Investigating the Usability and Impact of Notifications Generated from Automated Monitoring Systems in Modern Dairy Farms

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Abstract

Modern dairy farms are becoming increasingly high-tech, with common on-farm technologies including robots that tend the animals, sensors that monitor animal activity and environmental conditions, and desktop and mobile displays that provide 24/7 information about farm conditions. These technologies help farms run more efficiently and, thus, reduce the demand for human labour. Yet, farm staff must now monitor these technologies to maintain smooth – and safe – operation, and a healthy herd. Many farms have adopted different technologies at different times, each of which tends to communicate with farmers in different ways. For instance, some provide information through desktop or mobile phone dashboards, while others send text messaging alerts. Thus, farmers receive many types of information notifications from different devices with different levels of importance or urgency at anytime. Recent research indicates that these systems can be overwhelming and can increase the overall stress level of farmers. This work-in-progress research is investigating the usability and impact of current notification mechanisms of on-farm technologies in the dairy industry in Ontario, Canada, as an initial step toward a broader understanding of this problem. The goal of the research is to better understand farmers' informational needs as well as how well the current notification mechanisms offered by current on-farm technologies meet these informational needs.

Index Terms: Human-centered computing—HCI design and evaluation methods; Applied computing—Agriculture

1 Introduction

Increased competition from global sourcing of the food supply, rising global demand for food products, and consumer demand for safe and healthy food products are among many factors driving the adoption of advanced technologies on Canadian farms. The farming industry is undergoing a technological transformation that parallels many other modern production environments. A walk through a modern dairy farm, for instance, will reveal various robots feeding and milking cows, biological sensors detecting animal infections, wearable sensors monitoring animal activity, environmental sensors controlling animal habitat, and desktop and mobile computing systems providing 24/7 information about past and present farm and animal conditions [1,5,6]. Together, these systems can increase the efficiencies of modern farms [12]. However, they also change the type of work done by farmers.

A recent review of advanced dairy farm technologies–often referred collectively as "precision livestock farming" (PLF) technologies [3]–concluded that "mental workload can sometimes be increased [with PLF systems] due to the complexity of the information involved in managing the multiple alarms or alerts and equipment failures…if the tools are not adapted to farmers' needs and skills, PLF can also lead to negative impacts on farmers and animals." [12]. Another recent study of PLF technologies in Ontario found that farmers spend hundreds and thousands of dollars in consulting services from vendors to effectively learn how to use newly installed PLF systems [4]. We have also received anecdotal reports from local farmers who often receive text-based alerts at all hours of the day from PLF systems and are sometimes unsure about the urgency or implication of the information, a finding corroborated by Hostiou et al.'s [12] study.

Motivated by these recent findings, this research aims to better understand what types of notification mechanisms are used in current PLF systems, specifically in the dairy industry, and what opportunities exist to improve the usability and utility of PLF notification mechanisms using a human-centred design approach. This paper provides background for this project, and describes our planned research approach for this early-stage project.

2 Background

The appeal and promise of PLF is to use a wide range of connected technologies to automatically monitor and manage animal health, for instance, the automatic detection of diseases at early stages [3]. A network of connected environmental, biological, wearable, and image-based sensors is used to create a "SmartFarm", similar to the concept of a SmartHome, that can provide real-time, 24/7 monitoring of the farm [8]. These sensors can detect an ever-increasing variety of farm and animal conditions, including anomalies in feeding behaviour or lameness [2], or when a cow is ready for breeding (i.e. is in heat) [1] or ready to birth a calf [10]. Advanced algorithms are also being used to analyse the collected sensor data to detect more complex health and behavioural scenarios. For instance, Gonzalez et al. [5] applied decision trees to wearable sensor data to detect foraging, ruminating, traveling, resting, and other cattle behaviour.

