Squeezing gesture as an input modality
A review of the existing research

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ABSTRACT
UPDATED—February 25, 2024. This paper represents a review of squeezing gesture-based interaction interfaces. The current state of this technology, it's current use case areas and user feedback. It reflects on how far this technology has come, its limitations and what are the future potential scope for studies in this view.

Author Keywords
Squeezing gesture; gesture input; input modality

INTRODUCTION
The vast usage of computers and computer-generated mobile devices in our lives creates a constant need for a quest for new interaction methodologies. Although the existing interaction techniques can meet most of our expectations there always remains some thirst for more efficient ease cases of user experience in scenarios such as multitasking, if one hand is occupied, better feedback, or just for more comfort of usage [7].

This paper studies 9 existing research on squeezing gesture-based interaction interfaces from the past 5 years. This gives an overview of the current state of application areas of squeezing gesture interfaces, their efficiency, user feedback based on their experiences, limitations of existing models and future scope of study.

This paper stands as an understanding of this technology in terms of it's current stage and abilities to replace the current user interaction model with squeezing gesture-based interaction interfaces.

METHOD
The objective of this paper is to give a scoping review of the current state of squeeze-based gestural input interface research area specifically in the field of Human-computer interaction. For the search methodology I have followed PRISMA guidelines, a visual overview of my method is given in Figure 1.

UIST'20, October 20–23, 2020, Minneapolis, MN, USA

ISBN 978-1-4503-6708-0/20/04...$15.00

DOI: https://doi.org/10.1145/3313831.XXXXXXX

Phase 1: Identificaiton For searching papers I have used ACM digital library as the search engine. Although Google Scholar yields a lot of results but I wanted to stay specific to the CHI conference papers. Because of this I stayed with ACM since it is possible to filter out only the articles that are related to a specific conference series. Furthermore, I wanted to include only the papers that are form computer science field and ACM Digital Library is one of the key databases for accessing journal, newspaper and articles relating computer science.

The initial keyword to search with was 'squeeze input' which yielded around 441,232 results with a lot of articles that had nothing to do with the scope of this review. In the next phase of the search I used the keyword [Title: squeeze input] AND [Abstract: squeeze input modality] AND [Proceeding series: CHI: Conference On Human Factors In Computing Systems] which produced 298 results which was still a lot. The next search filter I used was to take only the last 5 years of studies related to my keywords as the majority of the research articles were published in this topic in the last 5-7 years and I was provided with 84 articles. This 84 was my final set of data for this review.

Phase 2: Screening For the screening phase, I have taken only the title to exclude papers. Articles that did not have squeeze as an input modality would be excluded For example, excluded a paper with title 'A Flexible Holographic Smartphone with Bend Input' that discusses about Bend gestures instead of squeeze input modality [2]. This eases up the process. If the article could not be excluded by it's title, I then move to it's abstract and see if it has any relevance to my scope of study, For example a record that got excluded in this phase was titled 'The embroidered musical ball: a squeezable instrument for expressive performance' which talks about a musical ball that let's untrained people to use certain musical instrument through squeeze gesture which is not related to human-computer field [9]. This process resulted in the exclusion of 73 records.

I retrieved the remaining 11 records and skimmed them for relevance with my scope of view and excluded 2 papers for the following reason:

Reason 1: Does not contribute to human-computer interaction specifically.

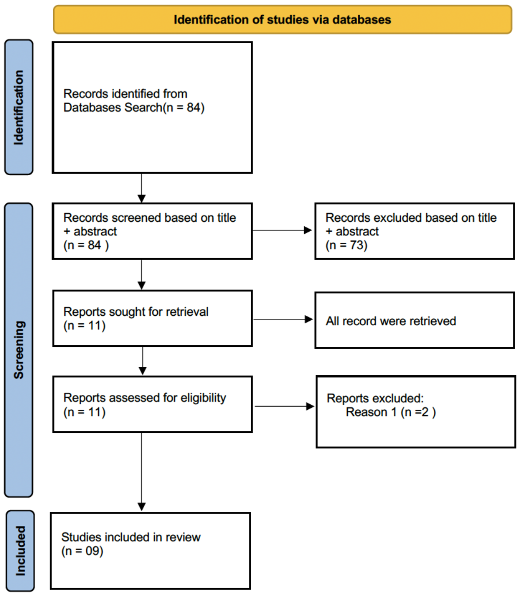

Figure 1. Figure 01: PRISMA flowchart documenting the process of searching papers as dataset

With this exclusion a record that discusses about how different textile materials react with squeezing and stroking movements [10].

Another record that was excluded by this criteria talks about an improved touchpad than a traditional one by replicating the theoretical idea of a squeeze film effect [1]. This paper mainly offers how surfpad helps people select targets on touchpads more easily rather than discussing a user-interface using squeezing gesture.

After screening, 09 papers were included in this review.

FINDINGS

The analysis of 09 papers is discussed in this section.

I have majorly categorized the findings into 3 sections. The different application areas of squeezing gesture, their design principles, their working efficiency and future scope of work or limitations.

