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**NURSING RESEARCH
CONGRESS**

27-31 July 2017 | Dublin, Ireland



Nurse-Managed Technology to Enhance Cancer Care Outcomes for Survivors with Breast Cancer or Head/Neck Cancer

Summary: Technology developed by nurses and their multidisciplinary collaborators for enhanced care outcomes for persons diagnosed with breast or head/neck cancer will be presented. Technology for (1) mobile-device assessment of limb swelling, (2) machine learning and touchscreen reporting, (3) integration of assessment data into the medical record, and (4) head/neck lymphedema assessment will be demonstrated.

Moderator: Melissa A. Stec, DNP, APRN, CNM, FACNM

College of Nursing, University of Cincinnati, Cincinnati, OH

Symposium Organizer: Jane Armer, PhD, RN, CLT, FAAN

Sinclair School of Nursing and Ellis Fischel Cancer Center
University of Missouri, Columbia, MO, USA

Nurse-Managed Technology to Enhance Cancer Care Outcomes for Survivors with Breast Cancer or Head/Neck Cancer

- 2:30-2:50 Mobile Platform for Assessment, Early Detection, and Management of Breast Cancer-Related Lymphedema
Jane Armer, PhD, RN, CLT, FAAN
Sinclair School of Nursing and Ellis Fischel Cancer Center, University of Missouri, Columbia, MO, USA
- 2:50-3:10 Health Information Technology (IT) to Promote Patient-Centered Care
Mei R. Fu, PhD, RN, FAAN
Rory Meyers College of Nursing, New York University, New York, NY, USA
- 3:10-3:30 Cancer Registry and Electronic Medical Record Data In Head and Neck Cancer Research
Janet Van Cleave, PhD, MSN, RN
Rory Meyers College of Nursing, New York University, New York, NY, USA
- 3:30-3:35 Assessment of Head and Neck Lymphedema with Ultrasonography
Jie Deng, PhD, RN, OCN, FAAN
School of Nursing, Vanderbilt University, Nashville, TN, USA



Early Detection, and Management of Breast Cancer- related Lymphedema

Jane M Armer, PhD, RN, FAAN, CLT¹

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Outline

- Introduction
- Background
- Proposed System
- Results
- Future
Work/Conclusion

**LYMPHOEDEMA:
Mobile
Platform for at
Home
Observation
Early-
DEtECTION and
MAnagement of
LYMPHOEDEMA**



Secondary Lymphedema

- Disruption or obstruction of lymphatic pathways
- Caused by cancer treatment: surgery, radiotherapy or chemotherapy
- 2.9 million at risk (US) 15-54% by 2 years after surgery (Norman et al., 2009)
- Debilitating and distressing even in early stages
- Frequent visits to a specialist beyond the requirement for cancer treatment

Norman SA, Localio AR, Potashnik SL, et al. Lymphedema in Breast Cancer Survivors: Incidence, Degree, Time Course, Treatment, and Symptoms. J. Clin. Oncol. 2009;27(3):390-397.

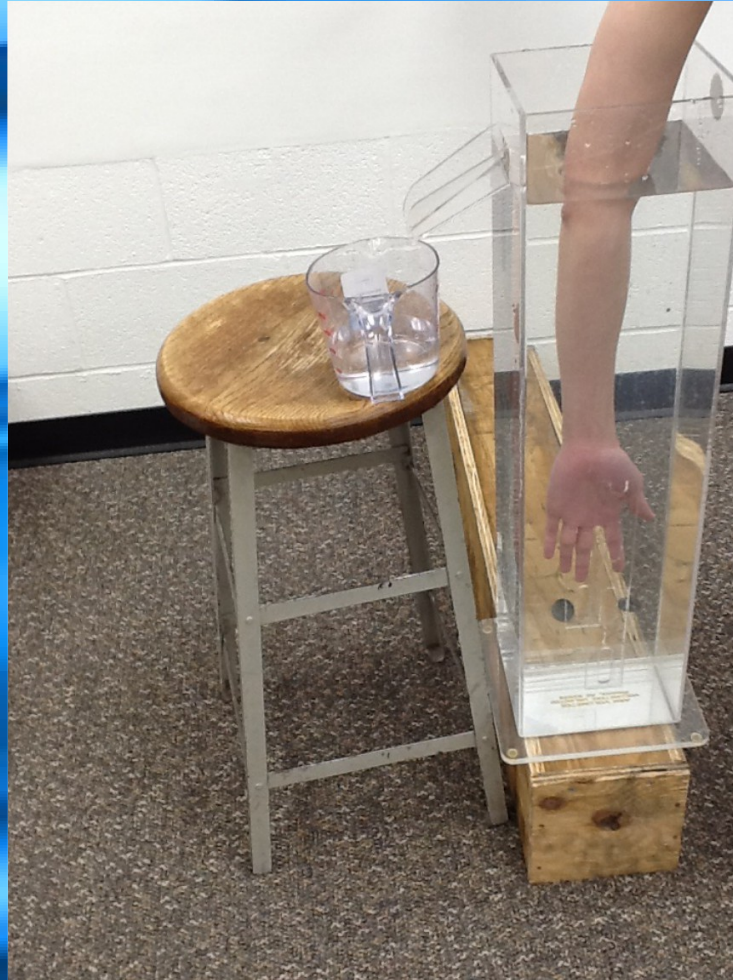
- Early detection of lymphedema is vital to maximizing a patient's quality of life (NLN, 2011)
- Early detection leading to early treatment could reduce the lifetime cost of treatment by 40+% (Chance-Hetzler et al., 2015).
- Accurate detection of lymphedema depends on both limb volume and symptoms (Armer & Stewart, 2005).
- **Until now, the capability for a patient to self-monitor limb volume change has been limited.**

