

Engineering Research Center for
Reconfigurable Manufacturing Systems



Outlier Teeth Detection in Sprockets

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Goals

The Objective

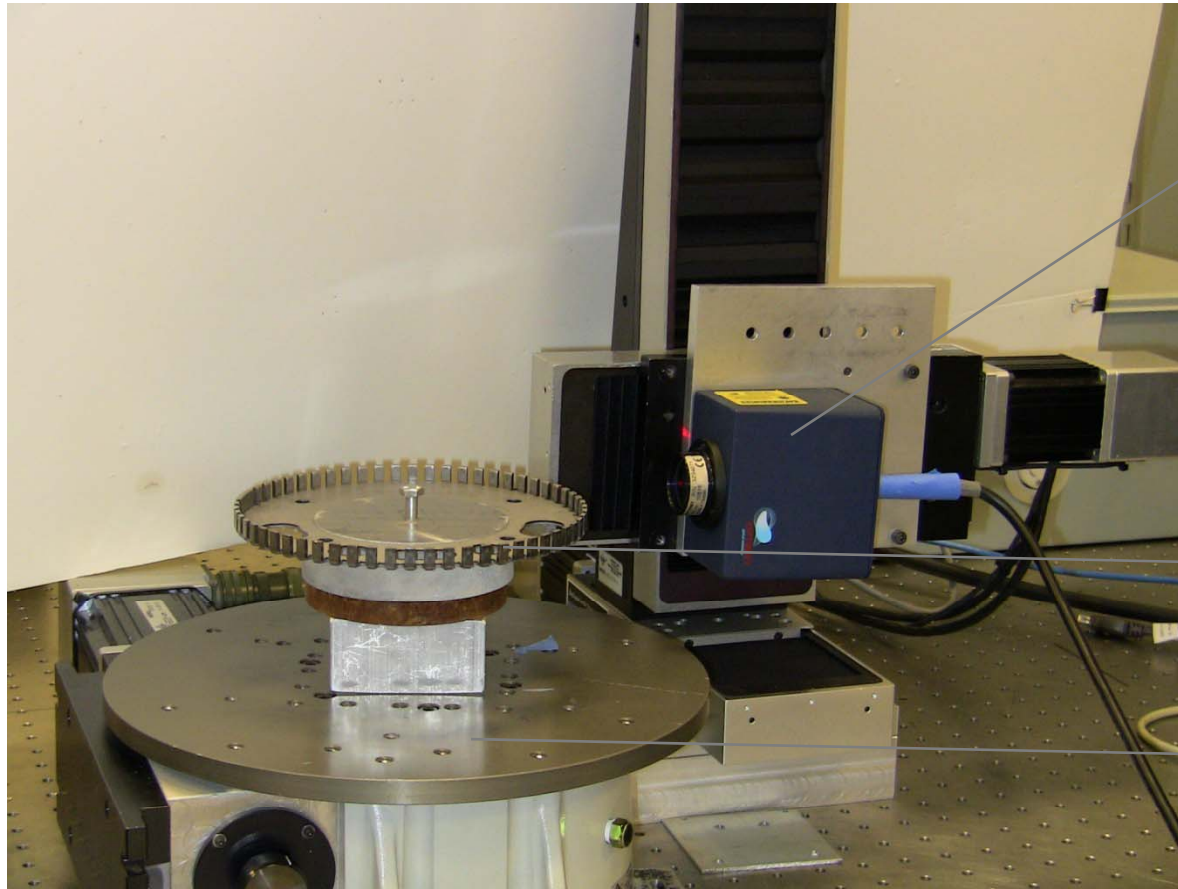
To decide if there is an agreement to initiate a project

Project Goals

- Detect the presence of misaligned teeth i.e. outliers in sprockets
- Measure in line the location and the extent of deformation for each outlier relative to its neighbors while the sprocket rotates