Receiving warnings as early as possible about farm or animal issues can work as an assistive tool to help farmers in their daily decision-making [14]. Recent efforts have focused on the development of algorithms to help generate such warnings. For instance, in the context of pig farming, Vranken and Berckmans [14] applied the principles of statistical process control to analyse acoustical signals of pig coughs to generating warnings of respiratory disease. In their work, they suggested that warnings could be classified into different types, which would each trigger a different notification mechanism to the farmer. For example, a soft warning could be sent as notification to a dashboard for informational purposes, whereas a hard warning could be sent as a text or email message for a farmer to take immediate action. This approach has the advantage of the system organizing and prioritizing different types of notifications sent to the farmer. If only urgent notifications are sent via text or email, the farmer is less likely to miss an important alert.

HCI researchers have studied user notification systems in a wide variety of application domains for decades [11]. Farmers, like other people in today's society, may receive notifications

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from many sources beyond their PLF systems, such as chat, email, text messages, and advertisements. This influx of disparate information can increase the chances of overlooking important notifications [9]. Recent work has shown that adding user preferences to notification systems can help people cope with large amounts of alerts from various sources in their daily lives and ensure that important notifications are not missed [13]. While notifications can provide important and timely information, they can also be highly disruptive, especially when the receiver is engaged in a task that requires concentration or is engaging with others. Recent work by Je et al. [7] has shown that classification and prioritization of notifications can help mitigate the negative distraction effects of alerts delivered to people while they are engaged in important work. We will be leveraging the known user impacts of notification systems to help guide our planned study of notification systems in the farming context. Once we gain a deeper understanding of PLF notification systems, we will also leverage the existing design knowledge from the HCI literature to help design improved notification designs for PLF.

2 RESEARCH PLAN

Our initial goal is to better understand the notification mechanisms PLF systems currently used on local dairy farms, and also to understand their usability and impact on farmers' daily operations and decision-making. Our initial research into the area has revealed that many PLF products used locally, and generally across Canada, are supplied by a few globally agricultural technology vendors, primarily from Europe. Thus, we expect our results to generalize beyond our local farm users.

First, we will continue our review of existing PLF technologies being sold and used on local dairy farms. This activity will involve review of farm supply vendor websites, and technology manufacturer websites, reviewing product descriptions, whitepapers, instruction manuals, etc. to better understand why types of notification mechanisms we can determine through this background research. We will also review academic papers describing the design or use of current or emerging PLF systems. This is a standard approach used to gain relevant domain knowledge before developing surveys and preparing for qualitative research involving direct access to domain experts (farmers in our case).

Once we gather this background information, we will use it to develop and conduct an online survey and face-to-face interviews with local farmers to help us understand farmers' perceptions and lived experiences with these notification systems. The survey and interviews will focus on understanding the following issues:

- The types of PLF notifications they receive, how they receive them (computing device, types of user interfaces, etc.), when they receive them (time, context, etc.), and how well they understand the received notifications.
- What types of decisions farmers make based on the information received from PLF notifications.
- Whether or not farmers use all the available notification information from their current systems.
- Their general impressions of the effectiveness of the notifications, and thoughts for improvement.

As aforementioned, HCI researchers have shown the value of classifying and prioritizing notifications sent to users. Thus, our survey and interviews will investigate the way that the PLF systems represent collected data to farmers.

Another aspect we hope to learn more about is how current PLF notification systems handling warnings generated based on data analysis by the PLF system. Ideally, a PLF system will generate a warning or alert whenever the system detects an abnormality in expected conditions. However, our initial research suggests that the ability to accurately and meaningfully handle such warnings is in the rudimentary stages in current PLF systems. Farmers may currently receive many notifications from many sources and every notification with different levels of importance or urgency. Therefore, we will also investigate current methods of handling warnings in PLF systems. For instance, are notifications sent to different computing mediums (e.g. text message, email, or system dashboard), depending on their priority or urgency?

3 CONCLUSION

As modern farms become increasingly automated, the role of farm workers is evolving to include more interaction with technology than ever. Thus, on-farm systems must be designed to be user friendly and fit the needs of farmers. This research is exploring the notification mechanisms used to communicate ongoing or urgent farm or animal issues detected by automated monitoring systems. In PLF, handling warnings strategically is important because sending effective notifications can decrease the chance of overlooking important or urgent information that can be either safety critical or operationally important. We are in the initial stages of this research, but we expect our results to be generalizable beyond the local farming population we intend to survey because these the most common on-farm technologies are supplied by only a few global farm technology vendors.

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