MetMap

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Vision Inspection Advantages of Mounting Optical Probes on Five Axis Measurement Systems

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REVO

- 5 Axis CMM Metrology
- Multi-sensor Technologies

REVO Vision Probe (RVP)

- Capabilities
- Lenses
- 3D Measurement by Projection
- 3D Measurement by Triangulation
- Inspection Techniques
- Application Examples

REVO
5 Axis CMM Metrology

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REVO – 5 Axis CMM Metrology

Traditional 3 Axis CMM Heads:

- Enable probe orientation to feature
- Most heads orient to discrete angles
  - Typically to distinct index angles
  - PHS2 can operate at any angle
- Angular positioning is very repeatable
- Calibration typically required at each orientation used
  - PH10M-iQ PLUS has inferred calibration with certain probes
- Measurement with 3 axis motion
  - Head angles remain locked/fixed

REVO – 5 Axis CMM Metrology

REVO 5 Axis Head:

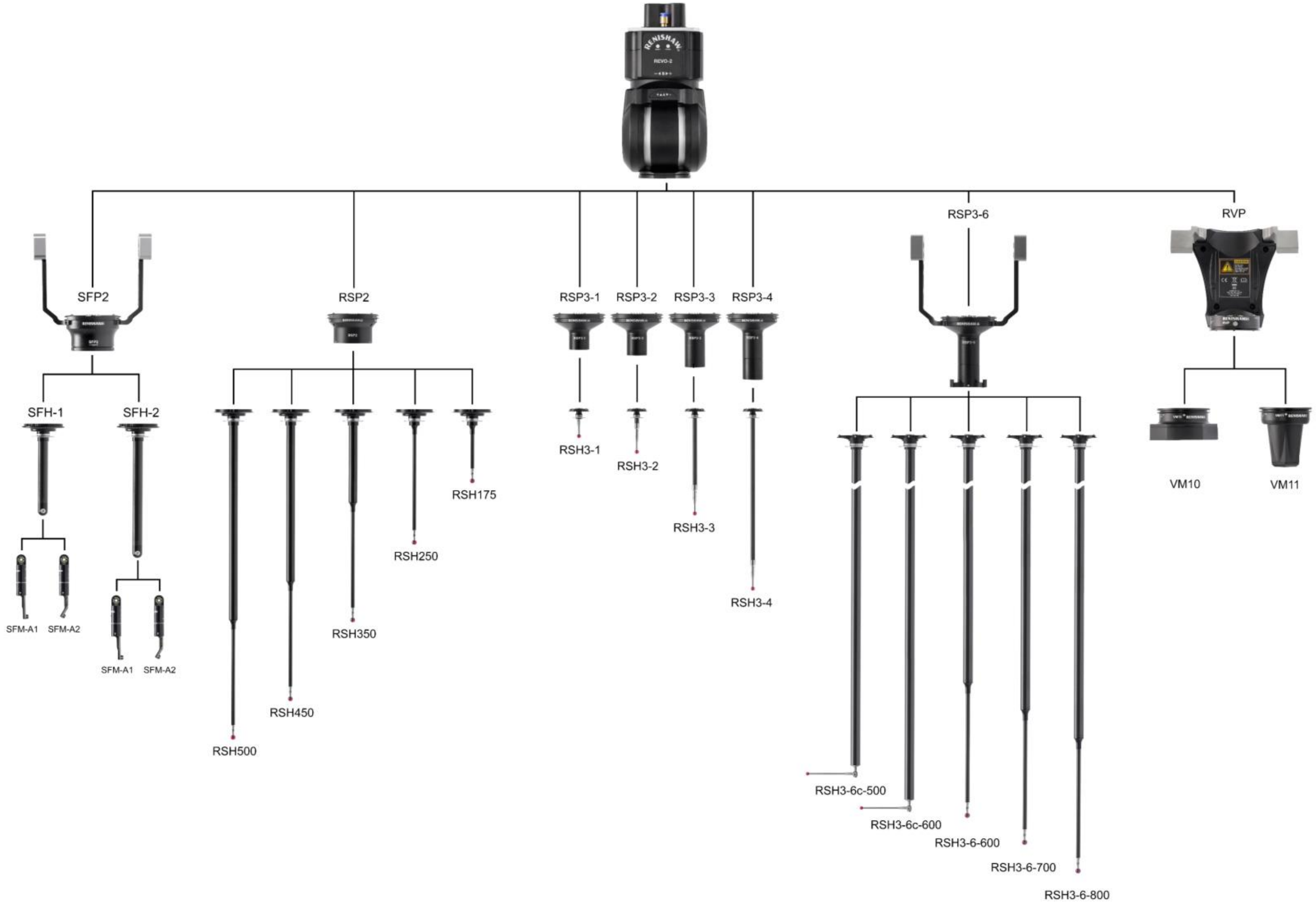
- Enables probe orientation to feature
- Orients to any angle
- Angular positioning is very accurate
- Single calibration for all angles (most probes)
- Measurement with 5 axis motion
  - Head more dynamic than CMM
  - Measure while head angles are changing
  - 10 x inspection speed increase possible

REVO
Multi-sensor Technologies

REVO – Multi-sensor Technologies

REVO System

- REVO Head
- Probe
- Holder/Stylus or Lens



REVO – Multi-sensor Technologies

REVO Sensor Technologies

- Tactile (RSP2, etc)

- Surface Finish (SFP2)

- Vision (RVP)

RVP Capabilities

RVP - Capabilities

Vision Inspection Applications

- Small features
  - Inaccessible to tactile probes
- Features in sheet metal
  - Thin surface area may be difficult to probe
- Delicate parts
  - Contact could damage part
  - Tactile probing might deform part

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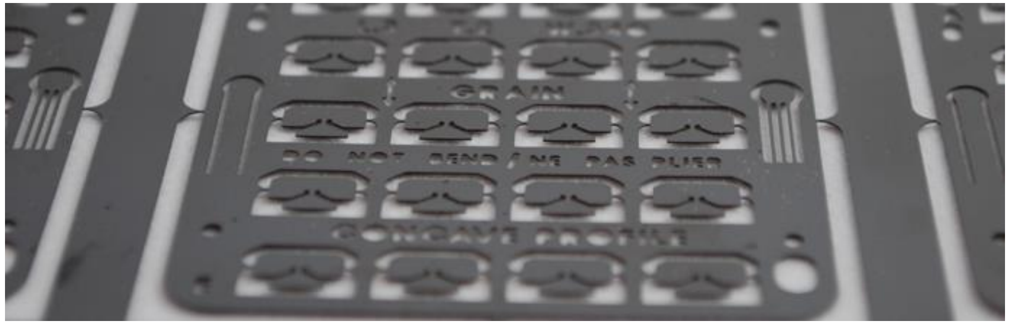
RVP - Capabilities

Traditional Vision System

- Typically camera aimed straight down
  - Suitable for flat sheet metal parts
- On 3 axis heads, discrete angles are possible
  - Features ideally at discrete (indexing) angles
  - Calibration required for each head angle used

RVP System

- Orientation to any angle
  - Suitable for any 3D part including shaped sheet metal
  - Feature can be at any angle
  - Only one calibration required, not one per head angle



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RVP
Lenses

RVP – Lenses

RVP Lenses

- Features
  - Interchangeable
  - Built-in Illumination
  - Fixed Focus
- VM10
  - Field of view: 50 x 40 mm
  - Resolution: 40 µm*
- VM11
  - Field of view: 12.5 x 10 mm
  - Resolution: 20 µm*

*** Measurement performance is to sub resolution accuracy**

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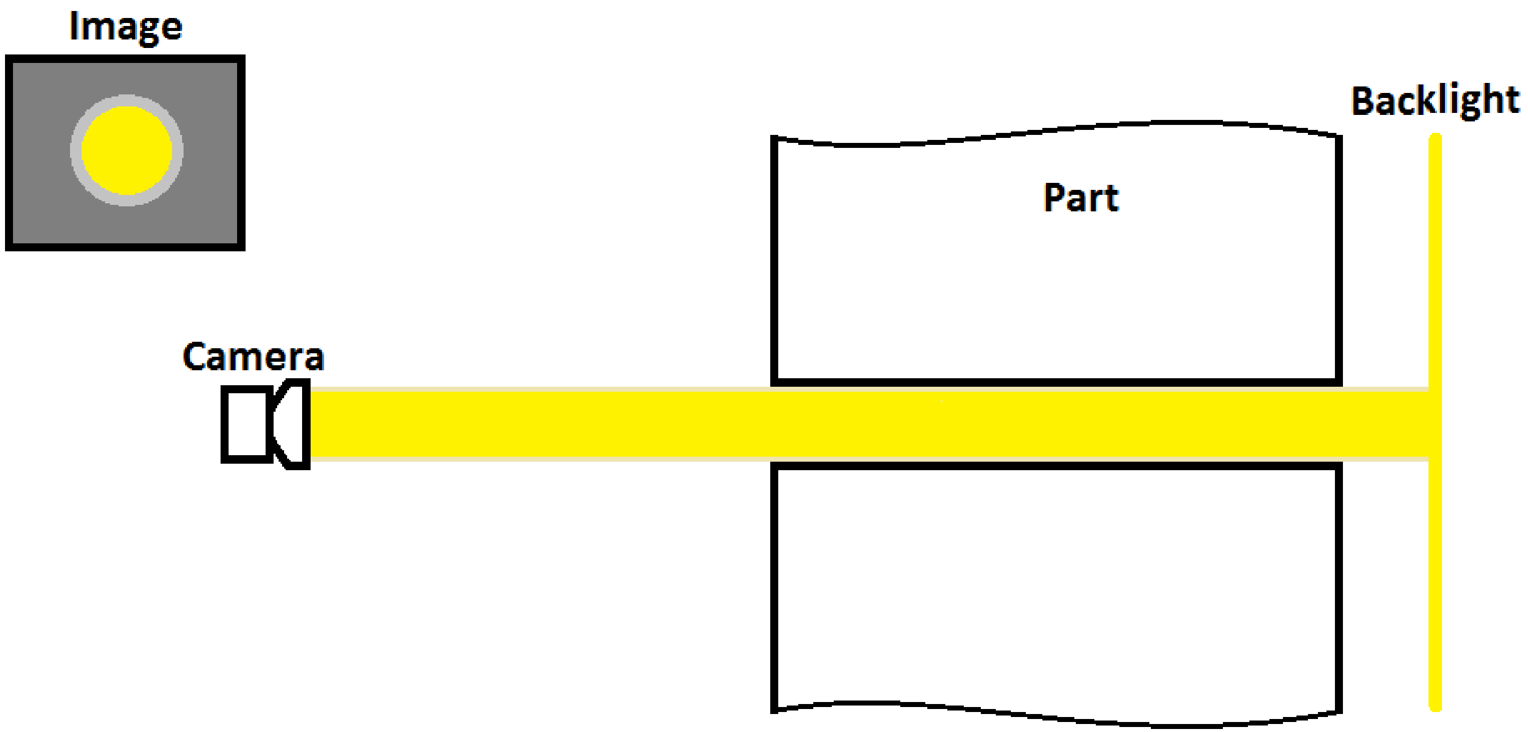
RVP – Lenses

Telecentric Lens

- Size invariant with distance to feature
- Commonly used in vision metrology
- Assumes camera and feature are aligned



