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ABSTRACT

Due to the coronavirus pandemic, remote work from home has rapidly become a necessity around the world, drastically changing the potential landscape for the future of work. Over the last couple of decades, microtask crowdsourcing has emerged as a viable means of carrying out remote online work to earn one's living — an alternative to traditional work for a large number of people. In the aftermath of the pandemic, there is likely to be an increase in people who need to work from home due to a variety of reasons, ranging from safety and well-being to massive layoffs. However, current crowdsourcing platforms and marketplaces are not adequately optimized for worker satisfaction or engagement. There is a need for a new means of interaction that can engage the workers, support their cognitive needs, cater to their well-being – all without compromising on the quality of work being produced. Drawing inspiration from prior studies which have shown that conversational systems can improve user experiences, we investigate the feasibility of microtask crowdsourcing aided by conversational agents. Findings based on our recent research in *conversational microtasking*, have important implications on improving both, the subjective mental condition and objective output quality of workers. We believe that conversational agents have an important role to play in shaping how remote work can be carried out in the imminent future.

KEYWORDS

Conversational Agent, Microtask, Crowdsourcing, Quality, User Engagement, Remote Work.

1 INTRODUCTION

The outbreak of coronavirus disease 2019 (COVID-19) has changed people's working habits all over the world. Due to the highly contagious nature of the coronavirus (SARS-CoV-2), authorities strongly suggest that individuals should keep social distance and try not to contact with others physically. While we are writing this paper, the coronavirus pandemic is still ongoing, and people have started seeking alternatives to traditional working ways. We noticed that remote work from home rapidly became common globally, as an increasing number of people have moved their workplaces home.

The rise of crowdsourcing has made a big leap with regard to full-time remote work. Currently, a large number of people, namely crowd workers, earn their living on crowdsourcing marketplaces by accepting and completing online microtasks. Typical tasks include labeling images, transcribing audio fragments, finding information on the Web, completing surveys, or even empowering real-time applications [1, 11]. A considerable part of crowd workers work full-time in these crowdsourcing marketplaces (such as Amazon Mechanical Turk, Prolific, Appen, etc.,) or data farms. Studying the working conditions in online microtask crowdsourcing can give the community clear indications for future remote work in general.

However, as crowdsourcing advances, many problems in terms of worker mental conditions have emerged. In the popular crowdsourcing marketplaces, crowd workers often suffer from fatigue, boredom, stress, and frustration, due to the repetitive and tiresome content of the work. Therefore, to foster a good relationship between crowd workers and task requesters, it is important to make workers more engaged during task execution. Previous work has shown the evidence that conversational systems can improve user experience generally [5, 6, 21]. Inspired by this, our research goal is to design conversational systems that could aid humans in remote work with high satisfaction, high user engagement, and less cognitive load. Since crowdsourcing marketplaces are a mature platform that already provides many people with working opportunities to earn their livings remotely, we try to achieve our research goal and carry out corresponding experiments based on microtask crowdsourcing.

1) We first design a conversational interface supported by a rule-based conversational agent to assist workers in executing crowdsourced microtasks. We research if dialogue-based microtask crowdsourcing can be an alternative to the traditional web-based way. We found that the task execution supported by conversational agents can produce similar output quality and execution time compared to the traditional way in online microtask crowdsourcing, for free-text and multiple-option microtasks.

2) Based on the prior findings, we conduct further experiments to see if a conversational agent can better engage crowd workers. We found that workers working with conversational interfaces (aided by conversational agents) generally stayed longer and completed more microtasks, showing that a conversational agent can significantly improve worker retention.

3) We design a conversational style estimation coding scheme and analyze worker behavior using conversational style estimation, to verify our assumption — the worker performance can be more predictable if the task is completed in a conversational way. We found that workers' conversational styles are highly correlated to their performances in terms of output quality, worker engagement, and cognitive task load.

Our findings in terms of conversational microtask crowdsourcing have important implications in current crowdsourcing marketplaces. We believe in the imminent future, when online remote work becomes more common, the conversational agent aided remote work will play its important role in improving the working condition.

