3D MODELING FRAMEWORK: AN INCREMENTAL APPROACH

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OBJECTIVES

- Develop a framework for on-line 3D modeling useful for human computer interaction (HCI) or telepresence applications
- Propose an adaptation of the Crust algorithm for incremental reconstruction
- Fuse new data into the reconstructed model based on measure uncertainty and novelty
- Virtual view synthesis through body motion estimation and hybrid sensor composed by a video and depth camera

CHALLENGES AND APPROACHES

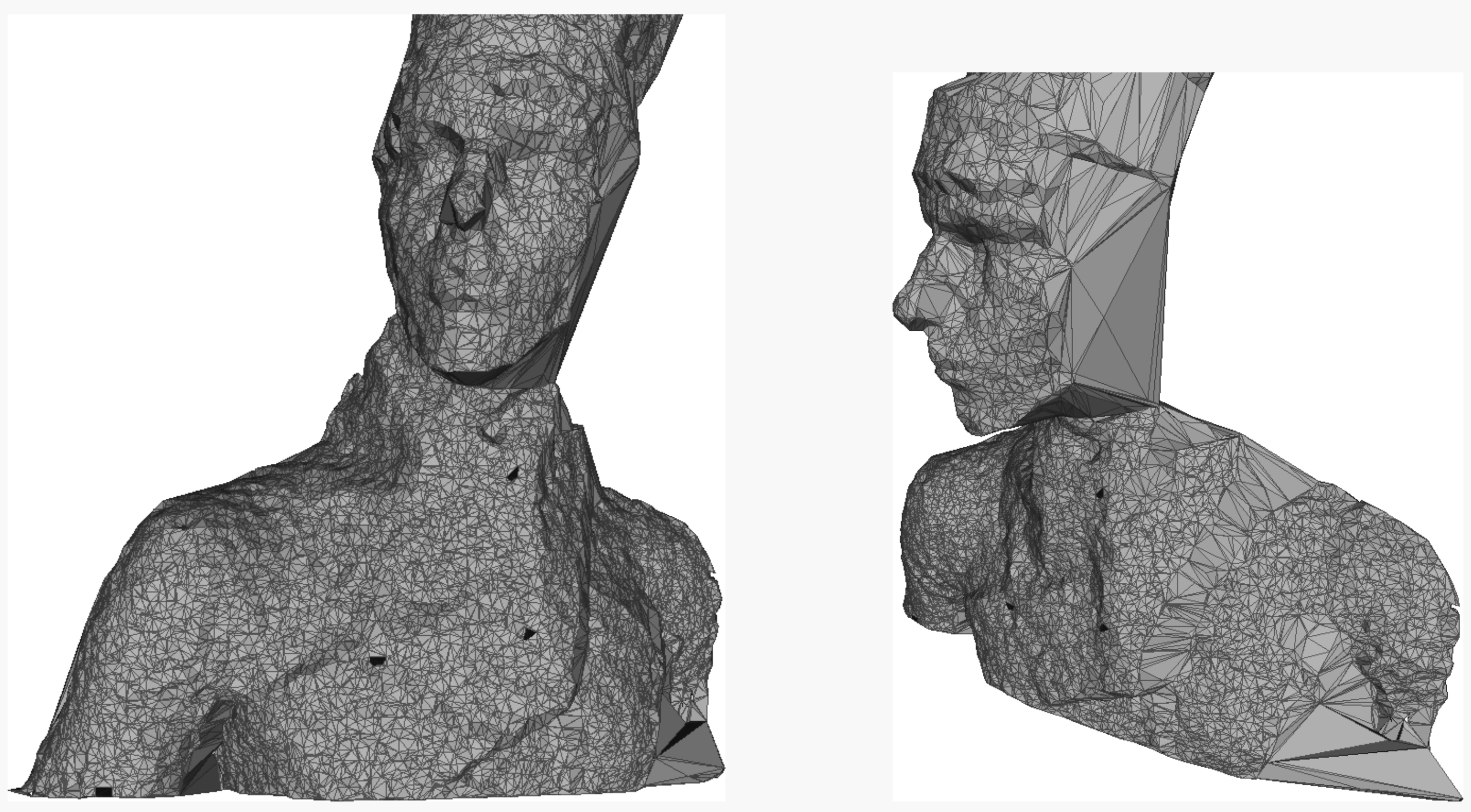
- Realistically represent the user's body appearance
- Enhance the presence feeling and immersion in netmeeting or interaction scenarios
- Combine body motions estimation to a depth camera to address the video reconstruction problem on object's low-texture regions
- Treat deformable bodies as a set of rigid transformations

MESH MODELING

- A new and incremental version of the Crust algorithm is proposed to add a new set of sample points X_{t+1} to the surface mesh, without a full recalculation :