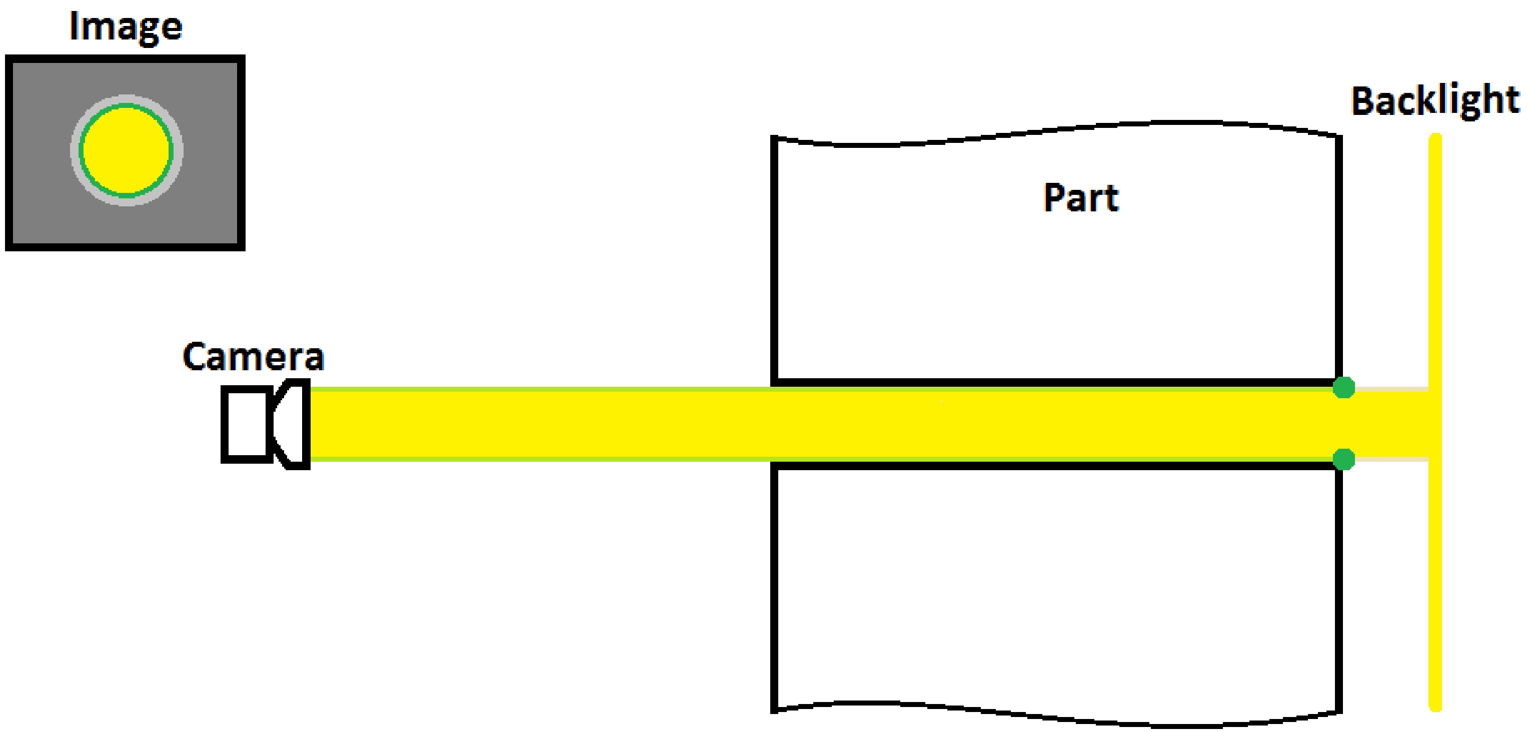
1. Capture image of feature

RVP – Lenses

Telecentric Lens

- Size invariant with distance to feature
- Commonly used in metrology
- Assumes camera and feature are aligned

Good measurement



2. Process image to get feature

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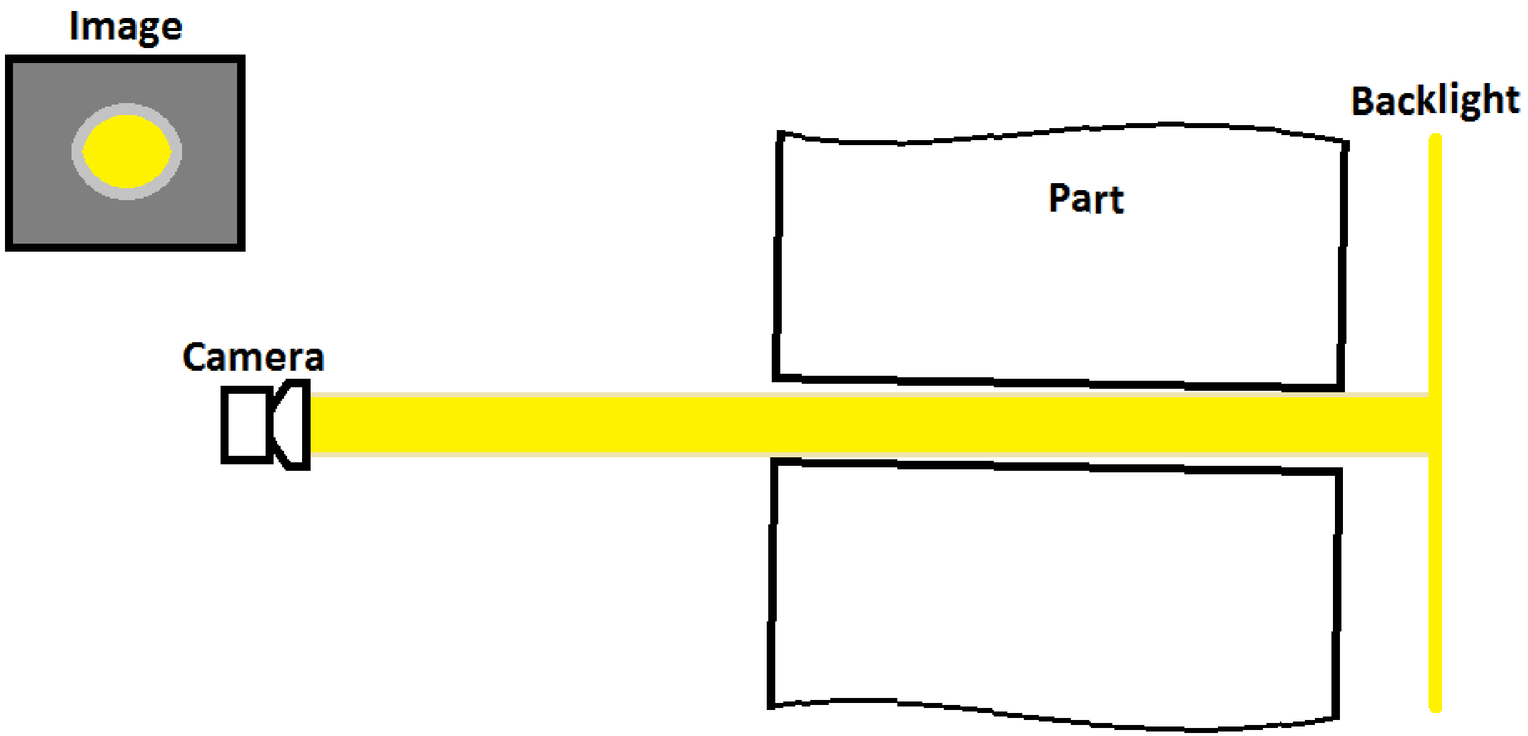
RVP – Lenses

Telecentric Lens

- Size invariant with distance to feature
- Commonly used in metrology
- Assumes camera and feature are aligned
- Does not work if camera and feature are mis-aligned



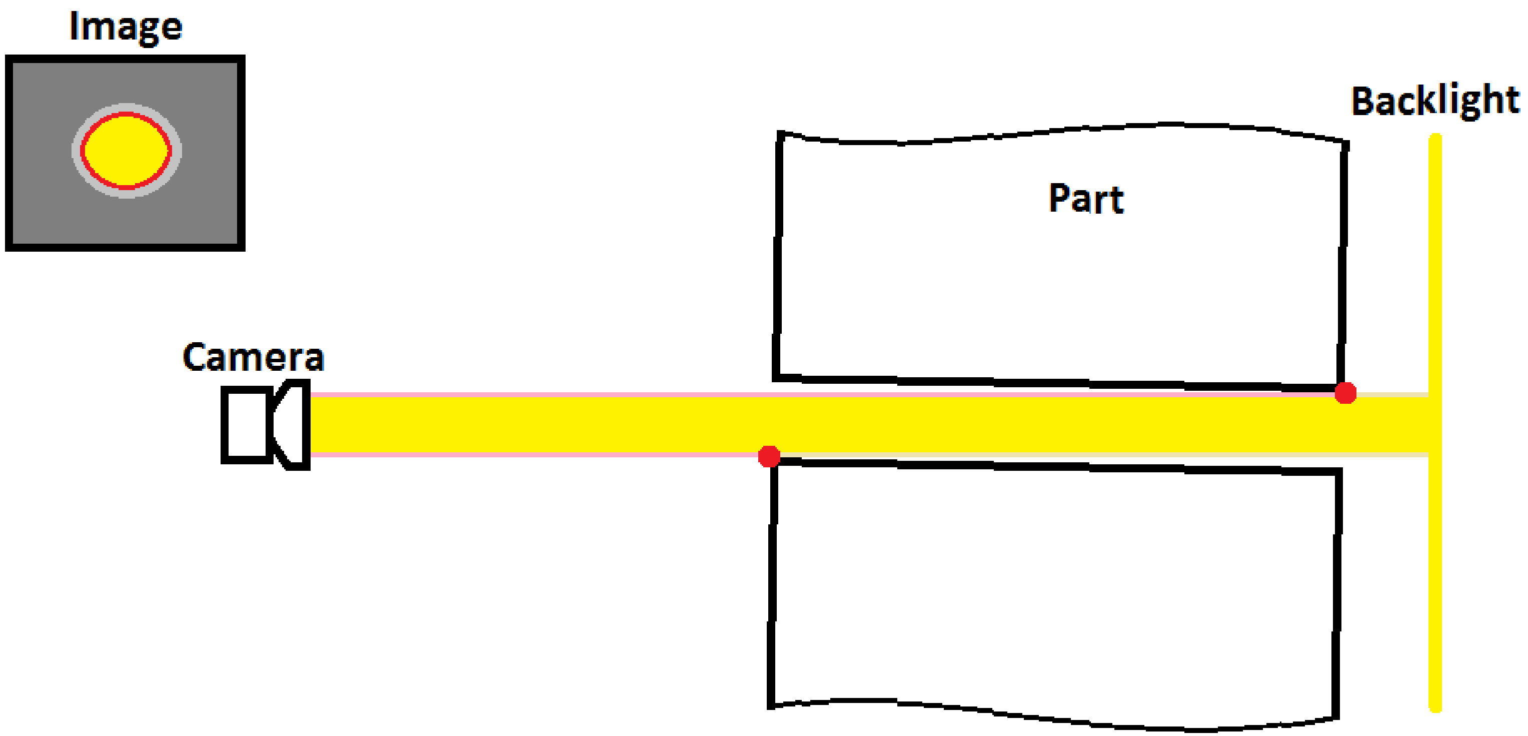
1. Capture image of feature

RVP – Lenses

Telecentric Lens

- Size invariant with distance to feature
- Commonly used in metrology
- Assumes camera and feature are aligned
- Does not work if camera and feature are mis-aligned