NLN Medical Advisory Committee. Post breast cancer related lymphedema network: Topic: Screening and Measurement for Early Detection of Breast Cancer Related Lymphedema. San Francisco, CA: National Lymphedema Network;2011.

Chance-Hetzler J, Armer J, Van Loo M, et al. Prospective Lymphedema Surveillance in a Clinic Setting. *Journal of personalized medicine*. 2015;5(3):311-325.

Armer JM, Stewart BR. A comparison of four diagnostic criteria for lymphedema in a post-breast cancer population. *Lymphat Res Biol*. 2005;3(4):208-217.

Limb Volume Measurement: “Gold standards”



Water Displacement



Perometry

	Water Displacement	Circumference	Impedance	Perometry	DEXA Scan	Our Method
Cost	Low	Low	High	High	High	Low
Time to Operate	Moderate-High	Moderate	Low	Low	Low	Low
Inter-Rater Disparity	Low	High	Low	Low	Low	Low
Pre and Post Maintenance	High	Low	Moderate	Moderate	High	Low
Local Measures	No	Yes	No	Yes	Yes	Yes
Self-monitoring Home/Travel	No	Yes	No	No	No	Yes

Figure 1

■ Our method:

- Allows for at-home monitoring of limb volume by patient and/or caregiver.
- Uses ubiquitous smart phones for video and gyro measurements
- Analysis is done on our Mizzou servers

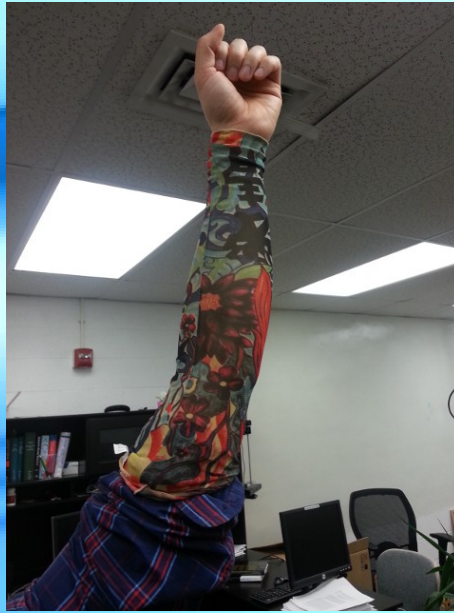
■ This is ideal for patients in developing countries or those for whom traditional (in-clinic) prospective surveillance is economically unfeasible or geographically impractical.

■ It can empower all patients in their own self-care.

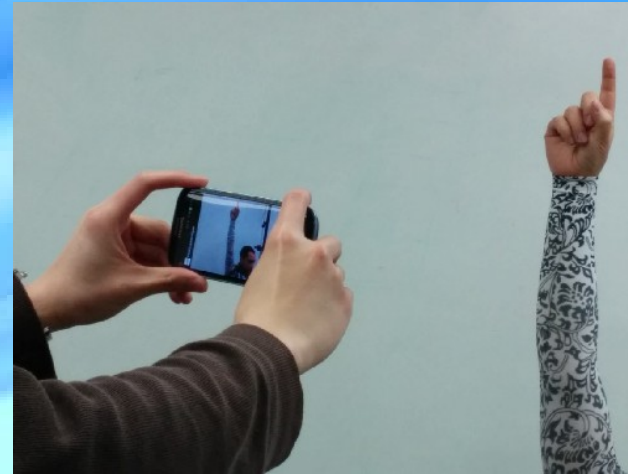
Proposed System (Client Side)