Algorithm 1 Crust incremental algorithm

1: $\mathbf{P}_{t+1}$= poles of $\mathbf{X}_{t+1}$
2: Add $\mathbf{P}_{t+1} \cup \mathbf{X}_{t+1}$ as new Delaunay triangulation vertices
3: Extract triangles whose vertices belong to $\mathbf{X}_t \cup \mathbf{X}_{t+1}$



Mesh model using Crust triangulation

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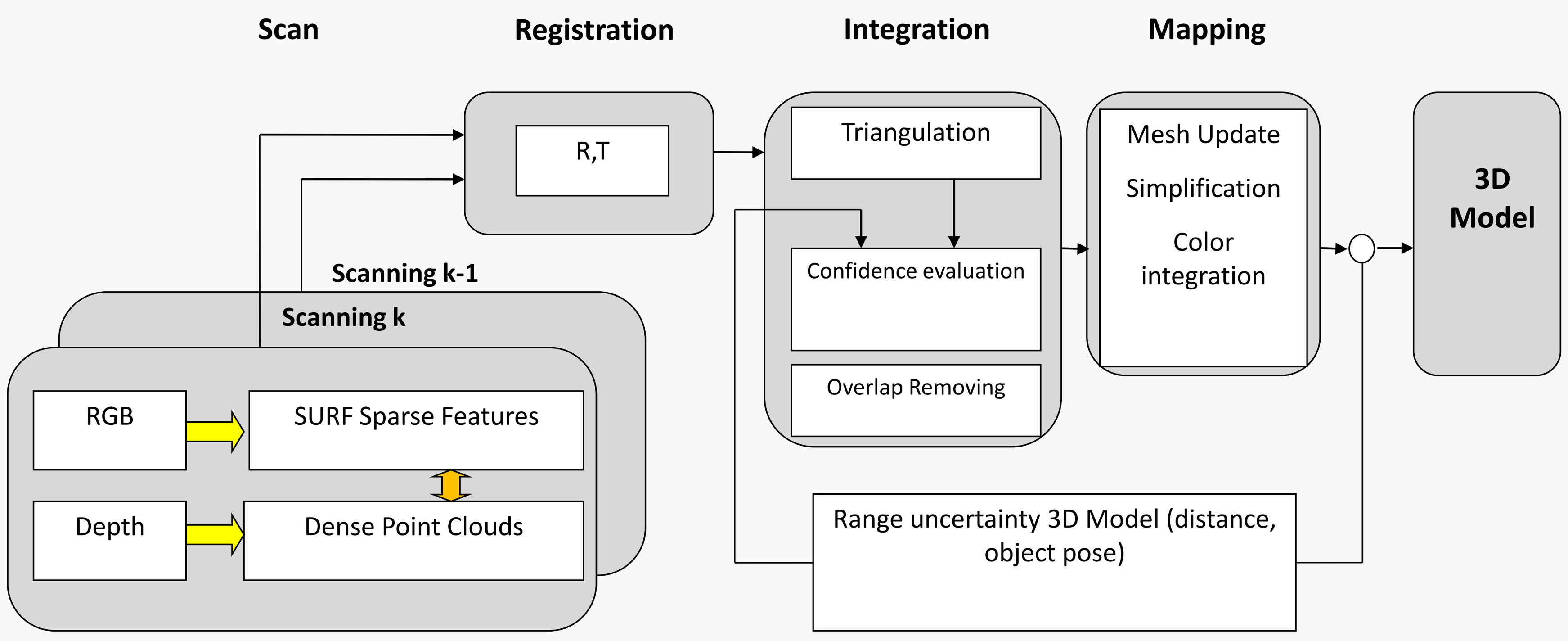
REAL-TIME 3D RECONSTRUCTION SYSTEM

