

# WearWrite: Orchestrating the Crowd to Complete Complex Tasks from Wearables

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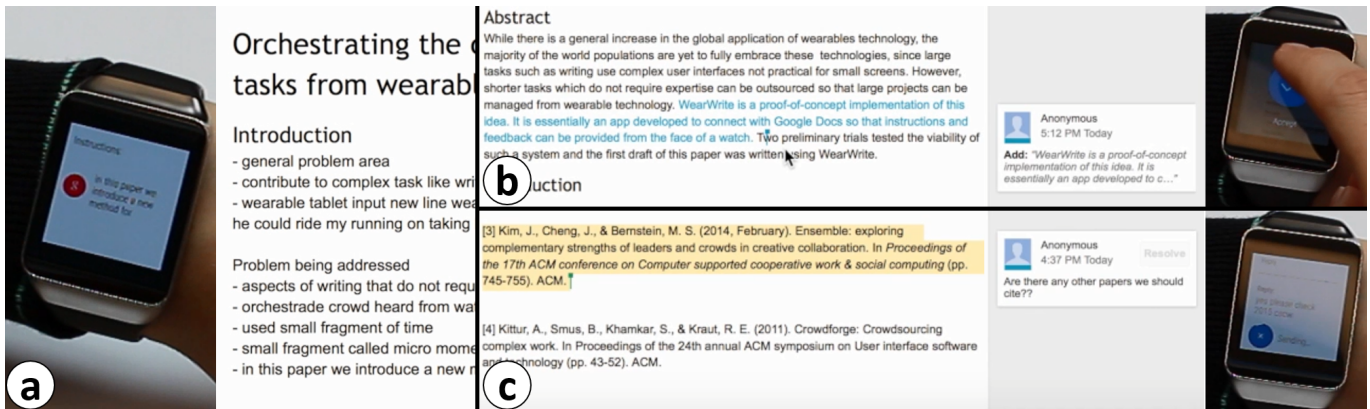


Figure 1. WearWrite allows a watch user to contribute to three paper writing tasks from a smartwatch: (a) outlining a document via simple speech commands, (b) accepting or rejecting crowd worker edits, and (c) replying to comments and questions left by crowd workers in the document.

## ABSTRACT

Smartwatches are becoming increasingly powerful, but limited input makes completing complex tasks impractical. Our WearWrite system introduces a new paradigm for enabling a watch user to contribute to complex tasks, not through new hardware or input methods, but by directing a crowd to work on their behalf from their wearable device. WearWrite lets authors give writing instructions and provide bits of expertise and big picture directions from their smartwatch, while crowd workers actually write the document on more powerful devices. We used this approach to write three academic papers, and found it was effective at producing reasonable drafts.

## Author Keywords

Crowdsourcing; wearables; smartwatch interaction; writing

## ACM Classification Keywords

H.5.m. Information interfaces and presentation

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## MOTIVATION

Smartwatches are quickly becoming powerful computing devices, but performing complex tasks with them remains difficult because of physical constraints. Text input is particularly difficult from a watch, and very little content can be displayed on their tiny screens at one time. While it is not possible to retain the full range of functionality available with large screens and keyboards, we hypothesize that complex tasks can still be supported on wearable devices by orchestrating crowd workers to complete complex tasks on one's behalf. Domain experts can contribute bits of expertise and maintain global context, while crowd workers actually perform the task.

The specific task we explored is academic writing. This is a challenging domain for crowdsourcing because the technical content of an academic paper requires expertise to explain, and writing a complex document such as a paper requires maintaining global context. We present the WearWrite system (Figure 1) that allows authors who do not have access to large devices, but want to take advantage of free micro-moments, to contribute their domain expertise and big picture directions from their watch, while directing crowd workers using more powerful devices to implement the changes suggested by the author. By using crowd workers to write content and only requiring the author to review it, WearWrite exploits the fact that it is easier to read compared to writing new text on a wearable device.