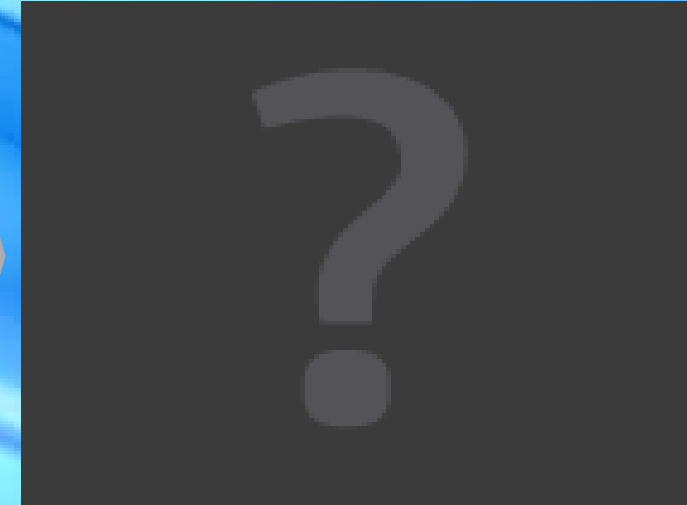
The helper
uses a smart
phone



The patient
wears a tatoo
sleeve



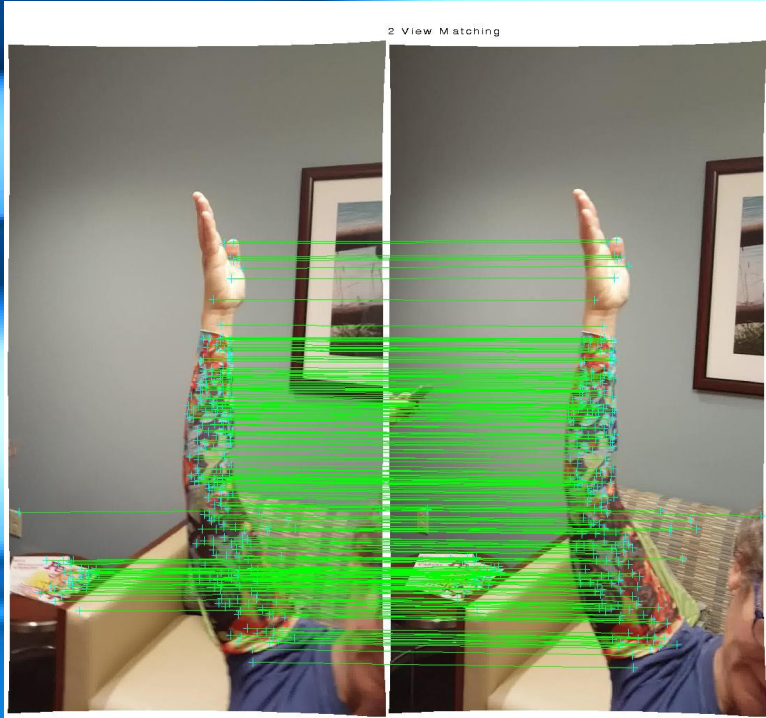
The helper shoots a
video (The patient
holds her body
steady)



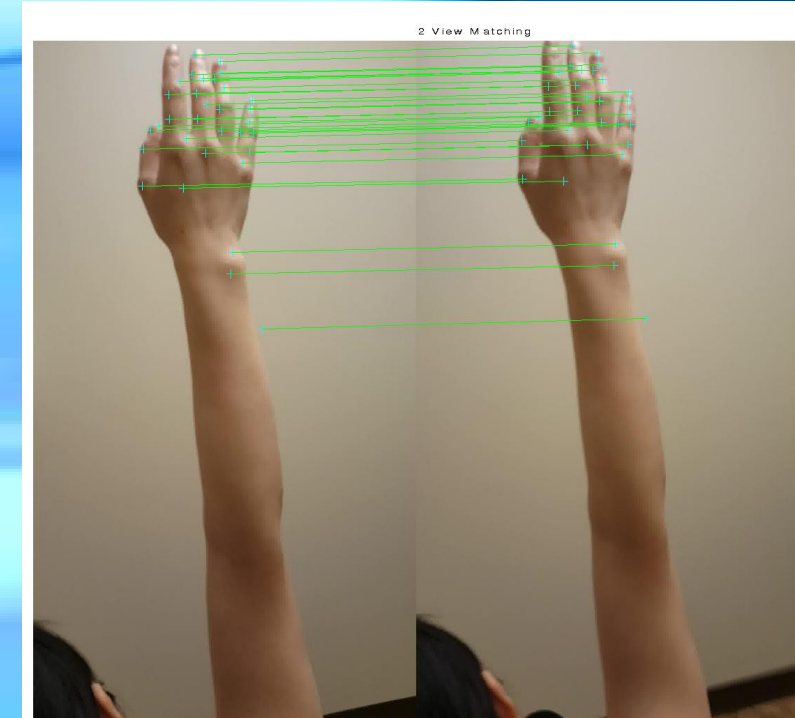
The helper circles
the patient while
shooting the
video