Experimental setup



Optimet laser sensor

Sprocket

Aerotech rotary stage



Suggested Method

- Measure the distance to tip of the teeth of a rotating sprocket using a non-contact single-point laser range finder
- Each tooth is clearly observed as a bar (several points)
- Outliers are observed as peaks



Evaluation of the method

Apriori

Rotating speed (sprocket)

$$w = 300 \text{ rpm} \rightarrow f = 5\text{Hz}$$

Tooth width (sprocket)

$$L = 5 \text{ mm}$$

Diameter (sprocket)

$$D = 175 \text{ mm}$$

Data collection frequency (Optimet)

$$f_{\text{op}} = 3000 \text{ Hz}$$

Number of points collected/revolution

$$N = 3000/5 = 600$$

Number of points per tooth/revolution

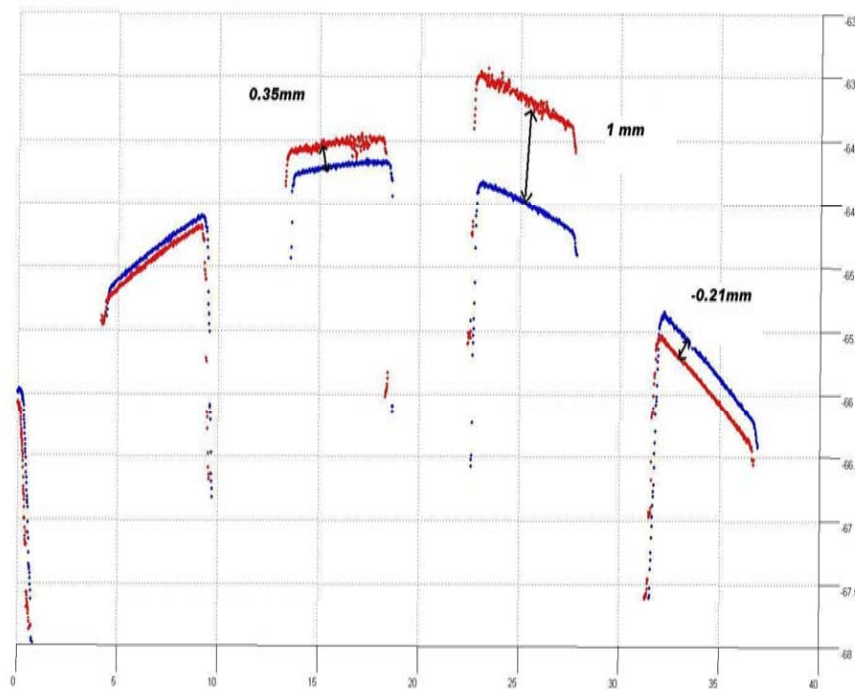
$$\begin{aligned} n &= NL / (\pi D) \\ &= 3000 / (175\pi) = \sim 5.45 \\ &= 5\text{-}6 \text{ points} \end{aligned}$$

Conclusion: Possible to be tested !!!



Stationary Experiment

Measurement of the profile of two sets of teeth for a stationary sprocket and linearly moving Optimet sensor: one containing all normal teeth (blue) and the second containing outliers (red)