  Poor measurement

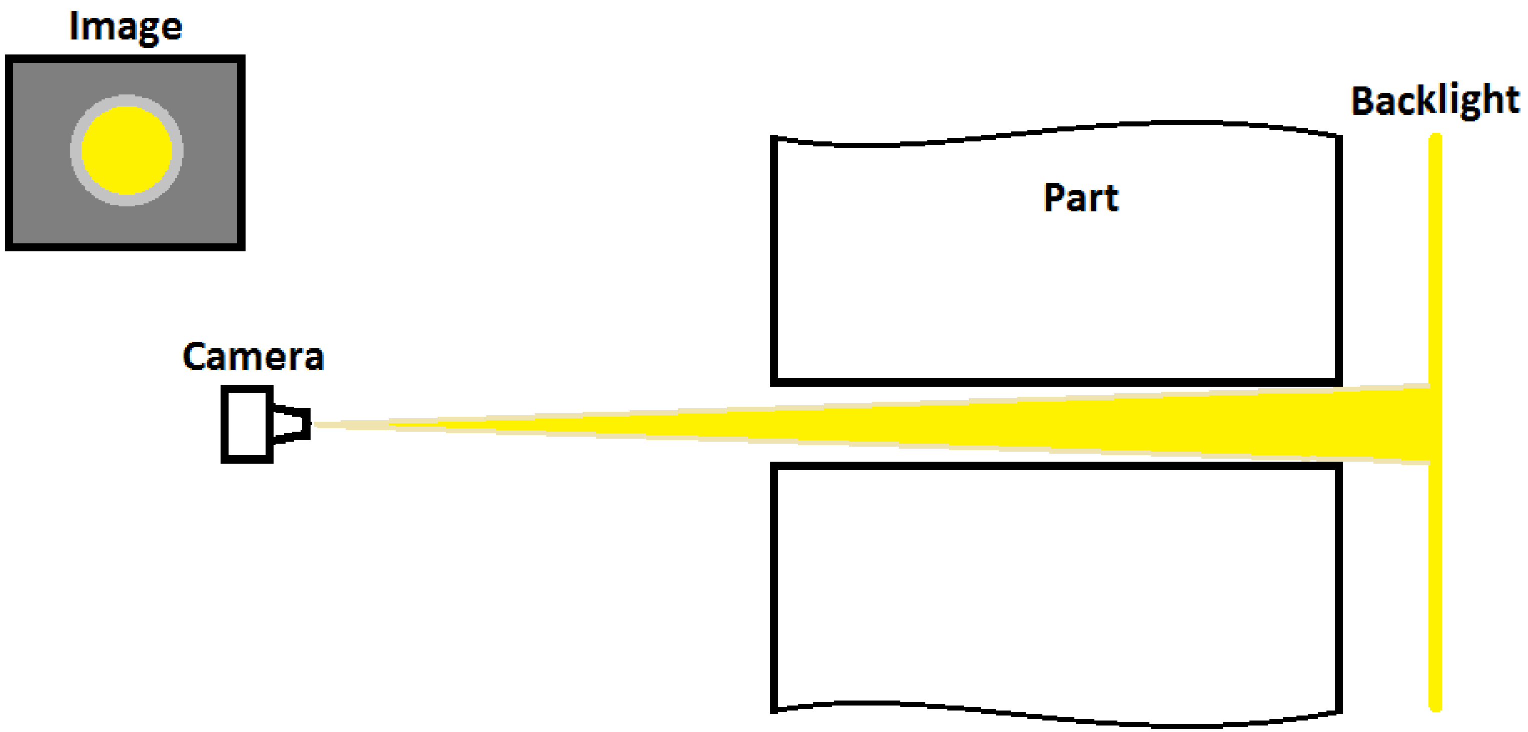


2. Process image to get feature

RVP – Lenses

Non-telecentric Lens

- Size/position varies with distance to feature
- Distance to feature needed anyway to get 3D points
- So size/position can be determined
- Works when camera and feature are aligned



1. Capture image of feature

RVP – Lenses

Non-telecentric Lens

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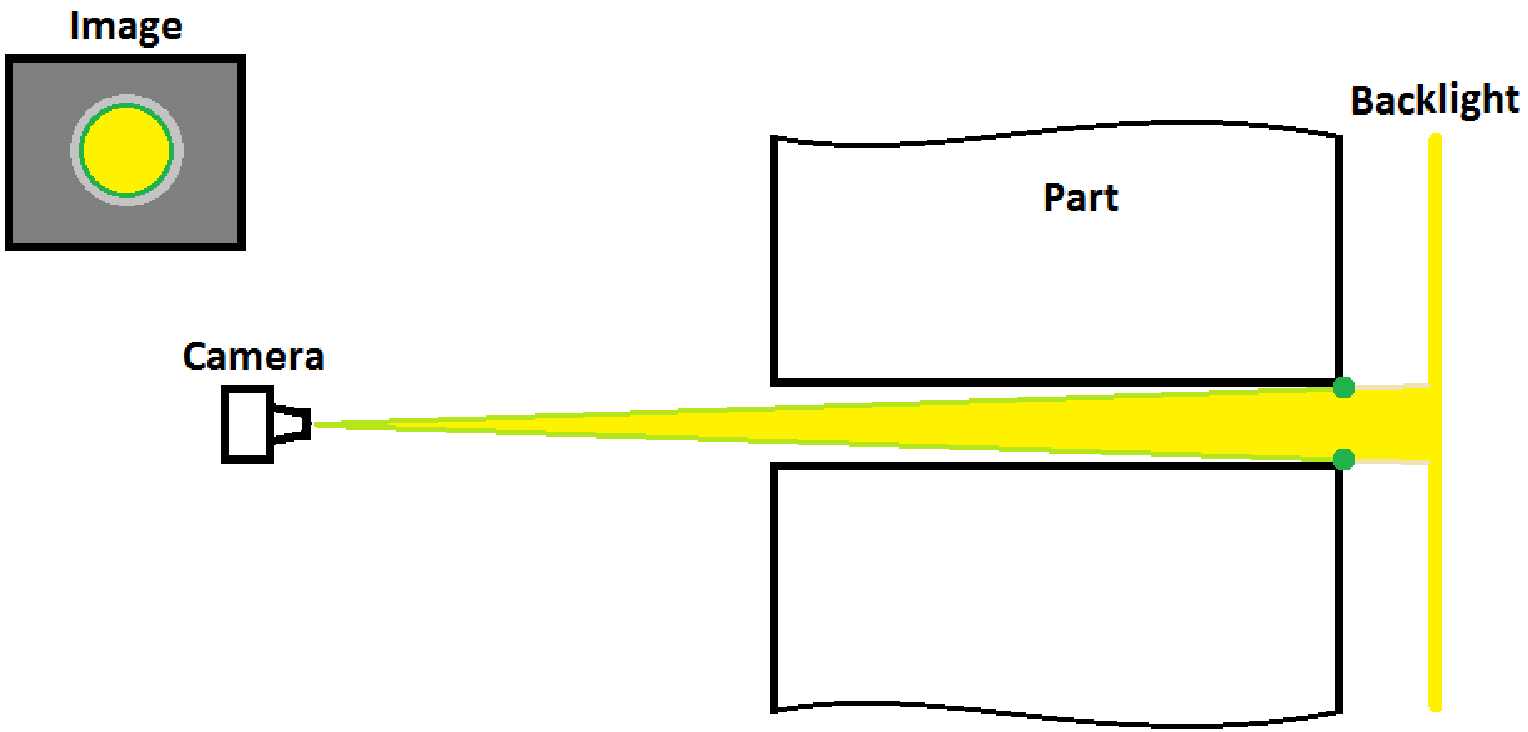
Good measurement



2. Process image to get feature

RVP – Lenses

Non-telecentric Lens

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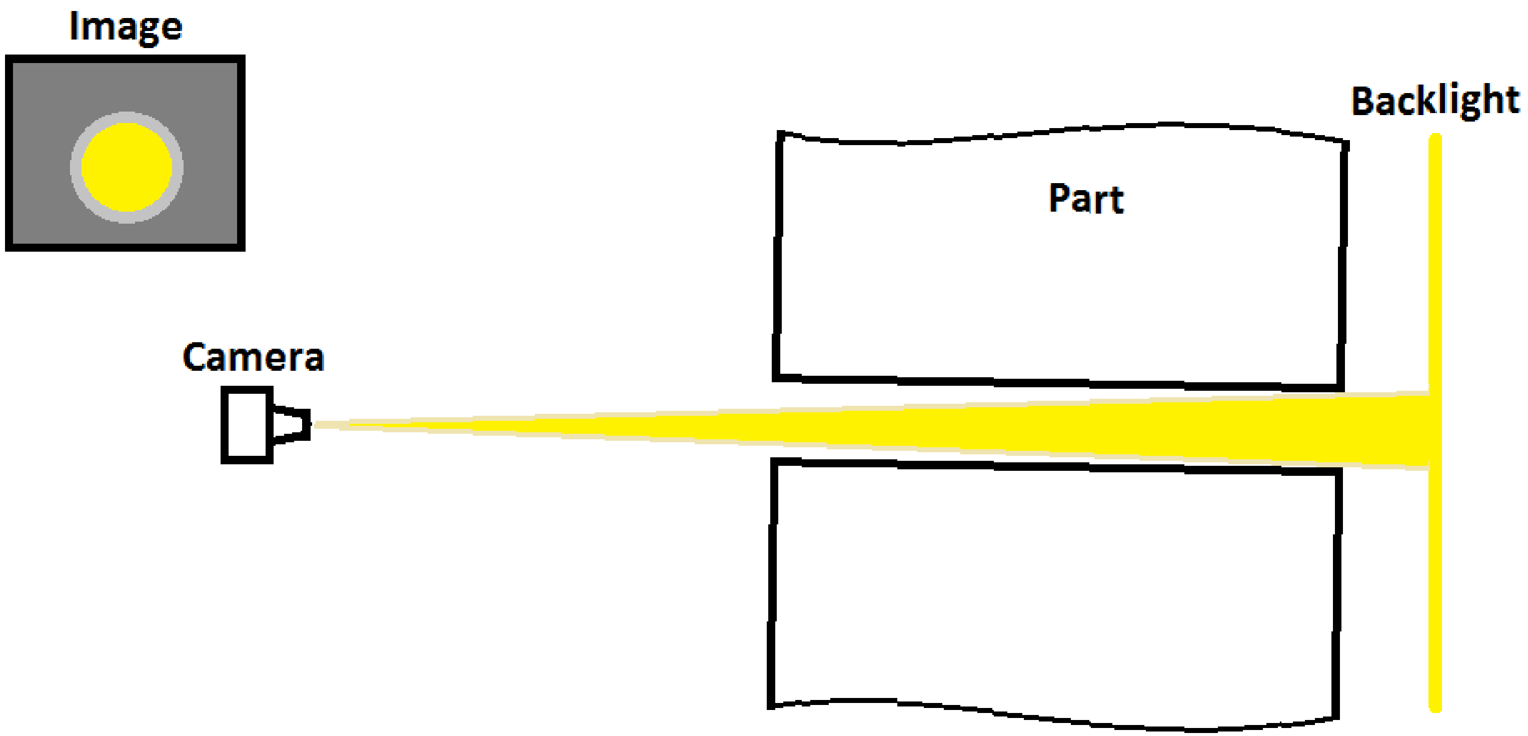

