# Imperial College

## MOTIVATION

Recovery of dense 3D shape from shading cues of multiple images of a single object under unknown illumination:

UNCALIBRATED PHOTOMETRIC STEREO





Recovery of dense 3D shape from thousands of images of a single class of object under unknown illumination



### AUTOMATIC CONSTRUCTION OF ROBUST Spherical Harmonic Subspaces YANNIS PANAGAKIS PATRICK SNAPE Stefanos Zafeiriou

## CONTRIBUTIONS

- Perform class-specific uncalibrated photometric stereo this can be solved via a factorisation of the data matrix into a spherical harmonic basis and coefficients for lighting and identity
- We propose to exploit the low rank structure of faces and spherical harmonics to perform the joint factorisation

## $\mathbf{X} = \mathbf{B}(\mathbf{L} * \mathbf{C})$

- Use very efficient sparse correspondence methods to construct models from thousands of in-the-wild facial images
- Low frequency dense facial shape is recovered from challenging images without prior knowledge of 3d facial shape

### APPROACH

### CLASS-SPECIFIC UNCALIBRATED Photometric Stereo AND MAY BE HARMONIC INPUT IMAGES CORRUPTED BY COEFFICIENTS Are Low Rank SPARSE NOISE $\|\mathbf{A}\|_* + \lambda \|\mathbf{E}\|_1 + \frac{\mu}{2} \|\mathbf{A} - \mathbf{B}(\mathbf{L} * \mathbf{C})\|_F^2$ argmin A,E,B,L,C subject to $\mathbf{X} = \mathbf{A} + \mathbf{E}, \ \mathbf{B}^T \mathbf{B} = \mathbf{I}.$ IDENTITY COEFFICIENTS Spherical HARMONIC WARPED BASI

### RESULTS

### SHAPE-FROM-SHADING PRIOR









-







We used the prior-based shapefrom-shading method of [44] to recover surface normals from images of celebrities. We compared our spherical harmonic basis learnt from in-the-wild images with a clean basis learnt from the ICT-3DRFE database. This demonstrates our model successfully recovers low frequency shape.





### SUBJECT SPECIFIC ALIGNMENT AND DEPTH RECOVERY



frequency shape information and We learnt a person specific spherical harmonic subspace for Tom Hanks using can aid in the recovery of high in-the-wild images from the Internet. This subspace was used to simultaneously improve the fitting of a state-of-the-art alignment method and to recover 3D.