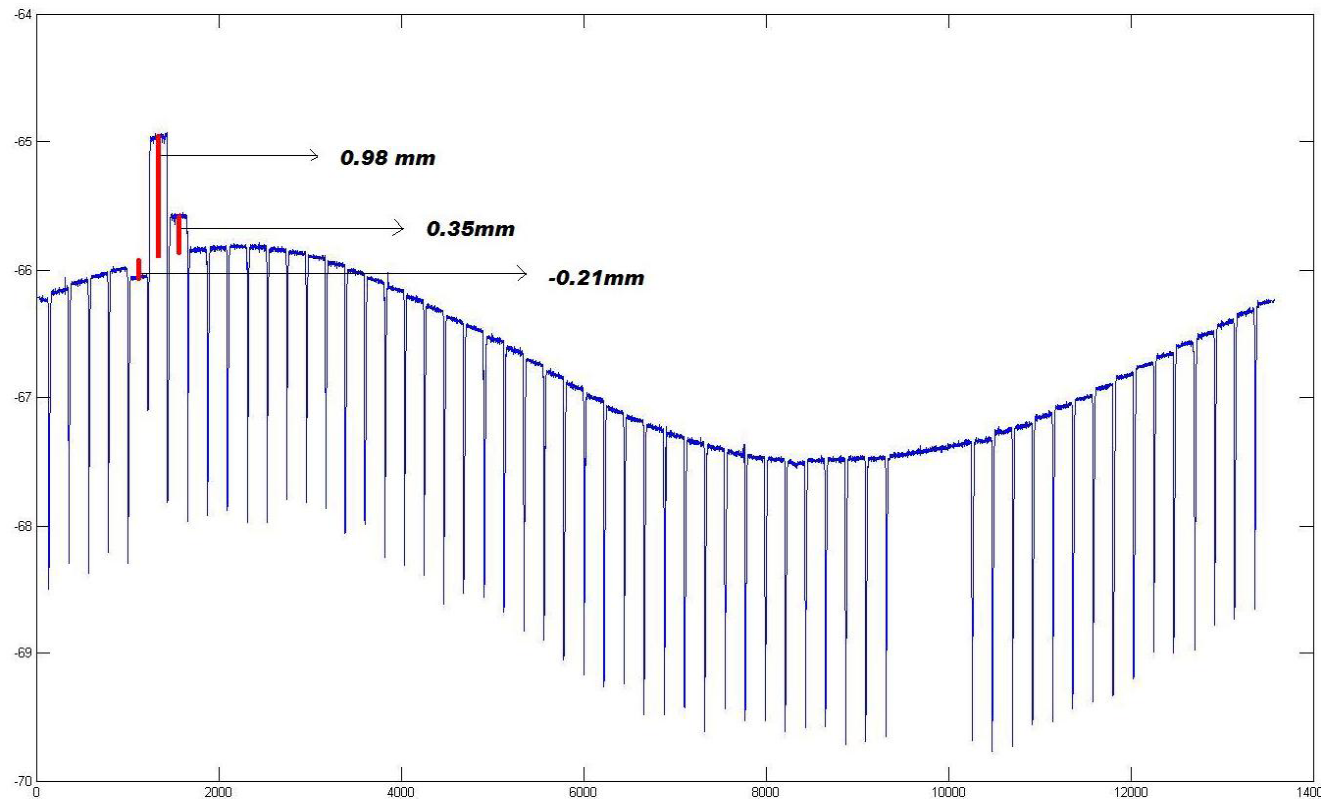
Observation : 3 outliers detected whose deformations are ~ 0.35 mm, 1mm and -0.21 mm respectively



Evaluation of the method

360 degree rotary scan profile of the tip of the sprocket at a slow speed gives the outlier tooth location (w.r.t. starting point) and the deformation

Outliers are observed at teeth 5, 6 and 7 (w.r.t. start tooth) and the measured displacements are -0.21mm; 0.98mm and 0.35mm respectively



Evaluation of the method

- To check the performance of the method, the number of collected points per tooth is down sampled from thousands to 5
- The outlier displacement values are calculated in each of the two cases
- Results are tabulated below

| Displacement | Thousands of points | 5 random points |
|--------------|---------------------|-----------------|
| Outlier 1 | - 0.2088 mm | - 0.2107 mm |
| Outlier 2 | 0.9899 mm | 0.9902 mm |
| Outlier 3 | 0.3585 mm | 0.3622 mm |

Note: negative deformation signifies inward deformation



Conclusion

1. The proposed method is an accurate way for the detection of outliers in sprockets
2. It is also accurate in estimating the deformation/displacement of outliers
3. Can be applied in an industrial application with a rotating sprocket