1. Capture image of feature

RVP – Lenses

Non-telecentric Lens

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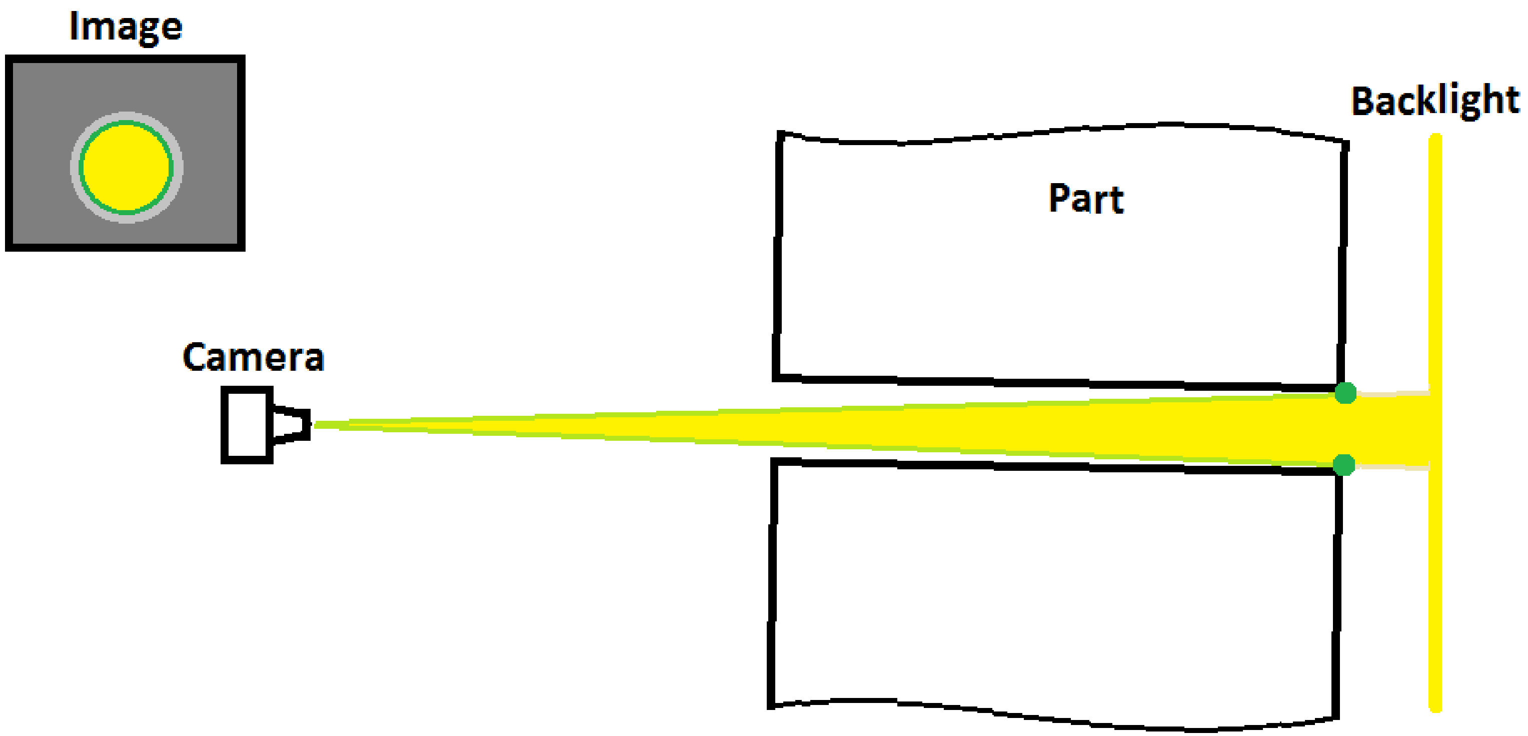

2. Process image to get feature

RVP - Lenses

RVP Lens Types

- Currently all RVP lenses are non-telecentric
  - Increased tolerance to part variability
  - Improves deep feature measurement reliability
  - Typically part surface measurement made using using REVO multi-sensor probes
- Future RVP lens may be telecentric
  - Specific application requirement
  - RVP’s lenses are interchangeable

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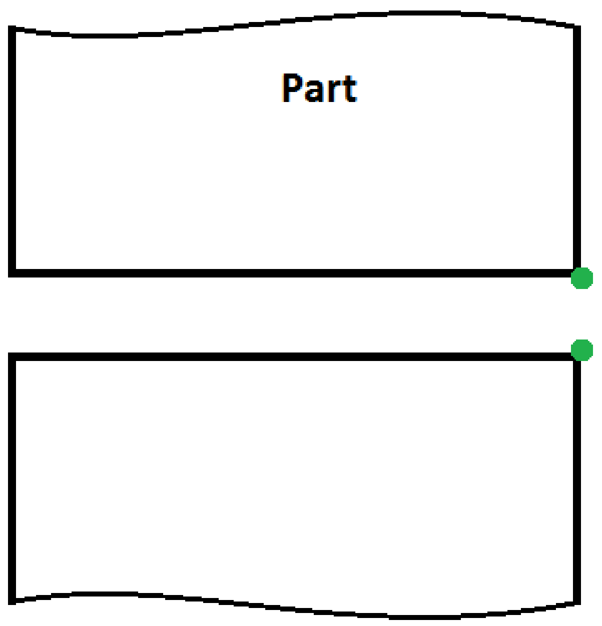
RVP
3D Measurement by Projection

RVP – 3D Measurement by Projection

3D Edge Points Found by Projection

- Camera image is 2D
- Edge points are 3D
- How do we find 3D edge points?



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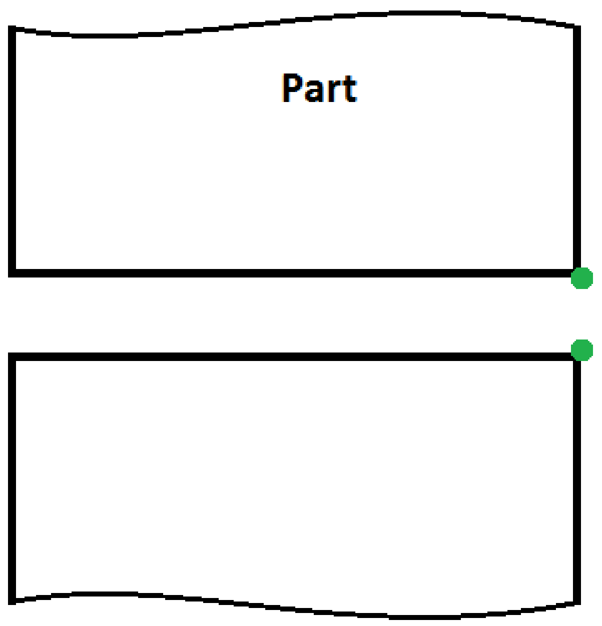
RVP – 3D Measurement by Projection

3D Edge Points
Found by Projection

- Camera image is 2D
- Edge points are 3D
- How do we find 3D edge points?
- If feature edge is on an accessible surface:

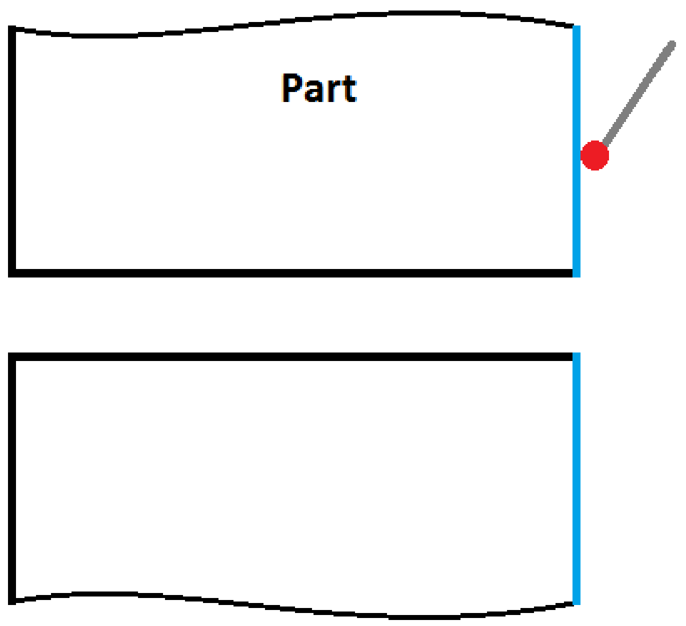
Use Projection Method



RVP – 3D Measurement by Projection

Projection Method

- Find 3D points by projecting images onto pre-measured surface
- Fast - typically feature extracted from 1 image