2 RELATED WORK

2.1 Conversational Agents

A conversational agent is a software programmed to automatically interpret and respond to requests expressed in natural language, so to mimic the behavior of a human interlocutor. *Chatbots* are a class of conversational agents that prevalently use text as a interaction medium. While research on chatbot systems dates back to the 1960s, the growing popularity of messaging platforms (especially on mobile devices) is sparking new interest both in industry and academia.

Conversational interfaces supported by chatbots have been argued to have advantages over traditional graphical user interfaces due to having a more human-like interaction [24]. Owing to this, conversational interfaces are on the rise in various domains of our everyday life and show great potential to expand [37]. Recent work in the CSCW and HCI community has investigated the experiences of people using conversational agents, understanding user needs and user satisfaction [5, 6, 21]. Other works have studied the scope of using conversational agents in specific domains. Vandenberghe introduced the concept of bot personas, which act as off-the-shelf users to allow design teams to interact with rich user data throughout the design process [35]. Others have studied the use of conversational agents in the domains of complex search [3, 16, 36] or food tracking [12]. These works have shown that conversational agents can improve user experiences and have highlighted the need to further investigate the use of conversational agents in different scenarios.

2.2 Worker Engagement

Crowdsourcing microtasks can often be monotonous and repetitive in nature. Previous works have attempted to tackle the issues of boredom and fatigue manifesting in crowdsourcing marketplaces as a result of long batches of similar tasks that workers often encounter. A variety of methods to retain and engage workers have been proposed. [29] suggested introducing micro-breaks into workflows to refresh workers, and showed that under certain conditions micro-breaks aid in worker retention and improve their accuracy marginally. Similarly, [7] proposed to intersperse diversions (small periods of entertainment) to improve worker experience in lengthy, monotonous microtasks and found that such micro-diversions can significantly improve worker retention rate while maintaining worker performance. Other works proposed the use of gamification to increase worker retention and throughput [10]. [22] studied worker engagement, characterized how workers perceive tasks and proposed to predict when workers would stop performing tasks. [8] introduced pricing schemes to improve worker retention, and showed that paying periodic bonuses according to pre-defined milestones has the biggest impact on retention rate of workers.

2.3 Conversational Agent for Crowdsourcing

Prior research has combined crowdsourcing and the conversational agent for training the dialogue manager or natural language processing component [18]. Lasecki et al. designed and developed Chorus, a conversational assistant able to assist users with general knowledge tasks [20]. Conversations with Chorus are powered by workers who propose responses in the background, encouraged by a game-theoretic incentive scheme. Workers can see the working memory (chat history) and vote on candidate responses on a web-based worker interface. Based on Chorus, an improved conversational assistant named Evorus was proposed. It can reduce the effort of workers by partially automating the voting process [13]. The same authors also developed a crowdsourced system called Guardian, which enables both expert and non-expert workers to collaboratively translate Web APIs into a dialogue system format [14]. Conversational microtask crowdsourcing is also deployed on social network platforms, combing with messaging applications, such as Facebook and Twitter. Savage et al. designed a platform named Botivist based on Twitter, engaging volunteers to action by using different strategies [30]. A previous work based on Facebook Messenger used a Chatbot to connect learners and experts, for providing experts' feedback to improve learners' work [34]. Moreover, a conversational agent called Curious Cat was proposed to combine the crowdsourcing approach from a different perspective [4]. While most crowdsourced conversational agents provide information to users according to their requests, the Curious Cat was designed as a knowledge acquisition tool, which actively asked data from users.

3 RESEARCH PROGRESS

3.1 Conversational Interface for Microtask Crowdsourcing

We first attempt to use conversational interfaces in crowdsourcing marketplaces. Although conversational interfaces have been effectively used in numerous applications, the impact of conversational interfaces in microtask crowdsourcing has remained unexplored. We aim to address this knowledge gap by investigating the suitability of conversational interfaces for microtask crowdsourcing, by juxtaposing them with standard Web interfaces in a variety of popularly crowdsourced tasks.

Lowering the entry barrier for workers to participate effectively in crowdsourcing tasks is an important step towards securing the future of crowd work [17]. The availability of effective automated text-based conversational interfaces – as an alternative to the traditional Web UI – could broaden the pool of available crowd workers by easing their unfamiliarity with the interface elements. Messaging applications are reported to be more popular than social networks [31], and we argue that such familiarity with conversational interfaces can potentially breed more worker satisfaction.