When internet becomes available, the video is
uploaded to the MU project server by email or
Dropbox. That is it!

Why do we need tattoo sleeves?



versus

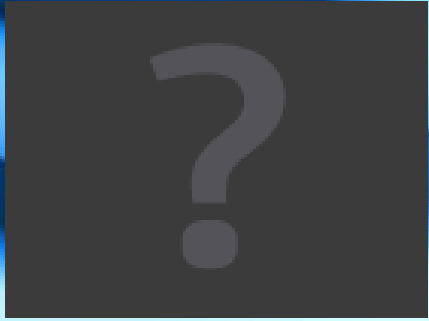


A good case: A large number of feature matchings

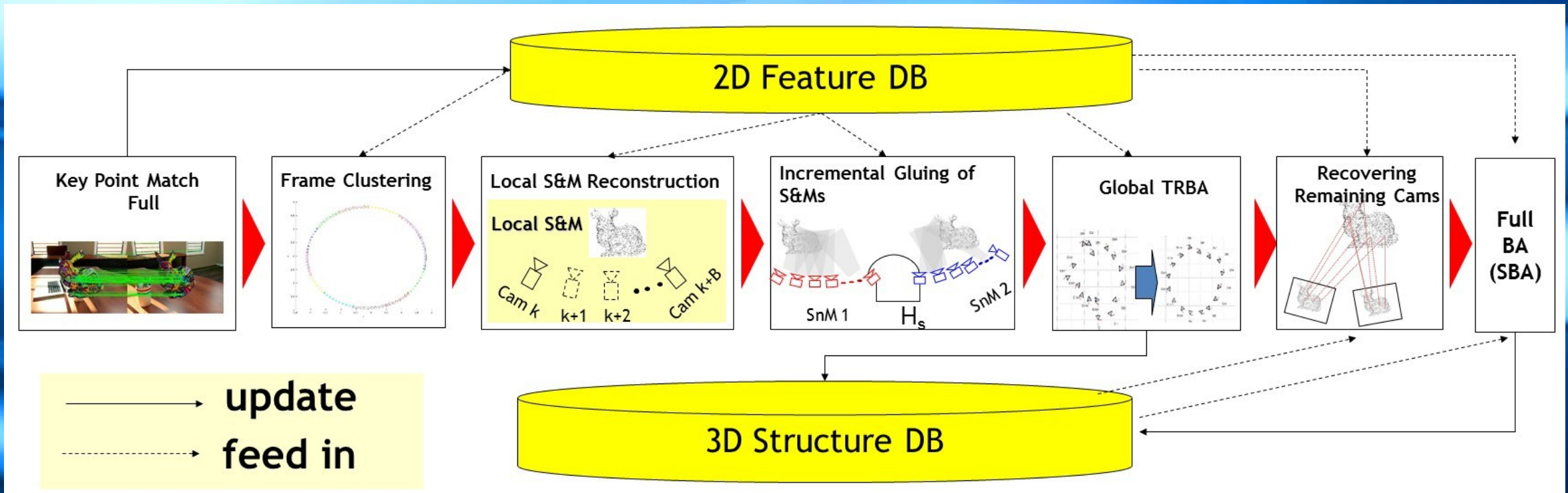
A bad case: Insufficient number of feature matchings

- M** We need tattoo sleeves in order to extract and match many point features from images
- M** This way, we can expect robust and stable 3D reconstruction

Proposed System (Server Side)

