Chapter 61
Trends in Wearable Technologies for Earth Science

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ABSTRACT

In this chapter, we discuss the need for wearable technologies for earth science field research, a discipline that can be both extremely physically rigorous and even potentially dangerous at times. The field is also technically challenging because of environmental conditions as well as often being conducted in remote offline regions. Current trends in available wearable technology devices suitable for earth science applications are explored, in addition to describing possible modifications to existing wearable technologies in order to make them deployable, practical offline-capable geoscience systems. Offline Health and safety monitoring systems designed to operate on a low-powered personal body-area network system as well as offline (non-internet dependent) wearable communication technologies are particularly addressed. These types of wearable technologies represent some of the most complex aspects in this field as well being some of the most customizable systems with highly configurable components for remote back country fieldwork functionality.

INTRODUCTION

The key focus of this chapter includes sections related to enhancing the performance of field research or operational activities. Wearable technologies of benefit to field exploration and extractive operations include but are not limited to communications devices, safety and navigation systems, and interface systems allowing the researcher or manager to electronically communicate with larger less-portable systems such as laser range finding survey equipment, seismographs, satellite communications equipment, data recording technologies, field analysis and remote sensing equipment. In addition, wearable integrated power storage systems are explored along with safety enhancement devices. Flexible, light weight, small configuration wearable computer systems are also examined (U.S. Patent US5285398 A).

The section on wearable technology communications devices include specialized smart watch devices running operating systems designed to both enhance digital radio communications capabilities and run

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sophisticated applications. In addition to the looming ubiquitous smart watch devices, wearable communications systems can have even more powerful capabilities related to field operations in remote and rugged terrains. This might include wearable polarized antennas including small portable integrated frequency tuners designed to allow for communication operations with orbiting satellites. This would be especially important for operations in locations where there are no operating cellular telephone networks, and normal UHF and VHF line-of-sight radio communications is made impractical due to terrain features or distances involved (Kaivanto, et al., 2011).

Wearable navigation and safety equipment would be related to devices capable of utilizing the Global Positioning System (GPS) to calculate reference point data using (UTM) to coordinate data and integrating the coordinates into an on-board application including a mapping database. As per Serra, et al. in 2010, the typical GPS-enabled smartphone navigation systems in 2015 require access to a cellular telephone network (3G or 4G connectivity speeds) in order to access a centralized navigation database. While on-board integrated navigation databases are available for some smartphone platforms (Pielot, et al., 2010) they are both uncommon and expensive on a smartphone platform. Fully integrated GPS databases on smartphones are also generally limited in scope and may not include sufficient reference data for off-road applications in remote terrains. Smartphone GPS antennas may also be susceptible to interference or lacking in sufficient sensitivity to receive weak GPS signals through dense foliage canopies or in rugged terrain blocking some weak navigation satellite signals utilize a digital UHF frequency band. More advanced and specialized devices within the wearable category for this case will be explored.

Safety systems in the class of wearable technologies for the earth sciences include Wireless Body Area Networks (WBANs) as per Muhammad, et al. in 2014, wearable fabric patch sensors for wearable health status, geolocation, monitoring and other uses as well. Such technologies enable a research manager or plant operator to monitor field conditions, personnel safety, health status, work environment conditions and operations in progress.

Remote sensing and cataloging wearable technologies includes both headset-based optical instruments like as well as more uniquely specialized systems. These systems allow direct wireless interfacing and control of larger, generally less-portable systems with common field applications including geophysics hardware such as radar systems, drilling equipment and induced polarization systems to name but a few possibilities. Support for wireless digital systems and non-networked electronic wearable systems will be analyzed. A review of the implications and potential applications for earth science education will also be discussed.

BACKGROUND

Recognizing that field research and commercial operations in earth sciences involves a unique degree of physical labor and potential risk related to working in difficult terrain (Higgitt & Bullard, 1999) combined with lack of infrastructure access in many cases, wearable technologies have the potential to reduce weight encumbrances. Because geoscience investigations often involve working on steep slopes, heavily forested terrain in remote locations, weight reduction associated with wearable technologies can be a tremendous asset. Risk of injury or even death can be a feature of field exploration geology and especially in related mining operations (Komljenovic et al., 2008), thus the ability to lighten the encumbrance of field staff without reducing the qualitative capabilities of their equipment is a welcome development.

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