Therefore, our goal is to further the understanding of how text-based conversational interfaces could serve as an alternative to the standard Web interfaces typically used for microtask crowdsourcing. We particularly investigate 1) to what extent text-based conversational interfaces can support the execution of different types of crowdsourced microtasks, and 2) How different types of UI input elements in conversational interfaces affect quality-related outcomes in microtasks [23].

Contributions and Findings. We carried out experiments to gauge the interest and acceptance of automated, text-based conversational work interfaces by crowd workers, while assessing their performance within different task types. We recruited workers from the crowdsourcing platform, and implemented a conversational interface based on *Telegram* messaging platform. We addressed five

typical microtask types (information finding, CAPTCHA recognition, speech transcription, sentiment analysis, image annotation) spanning content types (text, image, audio) and UI elements (free text, single and multiple selections). For each task type, we implemented both Web and conversational interfaces.

We compared the execution time, quality of results, and satisfaction of workers who used the standard Web interface with those who used the conversational interface. Furthermore, we also compared different implementations of conversational UI elements for single and multiple input selections in microtasks. Results show that the conversational interfaces are positively received by crowd workers, who indicated an overall satisfaction and an intention for future use of similar interfaces. In terms of performance, tasks executed using the conversational interfaces took similar execution times, and yielded comparable output quality [23].

3.2 Improving Worker Engagement

The above work has explored the suitability of conversational interfaces for microtask crowdsourcing by juxtaposing them with standard Web interfaces in a variety of crowdsourced microtasks. The findings suggest the use of conversational interfaces could be a viable alternative to the existing standard. However, little is known about the impact of conversational microtasking on the engagement of workers.

Previous works have studied the nature of tasks that are popularly crowdsourced on Amazon Mechanical Turk (AMT), showing that tasks are often deployed in large batches consisting of similar HITs (human intelligence tasks) [2, 9]. Long and monotonous batches of HITs pose challenges with regards to engaging workers, potentially leading to sloppy work due to boredom and fatigue [7]. There is a lack of understanding of whether conversational microtasking would either alleviate or amplify the concerns surrounding worker engagement. Therefore, we conducted a study on AMT, involving 800 unique workers across different experimental conditions to address: 1) to what extent conversational agents can improve the worker engagement in microtask crowdsourcing, and 2) how conversational agents with different conversational styles affect the performance of workers and their cognitive load while completing tasks.

Contributions and Findings. We used two measures of worker engagement — (i) worker retention in the batches of tasks, and (ii) self-reported scores on the short-form user engagement scale [26]. We considered different conversational styles within conversational interfaces that workers interact with, and used the NASA-TLX instrument to measure cognitive load after workers complete the tasks they wish to.

Our results show that conversational interfaces have positive effects on worker engagement, as well as the perceived cognitive load in comparison to traditional web interfaces. We found that a suitable conversational style has the potential to engage workers further (in specific task types), although our results were inconclusive in this regard. This work takes crucial strides towards furthering the understanding of conversational interfaces for microtasking, revealing insights into the role of conversational styles across a variety of tasks [28].

3.3 Analyzing Conversational Styles

The work about worker engagement investigated whether different conversational styles of an agent can increase worker engagement. Furthermore, previous works in the field of psychology have shown the important role that *conversational styles* have on inter-human communication [19, 32, 33]. Having been developed in the context of human conversations, the insights and conclusions of these works are not directly applicable to conversational microtasking, since the contrasting goal of workers is to optimally allocate their effort rather than being immersed in conversations. Previous work also studied how specific linguistic strategies and language styles can affect work outcomes [15, 30]. However, to the best of our knowledge, current conversational agents (particularly for crowdsourcing) have only studied the effects of the conversational style of agents, rather than the conversational style of online users (i.e., workers in the context of microtask crowdsourcing).