The contribution of WearWrite is not in crowdsourcing complex tasks, but in how it allows end-users to complete com-

plex tasks from wearables by sending instructions to crowd workers. Systems such as CrowdForge enable non-expert crowds to complete complex tasks by breaking them down into smaller context-free subtasks [3]. Crowd shepherding was introduced to help give workers feedback so they could improve over time [1]. Flash Teams bring together on-demand teams of experts from the crowd to complete complex tasks [6]. Finally, Ensemble uses a team leader to direct crowd writing projects [2]. The complementary writing skills of individuals produce better results in less time with higher creativity. WearWrite enables an expert user to guide the crowd through a lightweight wearable interface.

Wearable devices have recently received increased attention in the literature. Prior work has attempted to both increase the input capabilities of smartwatches and to increase the amount of information that can be entered by a smartwatch user [5, 7]. Despite this, text input remains much slower than from other types of devices; an author would not want to write an entire academic paper this way. Speech recognition is the current standard for input for smartwatches, but it can be error prone, especially for long sequences of text. WearWrite overcomes these limitations by integrating wearable input with crowd workers' input from more powerful devices.

## WEARWRITE

WearWrite enables watch-based interactions to give writing instructions and direct crowd workers (Figure 1). Firstly, it supports direct authoring of new content such as inserting sections, paragraphs, and bullets via simple speech commands. Secondly, as crowd workers edit the document, their changes become suggestions and are displayed on the watch where the expert can review them. Edits are sent along with a screenshot of the page on which they were made to provide context. Finally, comments written by crowd workers are sent to the watch and the author can reply using speech. To keep the process manageable for the watch user, the watch interface can be configured to notify of changes at varying levels of granularity and frequency. Only substantial changes of a certain text length and Levenshtein edit distance may be reported, and notifications can be snoozed for custom time intervals. The whole document can be browsed in a thumbnail representation showing the document as is or highlighting edits and comments to see where actions are required.

WearWrite uses a three-step iterative workflow: **1. Recruit**—The watch user recruits crowd workers from oDesk.com. While ideally done directly from the watch, our implementation requires pre-recruitment so that the watch user only needs to communicate with crowd workers who are on standby. **2. Outline**—The watch user efficiently uses free micro-moments as well as time spent waiting for crowd responses to outline the document. The seed document is created with Google Docs and authored exclusively from the watch. It contains the basic structure of the document, the key points it should include, and references for crowd workers to use. **3. Co-Author**—The watch user and crowd workers engage in an iterative authoring process and transform the seed document into the desired final document. A task queue is dynamically generated that contains generic paper-writing tasks

(e.g., “turn the bullets in the ‘Introduction’ into paragraphs”, “find the paper that each bullet in the ‘Related Work’ section refers to and create a reference to it”) as well as new specific tasks set by the watch user to be prioritized.

## INITIAL WEARWRITE EXPERIMENTS

WearWrite was successfully used by three authors to write papers. The first was a 2-page paper on a simple crowdsourcing experiment, the second attempted to duplicate an existing published paper [1], and the third was a report on the WearWrite system itself (see [4] for details). The authors were surprised by the quality of the content produced, and it was sufficient to occasionally provide the crowd workers with suggestions and feedback on edits. The experiments guided us in designing the system to provide necessary context to the watch user as well as the crowd workers while reducing the need for communication to a minimum. They revealed a number of interesting issues that we are currently addressing. Speech recognition often struggled with terminology so that we decided to send recorded audio and let crowd workers do the transcription instead. Other issues were related to task generation and queuing given the highly dynamic writing process. The question of who is actually writing the document—the watch user or the crowd—is a challenging one. We are developing new mechanisms to ensure the watch user remains in control when workers engage in intellectually intensive tasks.

## DEMONSTRATION

Our demo allows attendees to experience the WearWrite system both from the watch user's and the crowd workers' perspective at different stages of the document authoring process. Crowd worker input can be replayed to the system from data recorded from previous document writing experiences, or fed live to the system from a laptop running Google Docs in the worker role. Additionally, we will demonstrate the results of our WearWrite experiments conducted so far.

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