Authentication:

We use various authentication measures for authentication for example fingerprint, eye tracking, pin code, pattern recognition etc, but squeezing can also be a measure for authentication.

The design principle for this type of interface includes users freely designing their own custom squeezing gestures which are unique with parameters such as intervals, number of squeezes, pressure sensitivity and duration [11]. The practical approach of this model involves in user registering their custom squeeze gesture and use that squeeze gesture to invoke authentication. This authentication can be used for use cases like payment, app login and phone unlock [11].

They evaluated the efficiency performance of their model only on one use case of unlocking the phone in a simulation [11] that resulted in faster unlocking compared to fingerprint or face unlocking pattern. There remains scope of future work on evaluating the efficiency of app login and payment application and identifying the finger or the position of the grip [11]. In terms of limitations, there remains a scope of accidental triggering of gesture due to it's natural interaction of squeezing.

Active edge:

This feature was introduced in Google pixel 2 device naming as 'Active edge' feature. The design principle includes in attaching a gauge inside the edge of the device body that measures the strain force or pressure applied by the user intentionally [6]. This could then be used to trigger various functionality such as activating the google assistant, opening the camera application etc. The limitations for this model includes false detection and triggering without the user's intent and the inability to distinguish the difference of gestures and other activities [6]. Which involves in future scope of work to refine the detection of squeeze patterns and other expanding the possible application.

Improving typing accuracy:

Haptic feedback like a gentle squeeze on the wrist can help typing accuracy in mid-air for virtual reality keyboard typing [3]. The design principle involves in wearing a wrist-based feedback specifically squeezing haptic to remind the user of his hand position while typing in virtual reality. This way user can type without having to look at his hand's position towards the actual keyboard. Various design criteria of this idea exist such as, Pohl et al. [5] used pneumatic actuation to generate uniform haptic feedback on the wrist, Zhu et al. [12] designed a sleeve that could generate vibration, squeeze sensations, stretch to resemble haptic feedback. One limitation of this study is the potentially annoying sense due to continuous vibrations and squeezing in terms of haptic feedback [3].

Squeezing to Zoom:

This application area of squeezing gesture invokes the zooming feature rather than a traditional approach of pinch-to-zoom or slide-to-zoom. Patrizia et al [4] evaluates the user experience of zooming with squeezing with other traditional approaches of zooming like sliding or pinching. The design approach of the experiment is by feedback from the users with various questions based on their experience of using squeezing to zoom compared to other approaches. This model involves in zooking in-and-out by squeezing a device which gives feedback by haptic vibration. The result suggests that feedback in terms of vibration appealed to the user's experience. Additionally, the squeezing interface as a form of interaction was found to be interesting to the user concerning old traditional methods like pinch-to-zoom and Slide-to-zoom for its haptic feedback and unorthodox approach. Future scope lies in further improvements in feedback-gathering techniques to better understand of user's experience since the efficiency of this experiment lies heavily on user feedback [4].

DISCUSSION

This literature review shows this emerging user interaction technique by squeezing has a lot of ongoing use cases and a vast amount of potentials has yet to be studied upon. The current application areas yield huge potential for squeezing interaction techniques to enhance our interactions with computer-based machines to mediate social touch [8].

Currently, the design approach for squeezing interactions varies form device to device and to centric to targeted user only. There is no standardized method of measuring the efficiency of this user interface by which it can be decided upon if this interface can replace any of the existing traditional approaches. This can create variations of experience based on users and devices.

The efficiency of this interaction model lies largely in user feedback [4]. Most of the research papers do not conduct studies on user feedback for these interface models based on squeezing gestures. It is crucial to evaluate the real-world performance of users based on how long does it take to get used to the new interaction method. Additionally, scenarios like annoyance, multitasking with squeezing gestures in combination with other real-world activities, and adaptability should be measuring factors to determine the efficiency of these models.

Additionally, squeezing to replace any of the existing traditional methods deserves further exploration such as how it blends with combination to other interaction modalities like voice commands and touch gestures. Such examination could result in more application areas for this gesture-based interaction interface.

The limitations of this study should also be taken into consideration. Due to time constraints it has not been possible to explore data from other libraries rather than ACM such as IEE conference papers which might provide some potential studies that might give a wide view of this topic. Additionally, papers before the last 5 years were not included in this review which creates a future study scope as well. There could exist some ongoing studies on this topic which were not included in this review but those might answer some of the limitations of current findings,

CONCLUSION

In this review of the literature concerning squeeze-based gesture as an input modality has been conducted by studying 09 published research papers within the last 5 years. Although this technology is getting popular in recent years but the research work on this topic is still in it's early stage. From this study, application areas of squeezing techniques range from zooming, authentication of unlocking mobile devices, typing feedback to quick triggering application were found. I believe there are still lots of potential use cases for squeezing gesture-based user interfaces that could be discovered with further studies. Another finding was that most of the research did not conduct user feedback study. But my opinion is real real-life user experience feedback is the key to determining the efficiency and correctness of these models and their existence.

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