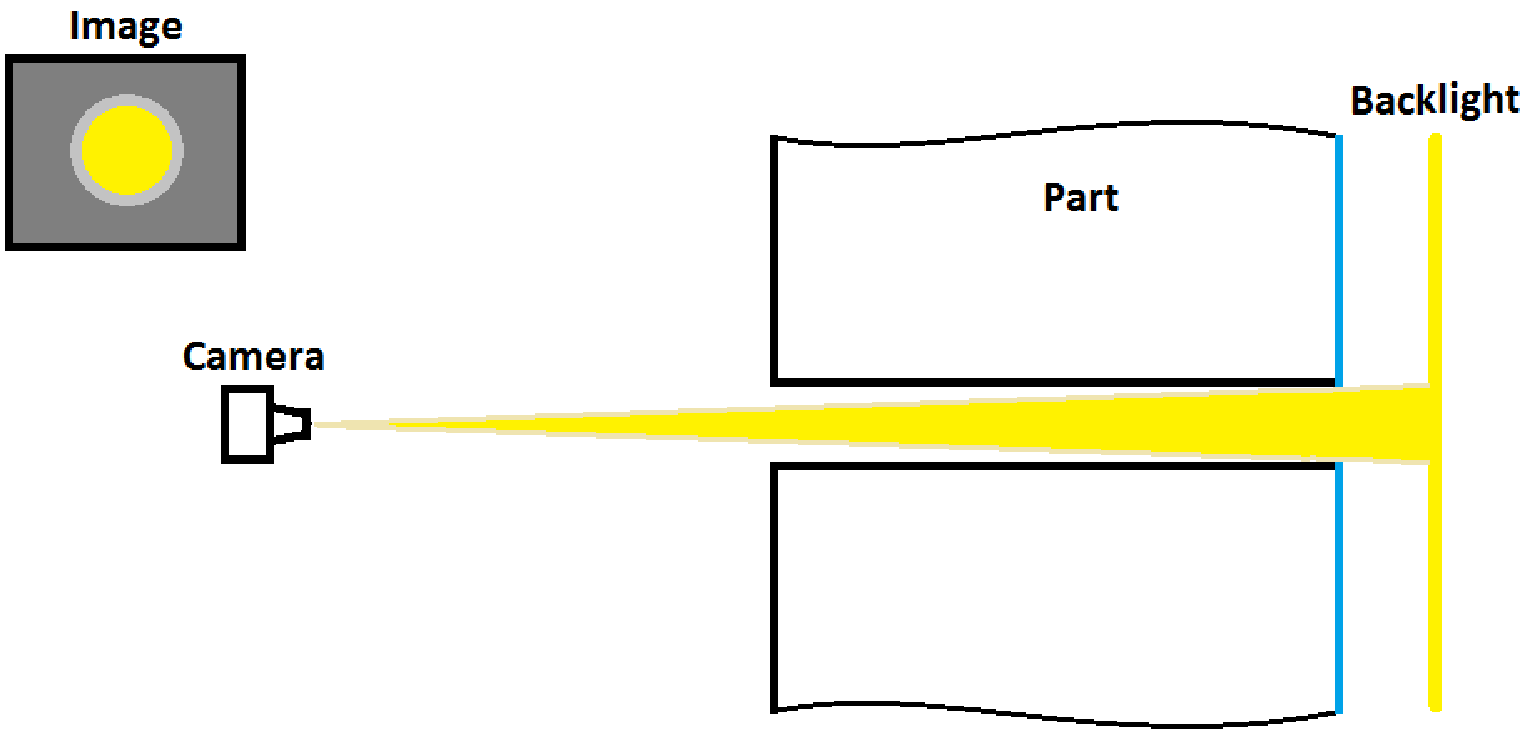


1. Measure projection surface (normally with a tactile probe)

RVP – 3D Measurement by Projection

Projection Method

- Find 3D points by projecting images onto pre-measured surface
- Fast - typically feature extracted from 1 image

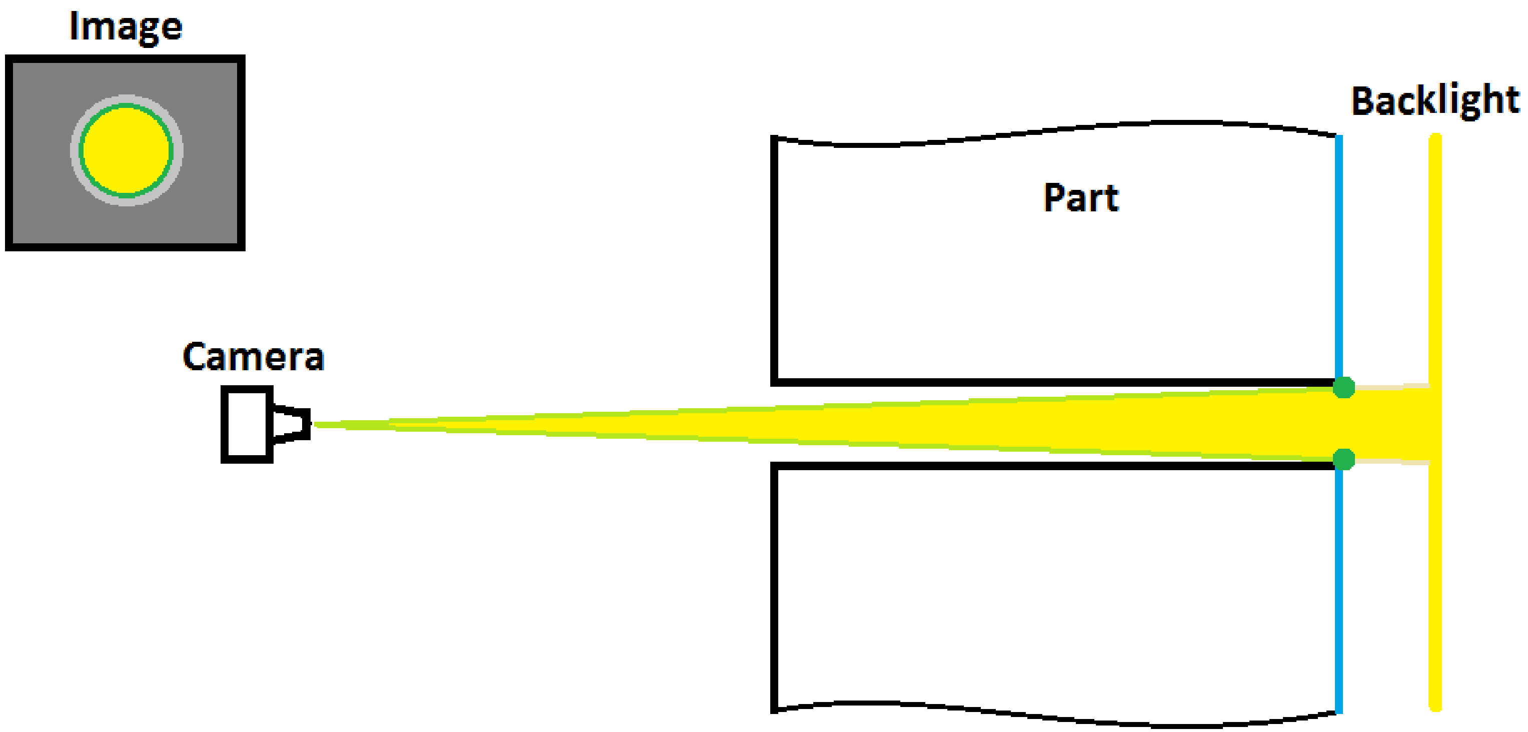


2. Capture image of feature

RVP – 3D Measurement by Projection

Projection Method

- Find 3D points by projecting images onto pre-measured surface
- Fast - typically feature extracted from 1 image



3. Process image and project onto surface to determine feature

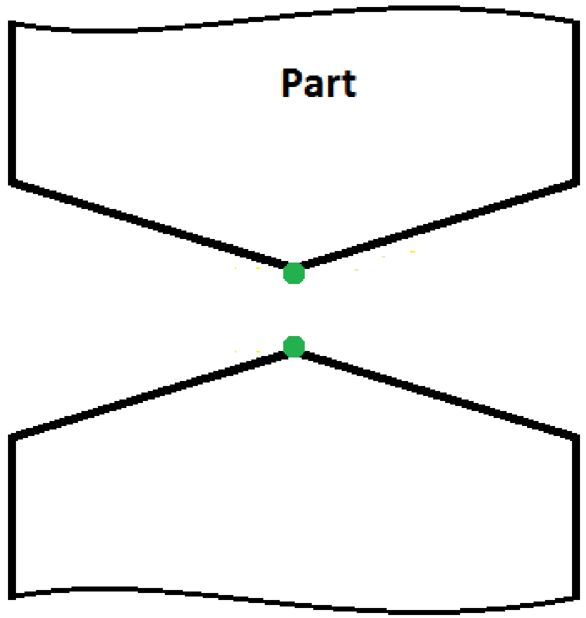
RVP

3D Measurement by Triangulation

RVP – 3D Measurement by Triangulation

3D Edge Points
Found by Triangulation

- Camera image is 2D
- Edge points are 3D
- How do we find 3D edge points?



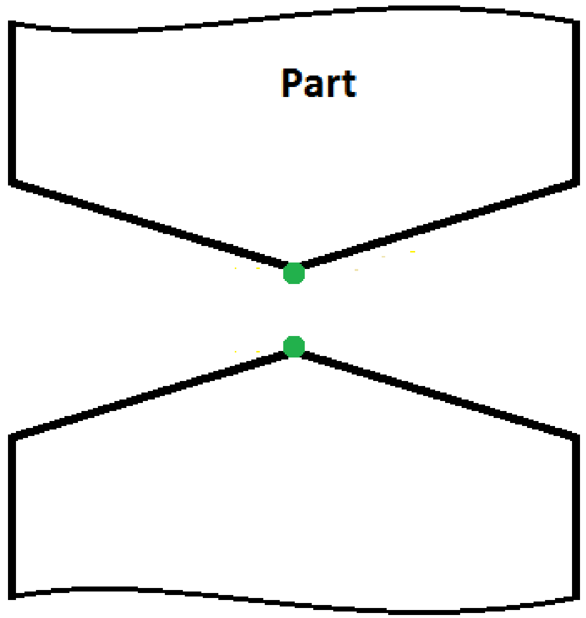
RVP – 3D Measurement by Triangulation

3D Edge Points Found by Triangulation

- Camera image is 2D
- Edge points are 3D
- How do we find 3D edge points?
- If feature edge is not on an accessible surface:
  - Feature edge is mid hole
  - Surface is inaccessible

