for approximately full surface scan of complex objects.
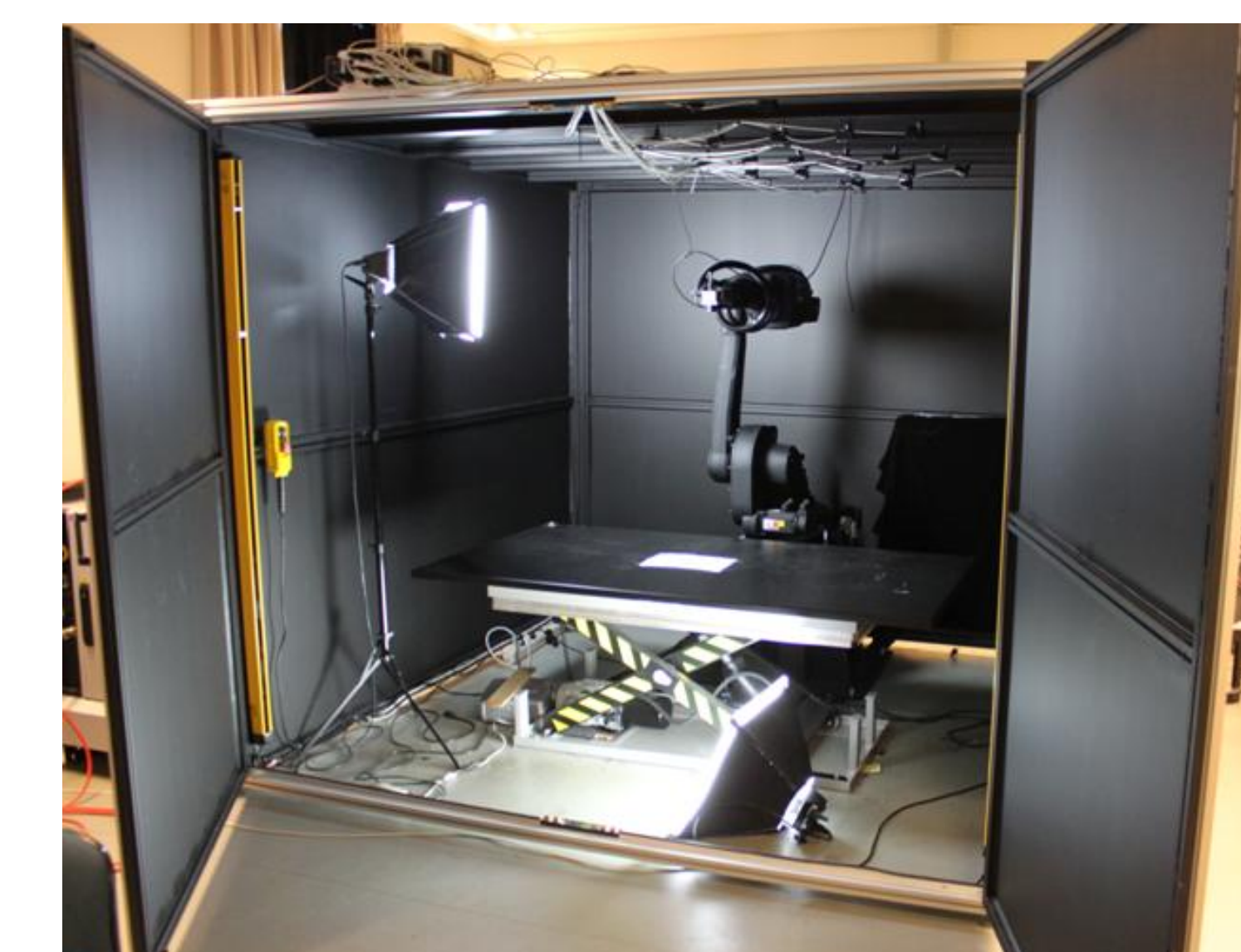
HOW IT WORKS

Moving the STL scanner around the object and recording the exact positions and directions of the scanner and the generated point clouds. Then it is possible to combine all the point clouds to one full surface point cloud.

POINT CLOUD   POINT CLOUD   COMBINED POINT CLOUD

STL
(x,y,z)
(rx,ry,rz)

OBJECT

STL
(x,y,z)
(rx,ry,rz)

POINT CLOUD

(x,y,z)
(rx,ry,rz)   STL

↑ Capturing datasets and generating point clouds from multiple angles. Recording all the positions and rotations of the scanner.

Rotating, moving and ↑ combining point clouds.

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IMM INDUSTRIAL ROBOT

ROBOT COMPUTER

INDUSTRIAL
Wednesday 11 May

DTU INFORMATICS
Department of Informatics and Mathematical Modelling

Imaging Robot | Bachelor Project 2010
Structured Light Scanner | Special Course 2011