# Interfaces for Farm Animals and their Caretakers in Outdoor (and Harsh Indoor) Computing Contexts

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## Abstract
Growing demand on the farming industry to increase productivity has fueled the need for increased automation on modern farms, including wearable sensors on individual animals, automated habitat monitoring, and mobile computing applications for farmers and other animal caretakers. Much of these technologies are utilized in harsh outdoor conditions, and often breakdown or are difficulty to use because of extreme usage conditions. These computing situations provide unique and interesting design challenges for outdoor interface design.

## Author Keywords
Precision livestock farming; animal-computer interaction; animal wearables; outdoor mobile computing.

## ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces; H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Figure 1: Farming in winter conditions. Top: Farmer breaking up ice in water tank in outdoor pasture (photo credit: [15]); Middle: Farmer wearing gloves to use mobile scanner with connected tablet to check on cows in outdoor pasture (photo credit: [11]); Bottom: Farmer with gloves removed inside cold barn to use cellphone and mobile touch tablet (photo credit: [14]).

## Introduction

A confluence of factors in the farming industry, including increasing world population, increasing demand for Western-style diets that include meat and animal products, and increasing land costs and farm supplies, has driven demand for automation on modern farms [5]. For example, farms now include technologies such as robots that milk cows on demand, full-automated tractors that till, plant, and harvest crops, GPS trackers on cows and sheep that track grazing patterns, and smart phone applications that notify farmers of animal health and welfare concerns. This automated approach to farming is often referred to as precision agriculture, or precision livestock farming (PLF) when used in animal farming contexts [1]. This field of technology research also overlaps with an emerging HCI field, referred to as Animal-Computer Interaction (ACI), which emerged from the ACM SIGCHI community and now has its own annual conference series [10]. ACI technologies often focus on developing computer interfaces to engage or enrich animals in captivity (e.g. zoo animals) or companion or service animals (e.g. dogs) (e.g. [6, 16]).

Many PLF and ACI technologies are utilized in harsh outdoor or non-ideal indoor conditions for common consumer technologies. Thus, these technologies often breakdown or are difficulty to use because of these extreme usage conditions. For instance, GPS trackers or other “wearables” often simply stop working after a few months of use due to extreme weather, jostling due to animal movement, or animal interaction with the environment. Smartphones used to alert farmers of animal health and welfare issues may need to be used in outdoor conditions that require gloves due to extreme cold or dirty conditions, or sunglasses due to extremely bright conditions that make it difficult to see mobile screens. Animal “users” do not take the same care with wearable technologies as human “users” might be expected to. Also, animals may not be willing to wear or use such technologies, and may actively attempt to disengage from the technologies. Thus, there is a need to consider the unique and extreme usage conditions of the different “users” (i.e. animals and their caretakers) in PLF and ACI contexts.

My interest in this ***HCI Outdoors*** CHI workshop is to learn from other researchers working on technologies designed for other outdoor, or non-ideal indoor, usage contexts, and to raise awareness of PLF and ACI as unique, but growing, HCI design contexts.

## Extreme Conditions in Farming Contexts

Many farm animals spend their lives in various extreme conditions, including crowded indoor housing, extreme hot or cold outdoor environments (see Figure 1), or outdoor environments that are exposed to extreme weather conditions (rain, snow, mud, ice, etc.). These natural and manufactured environments introduce considerable design challenges for developing suitably robust wearable devices for monitoring individual animal health and welfare (e.g., Figures 2 and 3) and mobile computing technologies that animal caretakers (farmers, veterinarians, etc.) can use safely and comfortably (Figure 1 (middle and bottom)).

Even indoor farm environments are often cold or otherwise inclement and non-ideal computer usage environments, and often require caretakers to wear gloves for safety, sanitation, or comfort. Yet, most mobile technologies such as smartphone or tablets typically utilize capacitive-sensing touch interaction that

Figure 2: Prototype wearable worn by a sheep (photo credit: [9]).

Figure 3: Wearable "anklet" on the leg of a dairy cow that uses accelerometers to track standing and lying behaviour in order to detect potential lameness (photo credit: [13]).

require direct skin contact (Figure 1 (bottom)). Indoor animal housing environments are particularly problematic for wearables that can get caught on or damaged by pens, feed and water buckets, other animals. Indeed, these challenges have led to the development of alternative biotechnology solutions, such as "ingestible" monitoring technologies, that are "worn" inside the body [5]. However, such ingestible sensors are not without safety concerns for the animals, and thus, externally wore sensors may be preferred [9].

Considering these PLF and ACI design contexts as unique HCI design contexts, where "user-centred" design methods are employed (for animal "users" or human caretakers) that carefully consider the harsh and/or non-ideal computer usage conditions, provides an opportunity to improve these technologies.

## Goals for the Workshop

Designing interfaces for PLF and ACI contexts are new research directions for me, and are the focus of a new research program I am mounting at the University of Guelph. This program combines a life-long passion of mine for animal welfare with a unique opportunity (due to a recent job move to Guelph) to collaborate with world-renowned agricultural, veterinary, and animal science researchers conducting state-of-the-art animal behaviour and welfare research that involves increasing use of PLF and ACI technologies.

Most of my prior 15+ years of HCI experience has focused on the design of computer-supported collaboration systems for small groups in face-to-face environments (e.g. [2, 7, 8, 12]) and the design of interactive large displays for public use (e.g., [3, 4]).

The latter research, which focused on designing for public spaces, we have had to consider issues related to technology robustness and interactions that occur in distraction-filled environments. However, I am extremely excited about this ***HCI Outdoor*** workshop, and the opportunity to meet researchers and practitioners who have been working on technologies for more extreme interaction environments.

My main goals in participating in this workshop are to learn from experienced and enthusiastic researchers in this field and to raise awareness of PLF and ACI as usage contexts for outdoor interaction design. I am keen to learn about others' experiences and insights on *engineering solutions to environmental constraints faced outdoors*, and on *how to design technologies which do not detract from the outdoor experience*.

The first topic is crucial for improving animal wearables and mobile and wearable solutions for animal caretakers. The second topic is also important for PLF and ACI contexts as the goals for animal caretakers are to focus on the animals, and to be able to interact with them safely, rather than focusing solely on the technologies.

It seems there are still significant advances to make in hardware and software towards developing more robust interaction technologies that are better suited to outdoor computing usage contexts. For example, the defacto standard adopted by smartphone manufacturers to utilize capacitive touch input has severe limitations on mobile computing applications in cold or inclement outdoor environments where gloves must be worn for safety or comfort reasons. I am excited to talk with other HCI research to learn of

hardware and software trends that provide more suitable interaction experiences for such contexts.

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