Understanding the role of workers' conversational styles in crowdsourcing can help us better adapt strategies to improve output quality and worker engagement, or better assist and guide workers in the training process. To this end, there is the need for novel methods for the classification of conversational styles in the context of microtask crowdsourcing. Therefore, we delved into the following research questions: 1) How the conversational style of a crowd worker can be reliably estimated, and 2) to what extent the conversational style of crowd workers relates to their work outcomes, perceived engagement, and cognitive task load in different types of tasks.

Contributions and Findings. We designed and implemented a conversational agent that supports crowdsourcing task execution and extraction of linguistic features from the text-based conversation between the user and the agent. We designed a coding scheme inspired by previous work [32, 33] and corresponding to conversational styles based on the five dimensions of linguistic devices that have been examined.

To evaluate our methods, we recruited 180 unique online crowd workers from AMT and conducted experiments to investigate the feasibility of conversational style estimation for online crowdsourcing. We also analyzed the impact of conversational style on output quality, worker engagement (using worker retention and the User Engagement Scale), and perceived task load (using the NASA-TLX instrument). Our experimental findings revealed that workers with an *Involvement* conversational style have significantly higher output quality, higher user engagement and less cognitive task load while they are completing a high-difficulty task, and have less task execution time in general. The findings have important implications on worker performance prediction, task scheduling and assignment in microtask crowdsourcing. To the best of our knowledge, this is the first work that explores the impact of conversational style on quality-related outcomes in conversational microtasking, and proposes methods to estimate the conversational style of users [27].

4 CONCLUSION

In terms of the conversational interface for online crowdsourcing, the obtained results are promising. We argue that the use of conversational interfaces for crowd work can provide a number of potential benefits, for instance: further democratization of crowd

work, as people with limited digital skills or connectivity could then perform retributed digital work [25]; increased workers diversity (in terms of demographics, knowledge, and skills), thus providing better digital working environment.

As for the study about improving worker engagement, we found that working interfaces supported by conversational agents can improve worker engagement. A healthy relationship between workers and requesters is critical to the sustainability of marketplaces. By adopting conversational interfaces, requesters can improve worker engagement, particularly in less complex tasks as suggested by our findings, allowing workers to complete more work, earn more money, and foster good faith in the requester-worker long term relationship.

The results with regard to conversational style analysis show that the conversational style has a significant impact on worker performance. Workers with a specific style (named Involvement) can produce higher work accuracy, perceive higher user engagement and feel less cognitive task load when they are completing difficult tasks. This gives us a strong indication that conversational style estimation could be an effective tool for predicting worker performance and assisting task assignment. Highly involved workers could be selected and assigned to tasks of higher complexity, to produce high-quality work outcomes. The proposed method can be applied in crowdsourcing marketplaces to improve work outcomes and foster a better worker-requester relationship.

New Future of Remote Work. Our research provides plenty of inspirations for future research directions. Naturally, more research is needed to better understand whether a conversational agent could aid remote work in general.

Specifically, in terms of conversational worker interface, further experiment could focus on push-based strategies initiated by the chatbot, as a method to perform and sustain near-real time crowdsourcing. We are also interested in investigating the utility and performance conversational interfaces addressed to requester, both for task creation and monitoring.

Moreover, we only focus on the text-based conversation across all these studies. In general, there are various means to interact with conversational agents (e.g., voice-based agent, video-based agent). The effects of voice- or video-based conversational agents on worker performance and mental conditions still remain unexplored. Furthermore, text-based conversation ignores several paralinguistic features (pitch, voice) and nonlinguistic features (smile, laughter, gestures), which could play important roles in human-computer interaction. Conversational agents and corresponding style estimation methods based on voice or video could be an interesting direction to explore.

The estimation and prediction of the conversational style of a worker also has clear implications for privacy and fairness of remote work. While performing a dialogue, workers could disclose personal information that should be treated according to best practices and regulation for personal data management. In this respect, the conversational style estimation allows for a data collection method that is minimally invasive, thus eliminating the need for storage and management of worker data while achieving good prediction performance. We also stress the potential fairness implications that conversational style profiling can have on task distributions and

therefore, on the earning power of workers. We believe that user modelling approaches like the one we propose should be used only in the context of an explicit, optional, and informed approval from workers, and such that a lack of approval does not lead to overall compensation penalties.

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