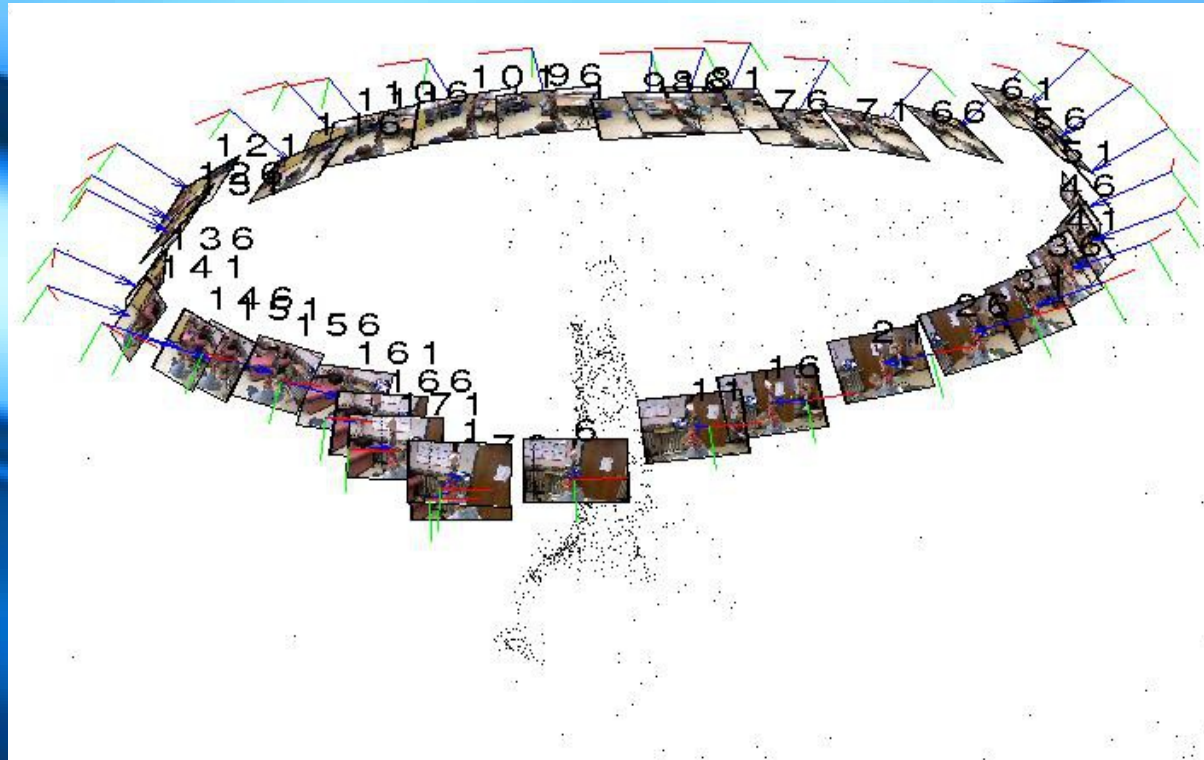


Extract Images from Video

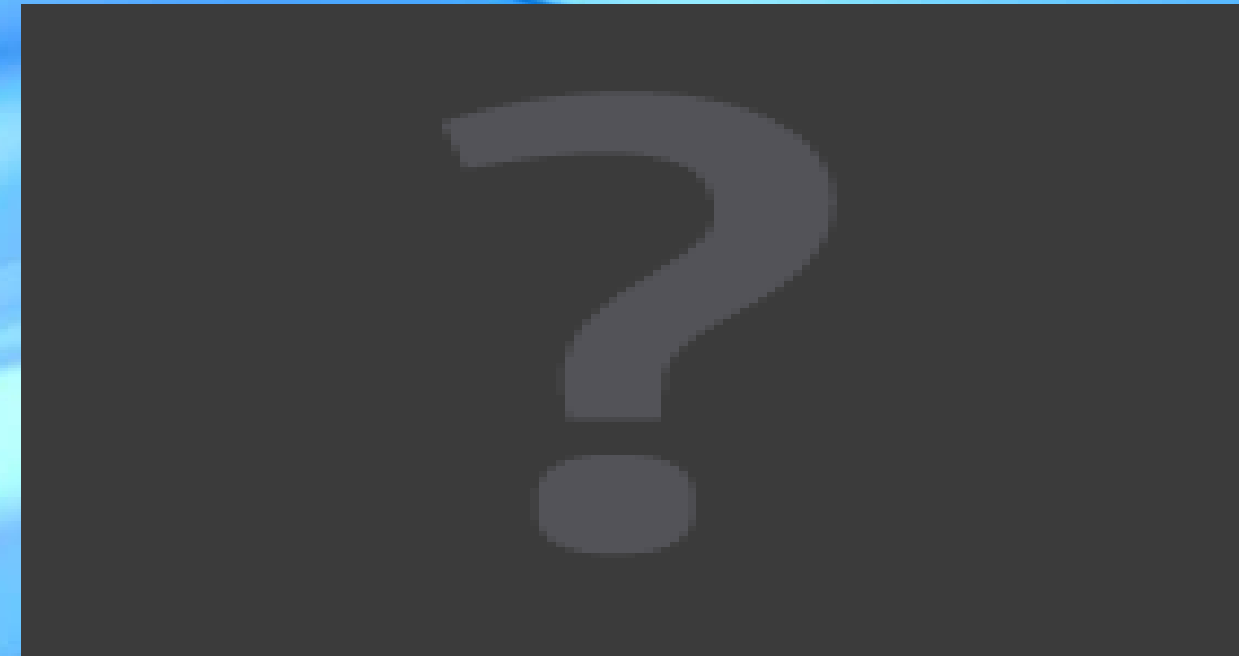


Run SfM pipeline

Results



Sparse Reconstruction: By our