Use Triangulation Method

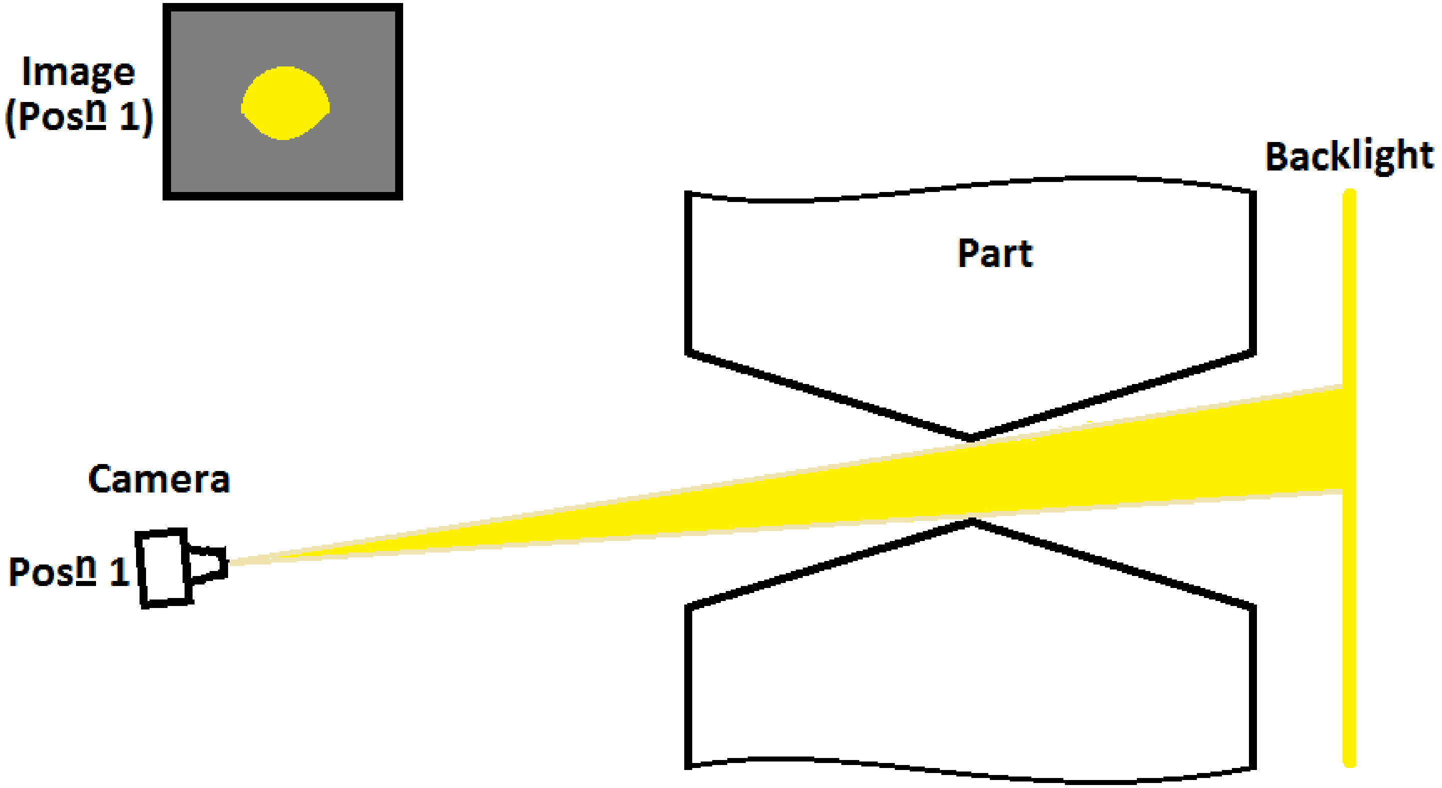
  - Patented by Renishaw



RVP – 3D Measurement by Triangulation

Triangulation Method

- Find 3D points by triangulating rays from two images

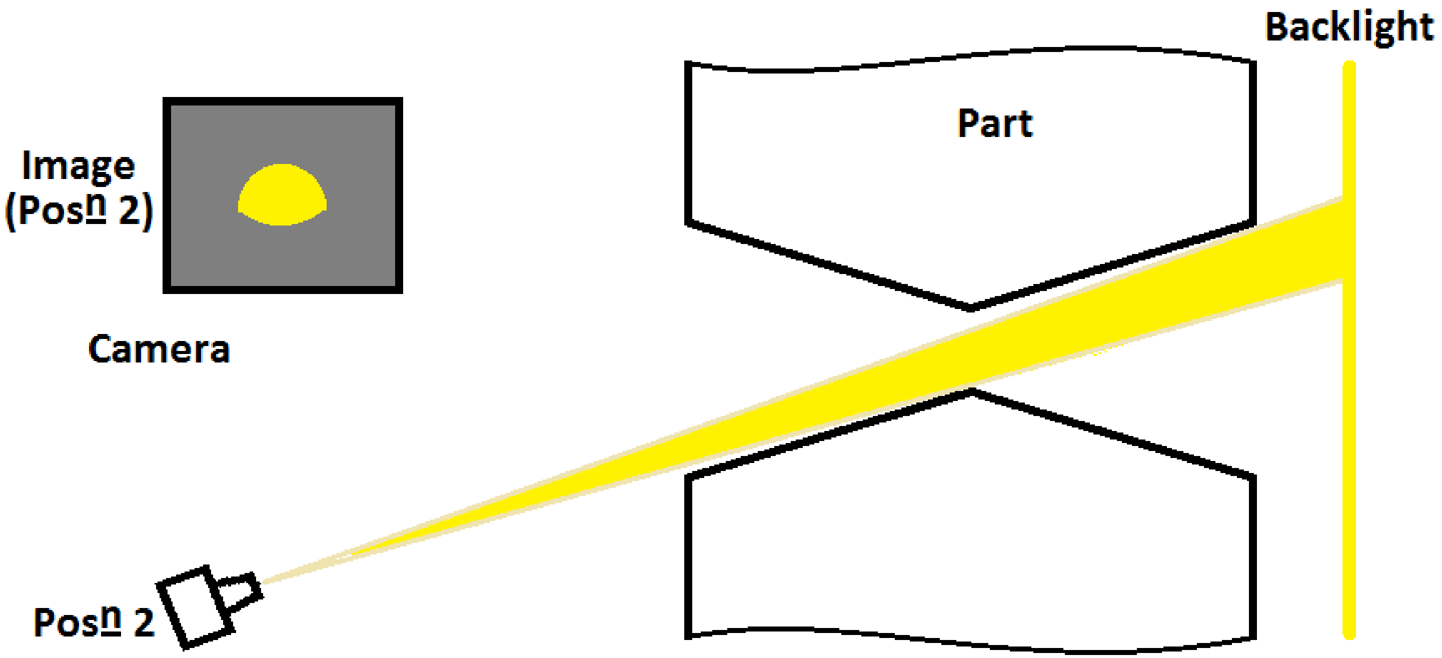


1. Capture first image of feature

RVP – 3D Measurement by Triangulation

Triangulation Method

- Find 3D points by triangulating rays from two images

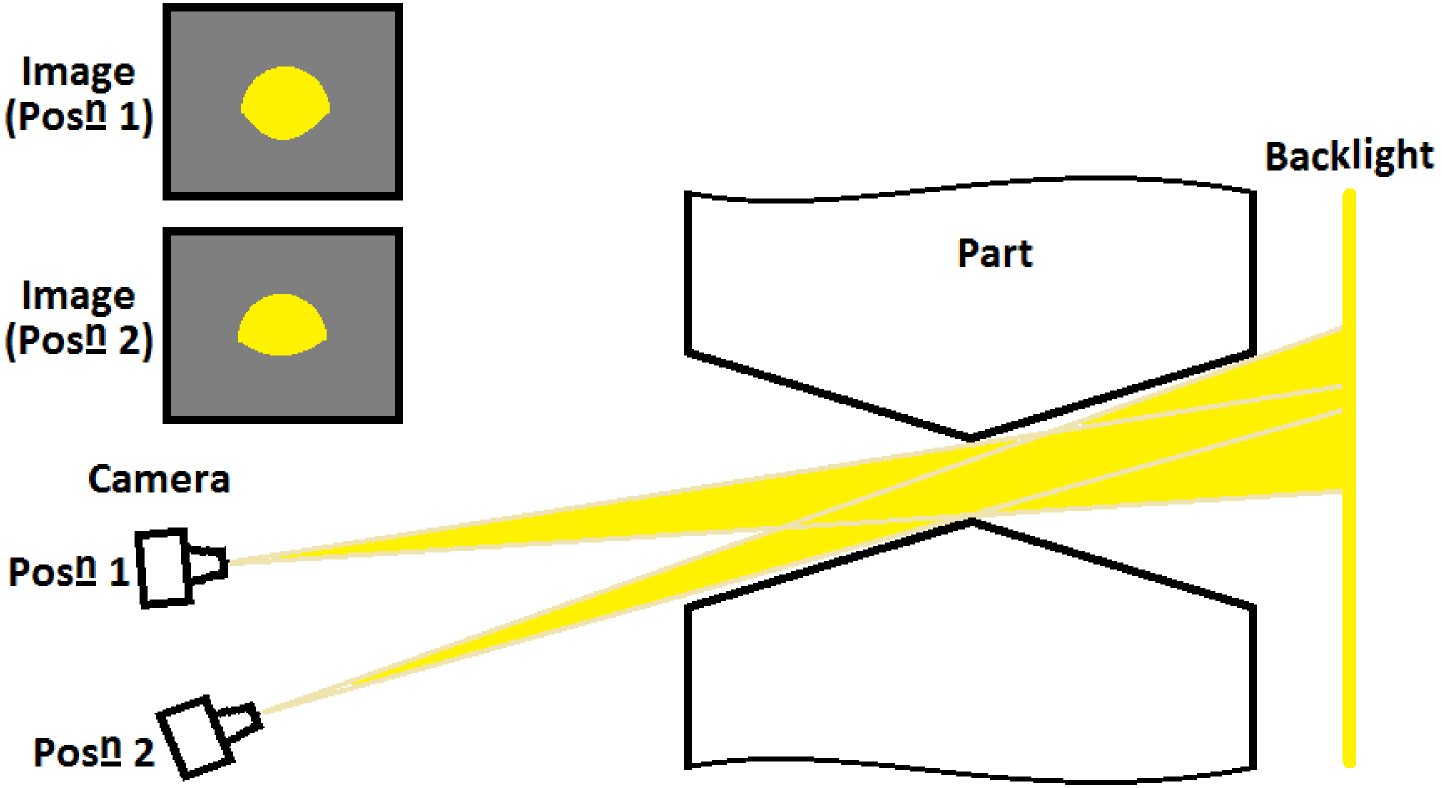


2. Capture second image of feature

RVP – 3D Measurement by Triangulation

Triangulation Method

- Find 3D points by triangulating rays from two images



3. Two images of feature can be used for processing

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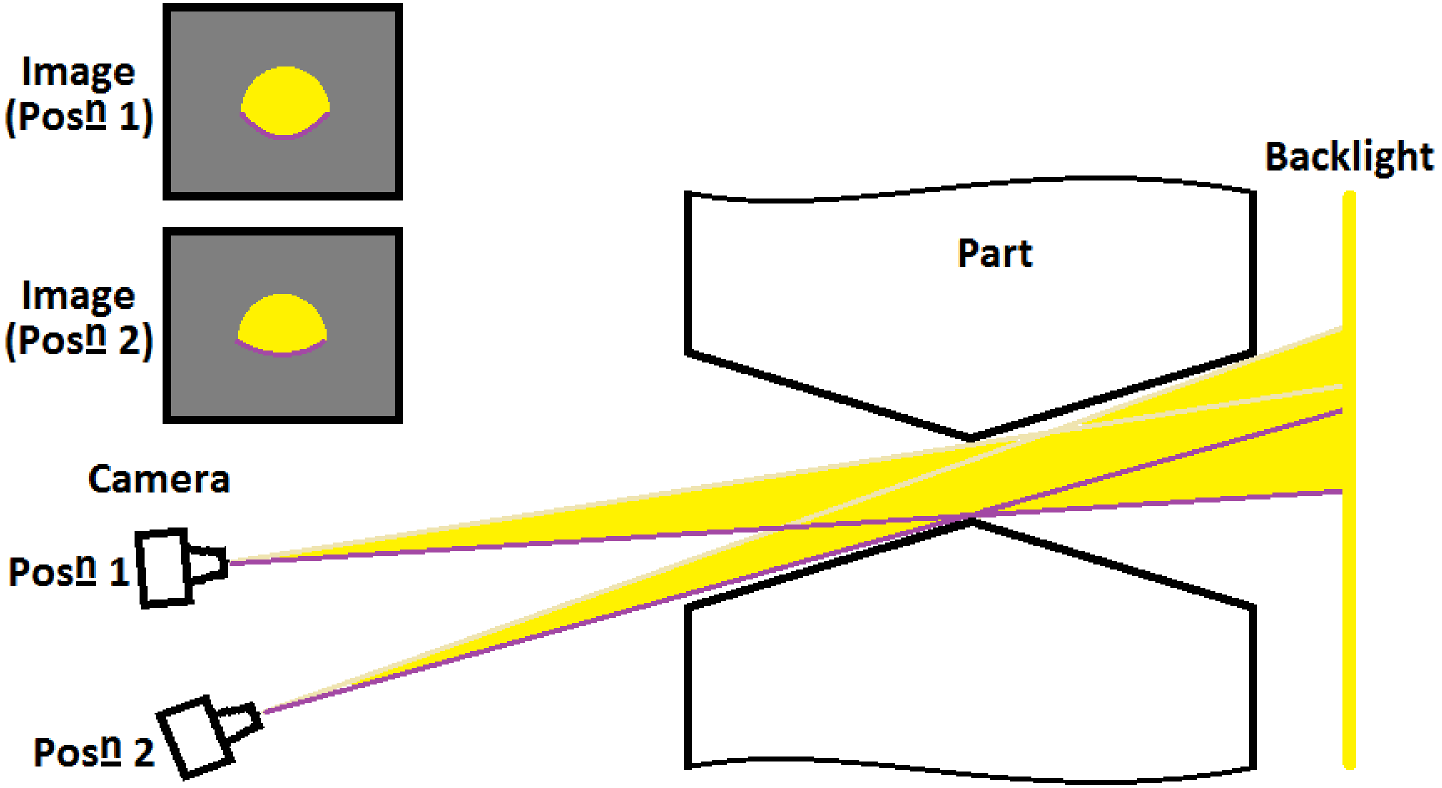
RVP – 3D Measurement by Triangulation

