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Ergonomics of human-system interaction —

Part 810: Robotic, intelligent and autonomous systems

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

A list of all parts in the ISO 9241 series can be found on the ISO website.

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Introduction

Product development of systems with robot, intelligent and autonomous characteristics is rapidly progressing. Given the human-system issues of such systems, timely guidance covering these issues is necessary to help all sectors of industry to design, field and operate first-time quality robotic, intelligent, autonomous (RIA) systems, and build appropriate trust in products and services that use these systems.

There is an urgent need for a Technical Report from ISO explaining the existing, emerging and potential human-system issues and consequences for use and users associated with systems that have robot, intelligent and autonomous characteristics. This document explains the existing, emerging and potential human-system issues and consequences for use and users associated with systems that have RIA characteristics. It identifies the potential risks and priorities for standardization to address these issues. Solutions will be the subject of future standards.

This document reviews the ergonomics for a range of RIA systems. It describes the human-system issues that should be considered in the application of these technologies and identification of priorities for future standardization work. The purpose of this study is to identify and explore the ramifications of a categories of issues involving RIA systems that suggest a need to reset the boundaries of what is called ergonomics. The conclusion is that to make an ergonomic RIA system, the practice of ergonomics will need to do more, working together with new disciplines, and can require new tools, methods and approaches to support the design and integration of these types of systems into working environments and organizations. Ergonomics will also need to identify relevant research from a wide variety of scientific disciplines, as well as conducting our own research to ensure we have a robust evidence base to guide the development of these systems.

The paradigm behind human-systems interaction standards so far has been that of tool use. The ISO 9241 series is for interactive tools and the physical environment within which they are used. RIA systems necessitate a new paradigm. Agents developed using these technologies will be more connected, complex, probabilistic and non-deterministic, social, and augment human capabilities well beyond merely replacing physical work. Interaction with these agents can become a relationship, their interface a personality, and users and agents can form complex human-machine teams, working together towards a shared goal.

The evolution of RIA systems will significantly alter the nature of tasks users perform. The design of work will likewise be altered. Applications of RIA systems represent a significantly more complete and impactful replacement of human activity than has been seen with any other form of technological labour-saving device. For example, when working with another person on a common task, how do you diagnose a failure state in your interactions? How are you to interpret the off-nominal behaviour of a team member? How are you to interpret and predict the behaviour of other people who are operating within the same environment as you are but are otherwise not directly coordinating activity? What is the safe state you can fall back on in the event of a failure in your interaction with another person? Now, replace that person or team member with an RIA system. The changes in the nature of tasks and the design of work to accommodate the complex, social human-machine interaction of an RIA system is fundamental for ergonomics, but will require that the ergonomics community adapt its best practices and expand into areas of psychology and sociology that few ergonomists deal with on a regular basis.

The focus of this document is breadth not depth, and issues not answers. The emphasis is on describing general issues and the consequences of not addressing them, even though not all will/can be relevant to all types or applications of RIA systems covered by this document. But be sure that this is the case for your application, and that you take account of the categories of issue and context that do apply.

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1 Scope

This document addresses:

— physically embodied RIA systems, such as robots and autonomous vehicles with which users will physically interact;

— systems embedded within the physical environment with which users do not consciously interact, but which collect data and/or modify the environment within which people live or work such as smart building and, mood-detection;

— intelligent software tools and agents with which users actively interact through some form of user interface;

— intelligent software agents which act without active user input to modify or tailor the systems to the user's behaviour, task or some other purpose, including providing context specific content/ information, tailoring adverts to a user based on information about them, user interfaces that adapt to the cognitive or physiological state, "ambient intelligence";

— the effect on users resulting from the combined interaction of several RIA systems such as conflicting behaviours between the RIA systems under the same circumstances;

— the complex system-of-systems and sociotechnical impacts of the use of RIA systems, particularly on society and government.

This document is not an exploration of the philosophical, ethical or political issues surrounding robotics, artificial intelligence, machine learning, and intelligent machines or environments. For matters of ethics and political issues, see standards such as BS 8611 and IEC P7000. However, this document does identify where and why ethical issues need to be taken into account for a wide range of systems and contexts, and as such it provides information relevant to the broader debate regarding RIA systems.

This document has a broader focus than much of the early work on autonomy that relates to the automation of control tasks and mechanization of repetitive physical or cognitive tasks, and centres on levels of automation.

Although this document addresses a wide range of technology applications, and sector and stakeholder views on the issues, the treatment of each can be incomplete due to the diverse and increasingly varied applications of RIA systems.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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