method



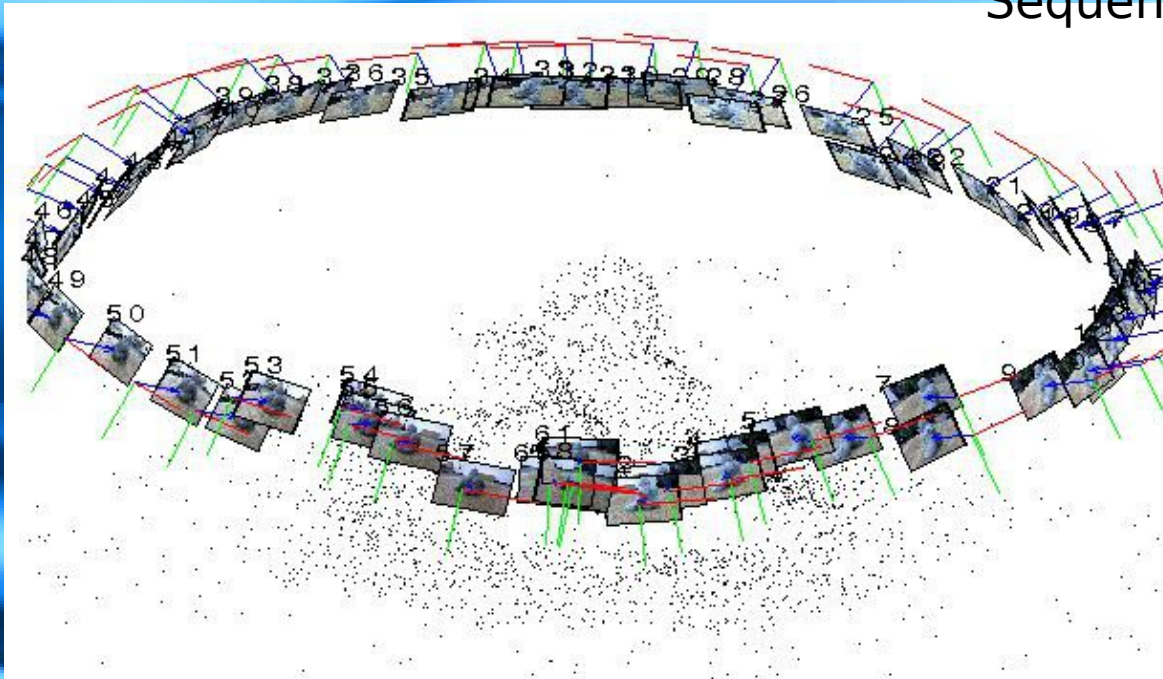
Dense Reconstruction: By
PMVS*

*Y. Furukawa and J. Ponce, "Accurate Dense Robust Multi-View Stereopsis", TPAMI pp 1362~1376

