Mixed Reality for Biopsy Site Localization - Paper Critique

Miller AC, Blalock TW. Augmented reality: a novel means of measurement in dermatology. J Med Eng Technol. 2021 Jan;45(1):1-5. doi: 10.1080/03091902.2020.1838641. Epub 2020 Nov 16. PMID: 33191825.

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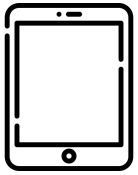
Project Summary

Problem

Skin biopsies are used by dermatologists to diagnose cutaneous ailments, but site identification can be difficult — leading to site misidentification



Goal

We aim to create a mobile augmented reality application that can provide dermatologists with additional guidance to locate the biopsy site

Paper: Augmented reality: a novel means of measurement in dermatology.

Austin C. Miller and Travis W. Blalock

Full citation: Miller AC, Blalock TW. Augmented reality: a novel means of measurement in dermatology. J Med Eng Technol. 2021 Jan;45(1):1-5. doi: 10.1080/03091902.2020.1838641. Epub 2020 Nov 16. PMID: 33191825.

A paper discussing the use of **augmented reality** for measurement in dermatology, particularly using **smartphones**

Related to our project: development of an augmented reality mobile app (smartphone/tablet) for locating a biopsy site in dermatology. Some takeaways:

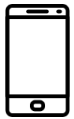
- Many AR applications lack published data on precision; we should compile an organized report on precision/accuracy for our application
- Variability in definition of accuracy for AR applications requires us to define it in our case
- Cross-platform reliability is good to have—we may want to expand to Android and other platforms

Intro/Background

Accurate/consistent **measurement** of the **size** of cutaneous lesions is important for diagnosis, treatment, monitoring, etc.

But measuring is **inconsistent** — varying methods/tools, human error, and other variables (lighting, skin tension, etc.) can lead to both inter- and intrapersonal variability

Existing technology for measuring lesions more accurately may require sophisticated software and complex equipment that can be **costly/bulky/time-consuming**



Paper proposes that smartphone AR applications can be used to assist

Paper Overview

Intro/Background

AR can overlay **digital content** over the real world/live camera

AR applications with a virtual ruler can be used for measurements; existing applications: Google's Android and Apple's iOS built-in AR measurement apps

Typical features:

- Measure distance between two points using real-time camera
- Make multiple measurements
- Track previous measurements
- Capture images easily
- Sometimes:
  - Height/surface area measurements
  - Toggle between standard/metric units

Image from Miller et al.

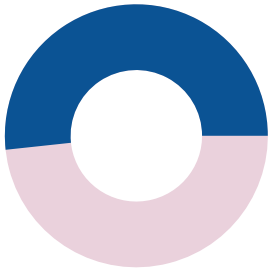
Discussion: Smartphone App Benefits

The paper discusses a number of studies demonstrating the improvement in accuracy/reliability that can result from using a smartphone application:

Ruler

within 1 mm
71%
of the time

Visual Estimation



within 1 mm
about half
of the time

The smartphone application produced **more consistent** and **more accurate** measurements.

	Intra-rater reliability	Inter-rater reliability	Accuracy
Smartphone App	Good	Good	Clinically useful, better than ruler
Ruler	Good	Poor	Inferior to app

Discussion: Dermatology Measurement AR

Paper discusses other applications/benefits of AR in dermatology:

- Portability and convenience
  - 85% of healthcare providers use smartphones
  - Camera requires only one hand, vs. ruler or methods needing two people
- Track lesions over time; one option: record distance from certain landmarks
  - Similarities to the registration method of our application?
- Measure distance between multiple fixed points and/or distances exceeding ruler size
  - Can be used for guiding routine procedures
- Create virtual landmarks for additional measurements in complex cases
- AR measurement can be incorporated into electronic health record software on phones/tablets
  - Can use in conjunction with image documentation for easy review
    - Could in turn improve speed/accuracy of lesion identification

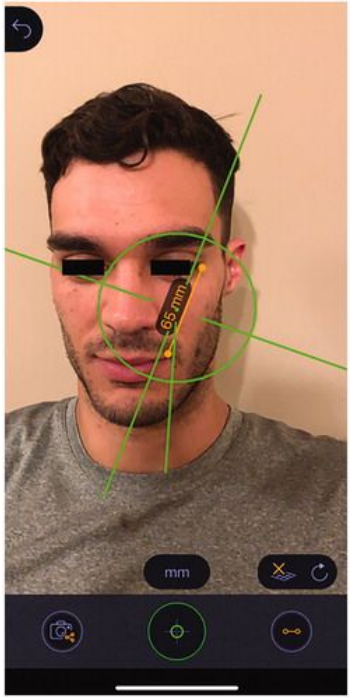


Image from Miller et al.

Discussion: AR in Surgical Fields

Paper discusses other applications/benefits of AR in surgical fields:

- 3D overlay of anatomy
- Dermatological surgery (our project!)
    - Quickly map incision points
    - Measure surgical margins perioperatively
    - AR measurement could provide additional measurements/calculations: tumor volume/area, ratios, etc.
    - Use of camera vs. physical ruler can lead to less wound contamination, wound infections, surgical cost, medical waste (from ruler usage)

Limitations of AR

- **Not much data generated** for smartphone AR measurements; most data are focused on nonhuman structures
- Many AR apps are **rudimentary** in area calculations; specificity may require further improvement + more advanced calculations
- AR measurement apps **lack published data** on precision/accuracy in dermatology — trials + research necessary to determine dermatologic usefulness
- **Variability in fundamental elements**: definition of accuracy, image acquisition, registration techniques, computers and software interfaces, integration of real-time data, tissue displacement, judgement and clinical experience
- Human error → technological/mechanical error; can compensate but doing so across platforms would need **cross-platform reliability**

Conclusion

- Most effective techniques for skin-lesion measurement would be simple/practical to implement in broad/diverse clinical settings
- Absence of validated gold standard for measurement of skin lesion size → difficult to conclude which method is superior. Still, AR offers certain advantages:
    - Easily accessible and user friendly technology
    - Could reduce inter- and intrapersonal errors
    - Reduce intraoperative infections, lengthy training, and costs

AR has the potential to become a standard, commonplace measuring tool

Paper Critiques

- Only demonstrated usage of iPhone AR app, but discussed Android and others — could have provided figures or further elaboration of other applications
- Discussed incorporating measurements into electronic health records — how feasible would it be? Would the information interface directly with the app or would the physician have to redo measurements to check?
- More data would have been nice: numerical data for smartphone accuracy, and perhaps something for tracking lesions over time, which is essentially the goal of our own project
- Paper states it is “difficult to conclude” whether a smartphone app would be superior due to the lack of a validated gold standard in the Conclusion. Surprising — the authors seemed to strongly support a claim of smartphone apps being beneficial in many ways + mention “the gold standard of wound area measurement” earlier
    - Could bring up the lack of validated gold standard earlier or mention that the method mentioned earlier is not validated if it is not; and/or they could say “despite the lack of a validated gold standard, AR offers many benefits” etc.

Final Takeaways and Application to Project

Paper summarized limitations of AR in dermatology; most takeaways reflect that:

- Many AR applications lack published data on precision; we should compile an organized report on precision/accuracy for our application
- Variability in definition of accuracy for AR applications requires us to define it in our case
- Cross-platform reliability is good to have—we may want to expand to Android and other platforms in future work

Some other takeaways:

- 85% of healthcare providers use smartphones — good to know if we want to distribute our application
- A simple, straightforward, and user-friendly application is ideal as opposed to a complex, time-consuming app
- Paper discussed use of existing AR applications; we could look into integrations for future work

References

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