Triangulation Method

- Find 3D points by triangulating rays from two images



4. Process by identifying feature edge in each image

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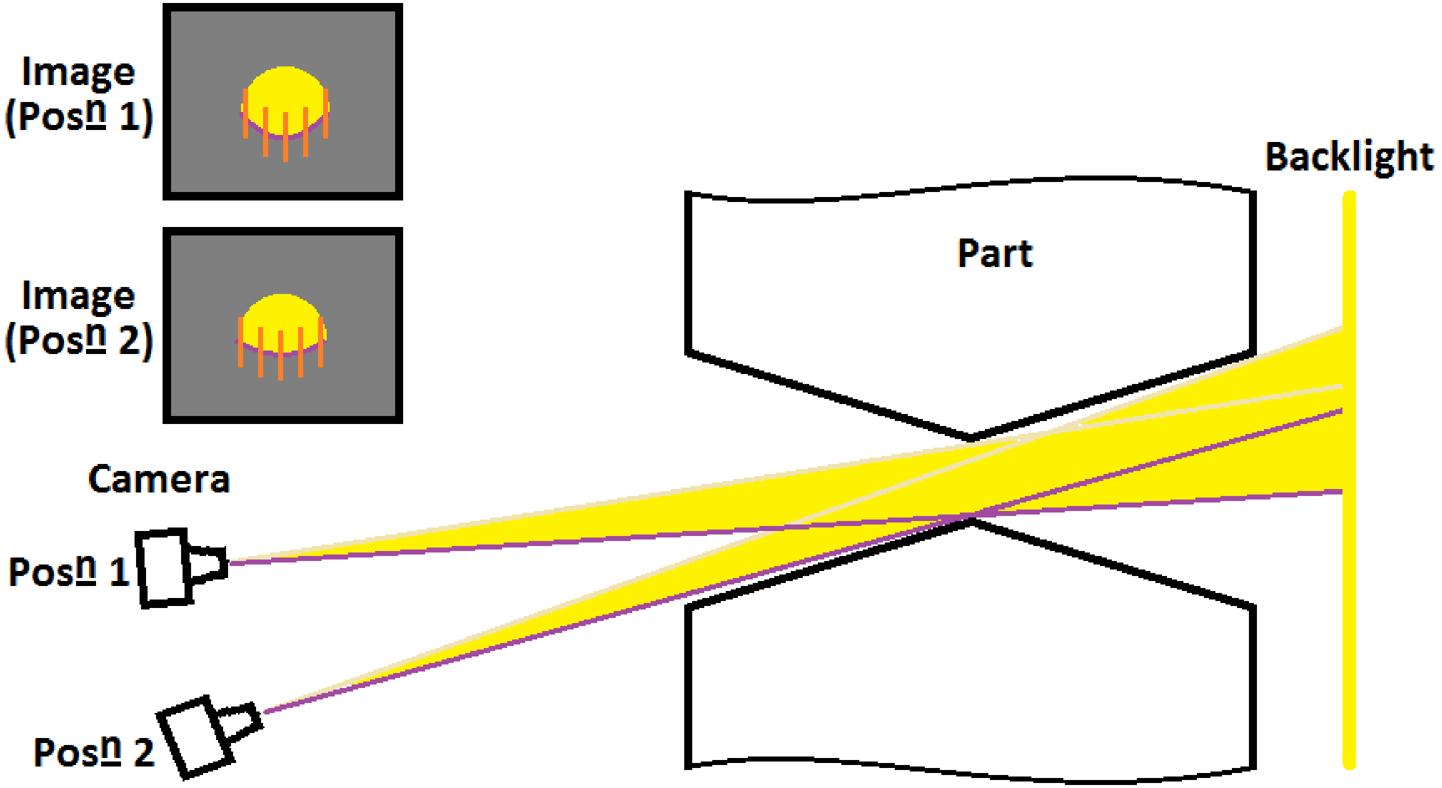
RVP – 3D Measurement by Triangulation

Triangulation Method

- Find 3D points by triangulating rays from two images



5. Triangulate common points on feature edge in each image

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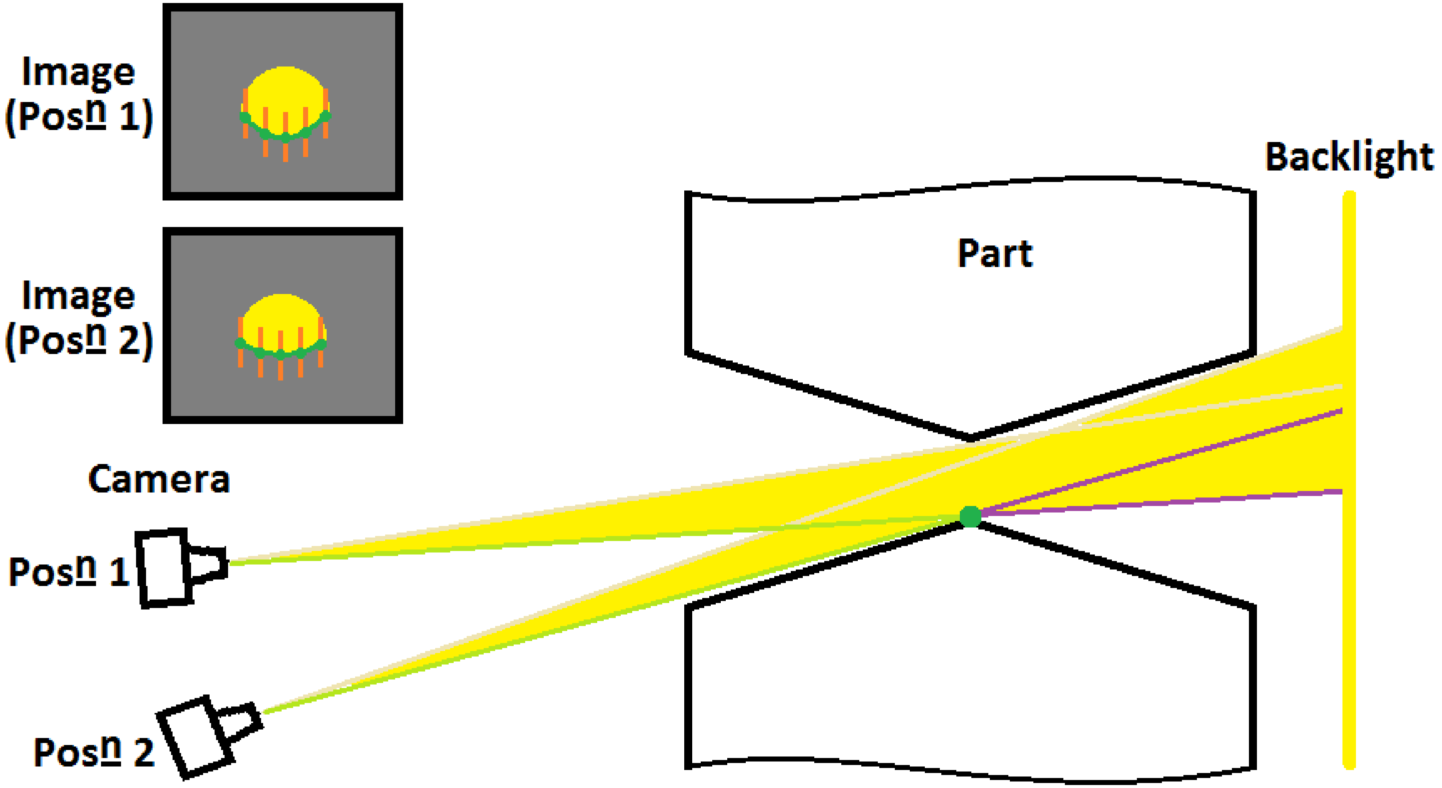
RVP – 3D Measurement by Triangulation

Triangulation Method

- Find 3D points by triangulating rays from two images



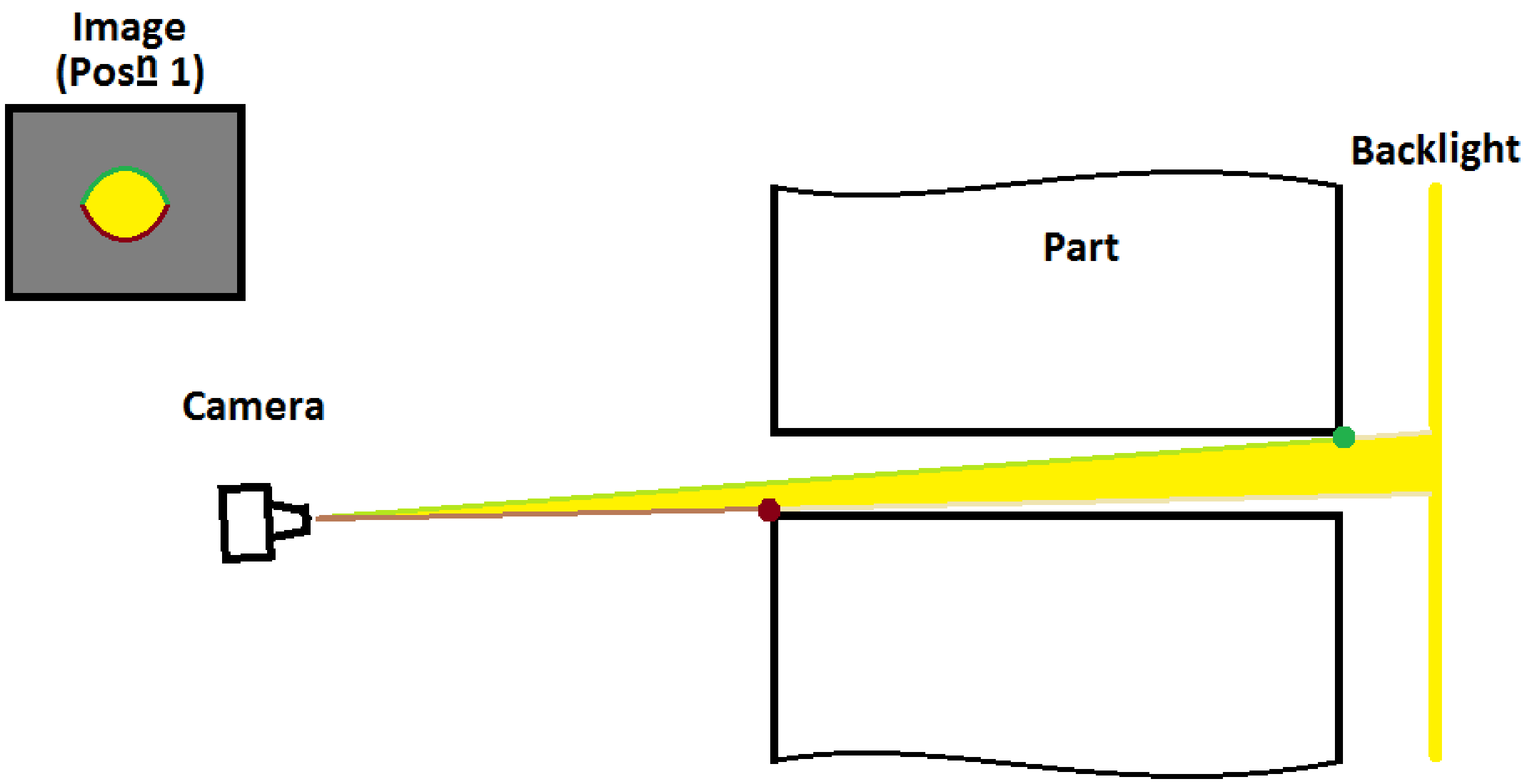
6. Use common points to determine feature

