**Paper Critique**

# Mixed Reality for Biopsy Site Localization

**EN.601.456 Computer Integrated Surgery II**

## Critique of:

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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# 1. Overview of Our Project

Skin biopsies are used by dermatologists to diagnose cutaneous ailments, including tumors and rashes. However, if a surgery becomes necessary after a biopsy, determining the original site of the biopsy can be difficult due to various factors including the skin healing, biopsy depth, and background skin disease. This difficulty can lead to wrong site surgery, which is a never event — an error that is preventable and should never occur.

This project aims to create a mobile augmented reality application (to be deployed on a phone or tablet) that can register biopsy images to surgery images and subsequently overlay the biopsy site on live camera images taken by the mobile device. This would provide dermatologists with guidance sufficient to locate the biopsy site on the patient at the time of surgery.

# 2. Paper Selection

The paper I have selected to review is:

> 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.

The authors (note: I shall use this to generally refer to the authors of this paper) discuss the use of augmented reality (AR) for measurement in dermatology, particularly using smartphones, which has parallels to our project, i.e. an application of AR in dermatology, though the exact application is for locating a biopsy site as opposed to measuring the size of a lesion.

Still, the paper offers a good summary of the benefits and limitations of AR in a subject that could benefit from improved inter- and intrapersonal reliability, as well as other advantages mentioned in the paper. This paper's work could offer insight so that we can improve certain elements or avoid downfalls in developing our application.

# 3. Paper Overview

## Introduction

The introduction explains the motivation for why dermatologists might want to use an AR application: accurate and consistent measurement of the size of cutaneous lesions is important for diagnosis, treatment, disease monitoring, prognosis, and reimbursement if necessary.

However, measuring is often inconsistent due to varying tools, human error, and other variables such as lighting and skin tension. These can all lead to both inter- and intrapersonal variability, that is, differing results both between raters and for the same rater.

There are existing technologies to improve measurements, but many can be costly, bulky, and/or time-consuming, so the author indicates that smartphone AR applications could be used instead.

Augmented reality can overlay digital content over the real world, which is often a live camera feed; the paper notes that many AR applications exist and are accessible, such as the default measurement apps in Androids and iPhones.

## Discussion

The authors discuss a number of studies to compare various methods of measuring lesions: using a ruler, by visual estimation, and using a smartphone application.

Ruler measurements were decent, being within 1 mm 71% of the time, while visual estimation led to almost half varying by more than 1 mm.

The smartphone application ended up being more consistent and accurate, having high intra- and inter-rater reliability and superior in measurements to the ruler, which also has poor inter-rater reliability.

This is useful for our project in that we have a better sense of what to focus on for our goals: if the primary benefits of using AR over traditional methods are the improvements in reliability (both inter- and intrapersonal) and accuracy, we would like to make sure our application captures those points.

The authors then move on to discuss other applications and benefits of AR in dermatology measurement: it is portable and convenient, since most people have and are familiar with smartphones; it could be used to track lesions over time by recording distance from landmarks,

which could have some similarities to our project's registration method; it could be used to measure multiple distances simultaneously and distances exceeding a ruler, which can be useful for guiding routine procedures; and virtual landmarks could be created where more detailed measurements are necessary. All these measurements could also be incorporated into mobile electronic health record software, which could make lesions easier to track and identify.

Then, the authors shift the subject to surgical fields, particularly dermatological surgery, which is highly relevant to our own project. AR could quickly map incision points, measure surgical margins perioperatively, and provide additional measurements and calculations. Additionally, using a camera instead of physical objects for measurement can lead to less wound contamination and infection, as well reduce as surgical cost and medical waste from using those physical objects.

In the context of our project, we may want to investigate how we can capitalize on these potential advantages our application could have.