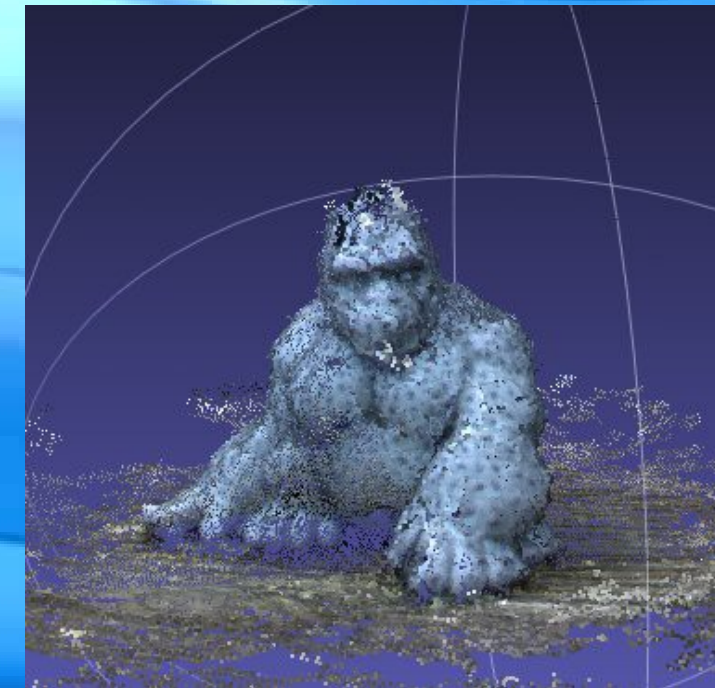
Results



Input
Sequence



Sparse
Reconstruction



Dense
Reconstruction

Results



Input
Sequence

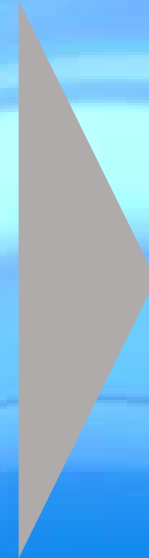


Dense
Reconstruction

Results

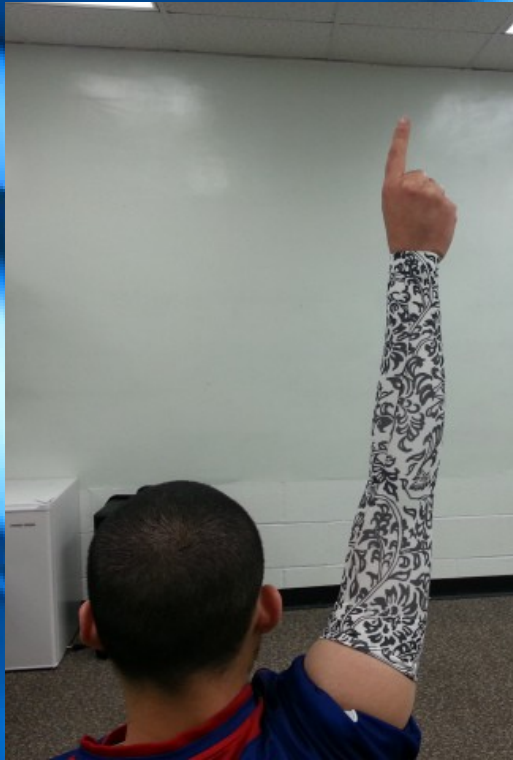


Input
Sequence



Dense
Reconstruction

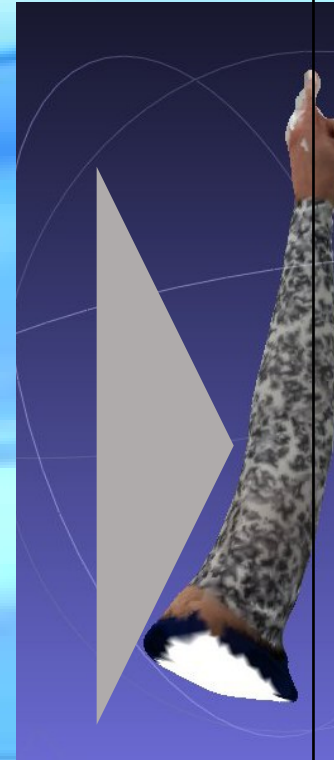
Limb Volume Measurement



RGB
image



3D point
clouds



Mesh
model

We measure volume
of the arm from this
model

Measurement

Reliability data

	Water-displacement	Kinect-based
Mean (ml) ± std (ml)	1560.06±387.01	1578.13±367.99
Pearson Correlation Coefficient	N/A	0.98

Figure 2: Two Statistical Tests performed between Water-Displacement and the Kinect-based system

	Perometry	Kinect-based	Smart-Phone
Mean (ml) ± std (ml)	1241.51±262.90	1244.17±265.06	1285.65±268.14
Pearson Correlation Coefficient	N/A	0.98	0.97