RVP
Inspection Techniques

RVP – Inspection Techniques

Edge Location

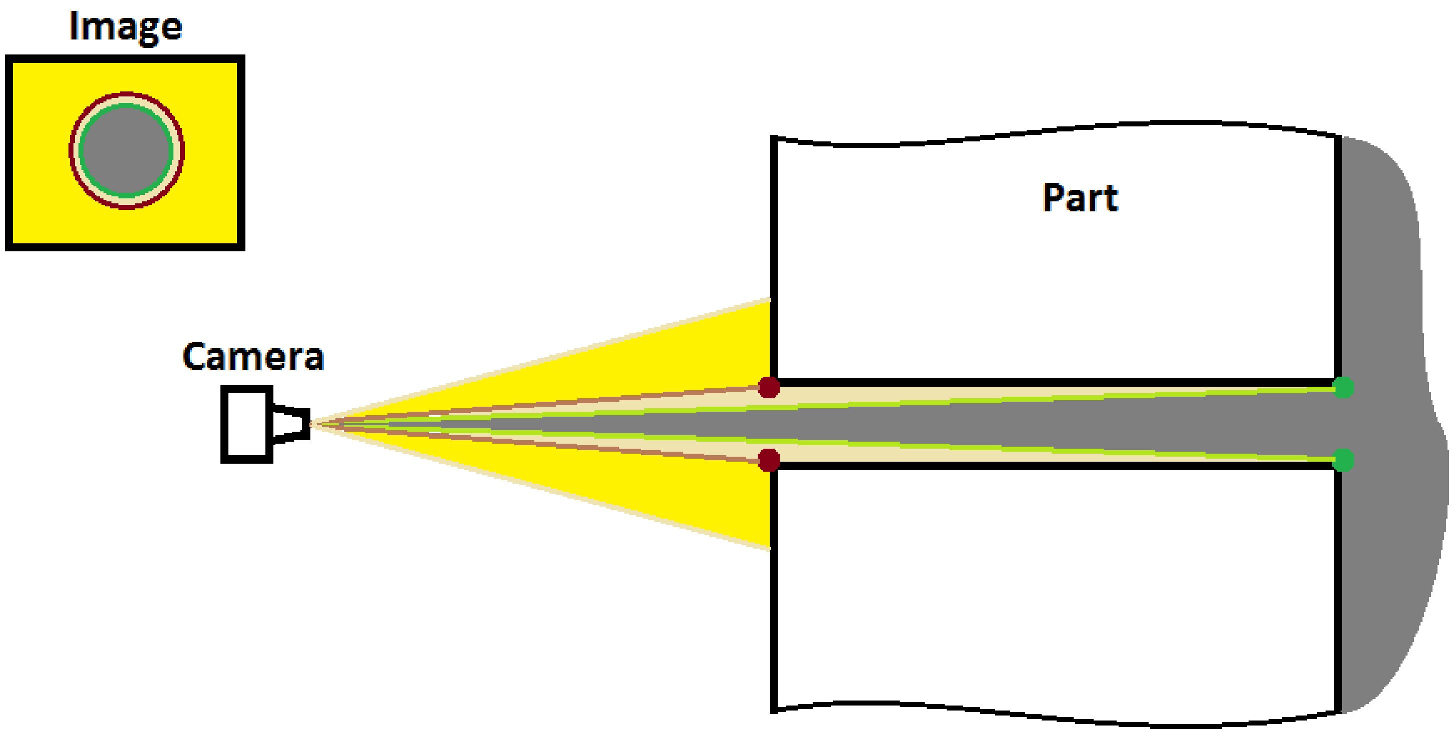
- Back & mid shown already
- Front also possible
- Front and back
  - Arcs from one image
  - Combine arcs for front and back edges



RVP – Inspection Techniques

Lighting

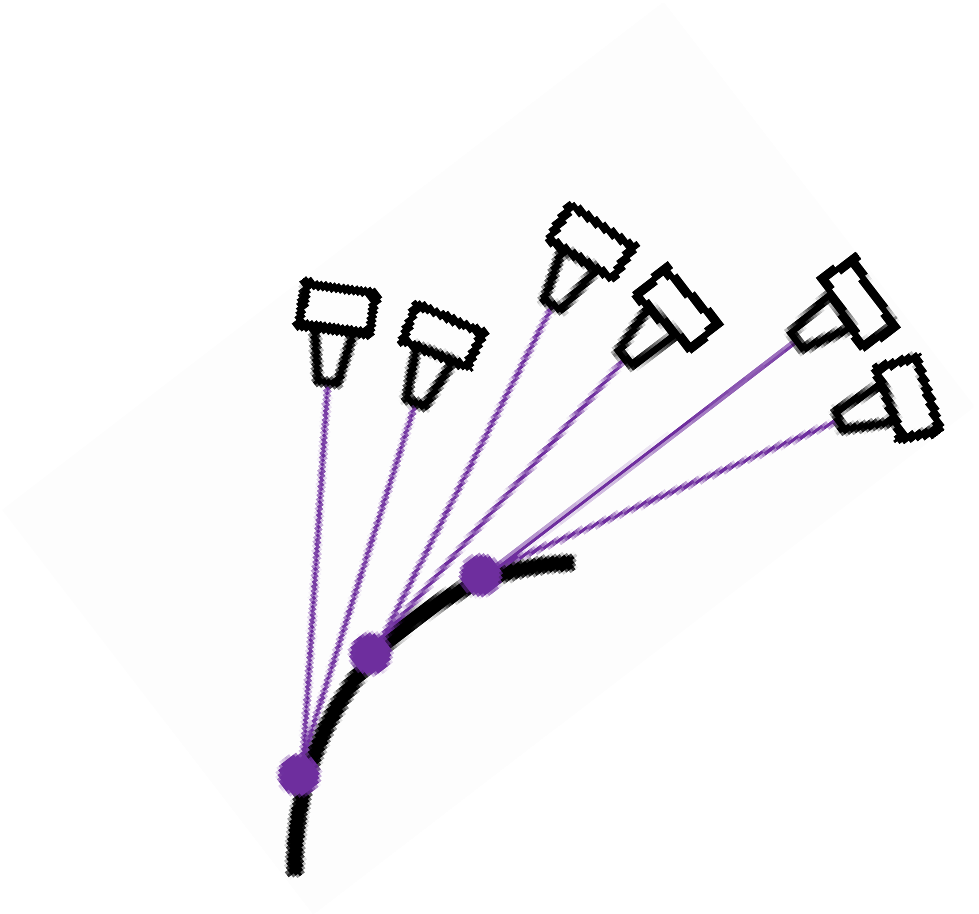
- Backlight shown already
  - Preferred technique
- Frontlight also possible
  - Lighting in lens modules
  - Front and/or back edge inspection



RVP – Inspection Techniques

Edge Profiling

- Using triangulation method
- Profile
  - Take image pairs at tangent to edge
  - Process to get points along tangent
  - Repeat for all required angles around edge
  - Combine to get complete edge description
- Works on large and small radii edges



RVP
Application Examples

RVP – Application Examples

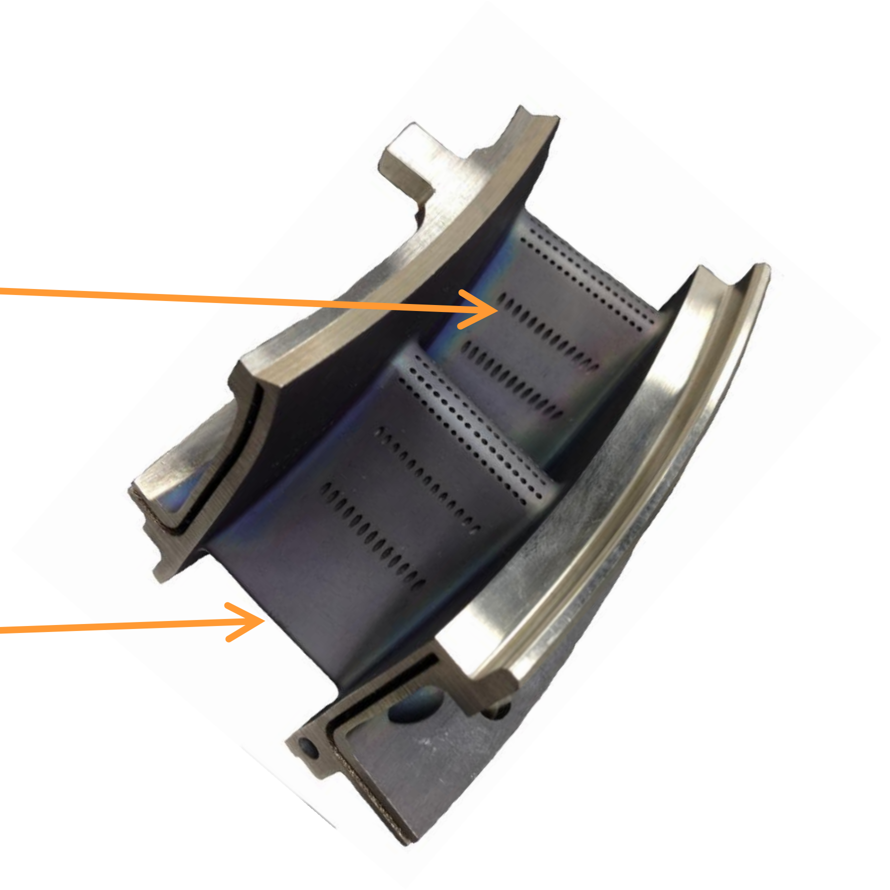
Combustor

- Cooling Hole
  - Too small for tactile probe access
  - Thin sheet metal part
  - 5 axis vision measurement required
  - Measure using Projection Method
- Port Hole
  - Thin sheet metal part
  - 5 axis vision measurement option
  - Measure using Projection Method

RVP – Application Examples

Nozzle Guide Vane

- Cooling Hole
  - Too small for tactile probe access
  - 5 axis vision measurement required
  - Edge not at accessible surface
  - Measure using Triangulation Method
- Aerofoil Edge Profile
  - 5 axis vision measurement option
  - Profile using Triangulation Method



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Thank You