COMBINES VISUAL FEATURES AND SHAPE-BASED ALIGNMENT



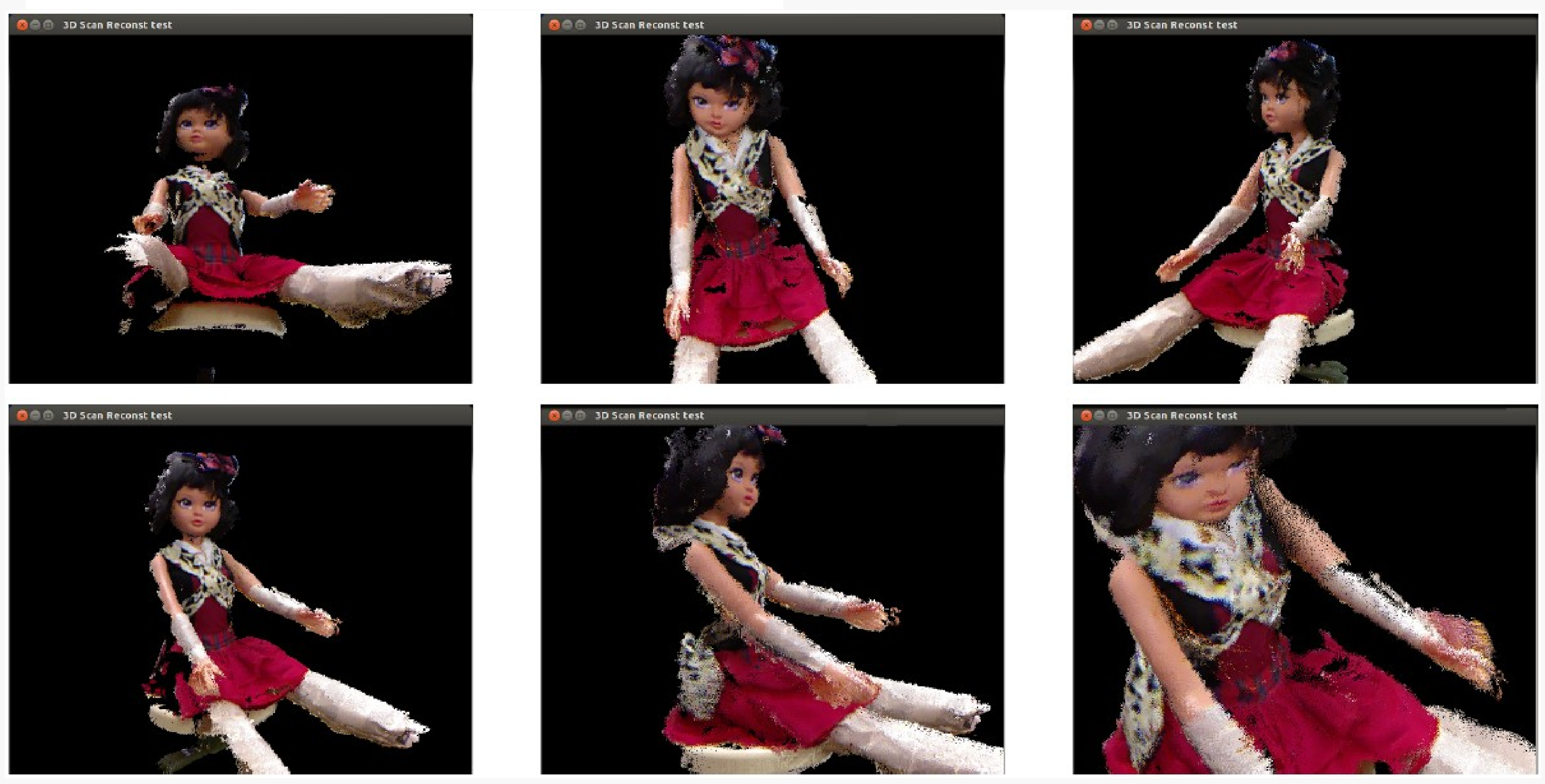
- *Multiview 3D Scan:* one single RGB-D sensor (kinect)
- *Correspondence:* RGB-D sensor provides simultaneously scene 3D information and respective 2D image, SURF establish the 2D match
- *Registration:* 3D point clouds alignment, two corresponding 3D points sets, $\{x_i^t\}$ and $\{x_i^{t+1}\}$, i=1::N

$$\mathbf{x}_i^{t+1} = \mathbf{R}\mathbf{x}_i^t + \mathbf{t} + \mathbf{v}_i \qquad \varepsilon^2 = \sum_{i=1}^{N} \left\| \mathbf{x}_i^{t+1} - \mathbf{R}\mathbf{x}_i^t - \mathbf{t} \right\|^2$$

R - rotation matrix, **t** - 3D translation vector, $\mathbf{v}_i$ - noise vector. equation minimization using a least square criterion (SVD)

- *Model Mapping:* To update the reconstructed model, each acquired 3D point set is transformed to initial sensor reference coordinates
- *Integration:* information relevance based on the uncertainty of range sensor. Confidence inversely proportional to the distance **L** and angle **Ø** of data acquisition: **Ci= |1/(LØ)|**

EXPERIMENTS AND RESULTS



Synthesized views of a 3D reconstructed model dependent of observer point of view

CONCLUSIONS

- A framework for on-line incremental 3D modeling useful for HCI
- Virtual view synthesis through motion body estimation & RGB-D sensor
- A new incremental version of Crust algorithm that efficiently adds new vertices to an already existing surface without full mesh recalculation
- Integration of 3D data based on confidence measures avoiding redundant information computation.

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