## Limitations

The authors next discuss the limitations of AR, particularly in the application of dermatology measurement. There are not much data generated for smartphone AR measurements, as most of the data are focused on nonhuman structures. These apps are also rudimentary in area calculations, so further specificity could require more improvement and more advanced calculations. AR measurement apps also lack published data on precision and accuracy in dermatology, so trials and research are necessary to determine dermatologic usefulness. Additionally, while using AR can convert human error to technological or mechanical error that could be compensated for,  doing so across platforms would require cross-platform reliability.

One notable concern is the variability in fundamental elements, such as the definition of accuracy, how images are acquired, registration techniques, computers and software interfaces, integration of real-time data, tissue displacement, and judgement and clinical experience, which can make things difficult to standardize.

For our project, we should keep these limitations in mind in order to minimize or counteract them; for instance, we could mitigate the uncertainty of the fundamental elements by defining them precisely.

### Conclusion

The final section of the paper is the conclusion, and the authors state that the most effective and useful techniques for skin-lesion measurement would be simple and practical to implement in broad, diverse clinical settings.

The lack of a validated gold standard for measurement of lesion size makes it difficult to conclude which method is superior, but AR offers a number of advantages, including that it's easily accessible and user friendly, can reduce inter- and intrapersonal errors, and reduce intraoperative infections while shortening lengthy training and lowering costs.

The authors thus conclude that AR has the potential to become a standard, commonplace measuring tool—our own project is working towards that goal as well.

## 4. Assessment

This paper provided a succinct and informative overview of how smartphone AR could benefit lesion measurement in dermatology, in that it discussed the strengths and limitations of AR and the use of a smartphone. Figures were useful to demonstrate usage, and the overall flow of information was decently organized.

However, I do have a number of critiques:

The authors discussed various AR measurement apps, but only demonstrated the usage of the iPhone AR app. I have to wonder: just how similar are they? I feel that the paper could have provided additional figures or further elaboration on the topic, and if the authors pursue future work, they could expand on the cross-platform aspects of AR in dermatology.

There were also mentions of incorporating measurements into electronic health records, but how feasible would this be? Would it require systematic adoption across a large organization (or multiple)? Would AR applications directly interface with electronic health records for streamlined recording of data, or would physicians have to manually input measurements? I can imagine that a streamlined workflow would be extremely helpful, but a thorough integration into existing procedures may not be so easy.

In general, the paper could have used more data, such as numerical data for smartphone app accuracy and some data for other proposed applications, such as tracking lesions over time—which is essentially the goal of our own project, though we are only attempting to track a site from one time point to another.

One thing that jumped out at me is that the authors state that it is “difficult to conclude” whether a smartphone app would be superior due to the lack of a validated gold standard in the Conclusion. This was rather surprising to me, since the entire paper seemed to strongly support the advantages or AR over rulers and other methods without discussing any particular advantages of those other methods. They also mentioned “the gold standard of wound area measurement” earlier—is that not a *validated* method? I feel that this is a point to bring up earlier and not in the conclusion, at the very least.

# 5. Takeaways and Application to Project

The authors summarized the limitations of dermatology in AR fairly well, and many of my takeaways reflect that discussion:

- Many AR applications lack published data on precision, so we should compile an organized report on precision/accuracy for our application.
- There exists notable variability in definition of accuracy for AR applications, which requires us to define it in our case.
- Cross-platform reliability is good to have for widespread adoption, so we may want to expand to Android and other platforms in future work.

Other than takeaways regarding the limitations of dermatology AR, I also learned a few other points relevant to our project:

- 85% of healthcare providers use smartphones, which is good to know if we want to widely distribute our application.
- A  simple, straightforward, and user-friendly application is ideal as opposed to a complex, time-consuming app. (I was already somewhat aware of this, but further confirmation can be beneficial.)

Also, the authors focused on the use of existing AR applications as opposed to our project of developing our own. It leaves me wondering if there are possibilities for integration of existing software… but that’s a question for people who continue working on the project after I graduate to answer.

In conclusion, this paper was a helpful overview of smartphone AR in dermatology; while the paper itself was focused on measurement in particular, many aspects of the discussion could be applied to our application of biopsy site localization.

# References


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