Figure 3: Two Statistical Tests performed between Perometer and both systems




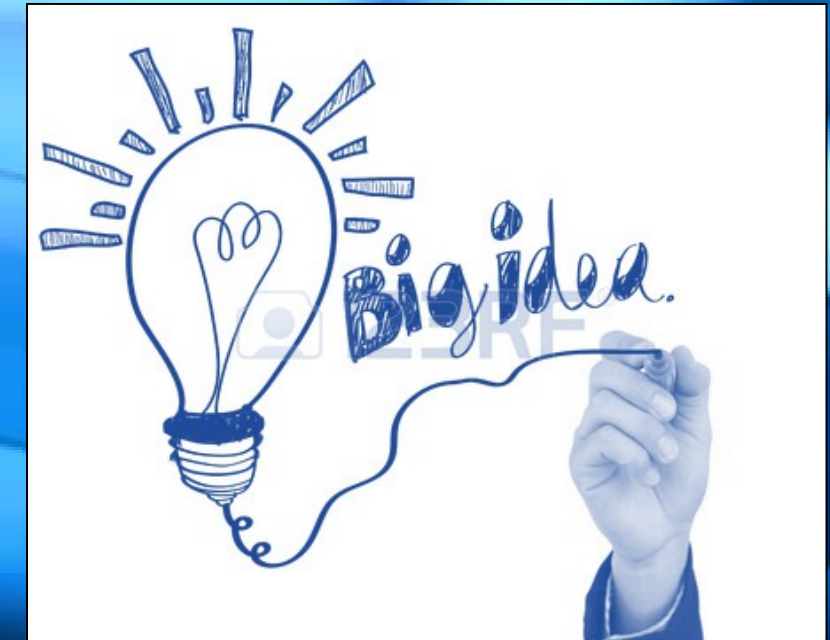
- Continue beta tests with data collected from other testing sites
- Further improve the algorithm, if needed
- Eliminate the camera calibration procedure (Use EXIF tags)
- Further test the ability to detect localized swelling
- Continue to study the intra- and inter-rater reliability of the measurements
- Make software available to public

- In this research, a completely automated and robust system for 3D imaging of human arms is presented.
- Our method out-performs existing methods in many aspects, including cost, maintenance, and ease of use, while they maintain high correlation with the “gold standards.” Such performance of the proposed method was demonstrated by exhaustive tests with healthy people, as well as patients with lymphedema.
- We will continue to assess the ease of use by patients with variable levels of comfort with technology.

Knowledge is POWER!

 The LYMPHOEDEMA project is about making accurate information more readily-accessible to an increased number of patients, care-givers, clinicians, and policy-makers.

 The end result will be to empower patients to monitor for changes in their limbs and provide actionable data to clinicians for real-time intervention and management.



- [1] J. A. Petrek and M. C. Heelan, "Incidence of breast carcinoma-related lymphedema," *Cancer*, vol. 83 (12 Suppl American), pp. 2774-2781, 1998
- [2] J. M. Armer and B. R. Stewart, "A comparison of four diagnostic criteria for lymphedema in a post-breast cancer population," *Lymphatic Research and Biology*, vol. 3, no. 4, pp. 208-217, 2005.
- [3] S. H. Ridner, L. D. Montgomery, J. T. Hepworth, B. R. Stewart, and J. M. Armer, "Comparison of upper limb volume measurement techniques and arm symptoms between healthy volunteers and individuals with known lymphedema," *Lymphology*, vol. 40, no. 1, pp. 35-46, March 2007.
- [4] G. Lu, G. N. DeSouza, J. Armer, B. Anderson, and C. -R. Shyu, "A system for limb-volume measurement using 3D models from an infrared depth sensor," in *2013 IEEE Symposium Series on Computational Intelligence, Symposium on Computational Intelligence for Healthcare and e-Health (CICARE)*, Apr 2013, pp. 64-69, Singapore.
- [5] C. Shyu, B. Anderson, S. C. Xu, J. Armer, "Implementing a Multi-Layered Architecture for Source-Agnostic Lymphedema Data Storage and Analysis", *2014 ILF Conference*, Glasgow, 2014.
- [6] C. Shyu, B. Anderson, S. C. Xu, J. Armer, "Look4LE: A Mobile App to Search Lymphedema Specialists and Provide Up-To-Date Patient-Centered Resource Analysis", *2014 ILF Conference*, Glasgow, 2014.

