ISO 9241-820:2024-04 (E)

Ergonomics of human-system interaction - Part 820: Ergonomic guidance on interactions in immersive environments, including augmented reality and virtual reality

Contents

Page

Foreword ..... **vi**

Introduction ..... **vii**

1 Scope **1**

2 Normative references **1**

3 Terms and definitions **1**
3.1 High-level concepts 1
3.2 Realities and environments 2
3.3 Systems and interfaces 3
3.4 Ergonomic-related concepts 4
3.5 Interaction-related concepts 5

4 Unique characteristics of immersive environments **6**
4.1 General 6
4.2 Realities 6
4.2.1 General 6
4.2.2 The actual reality of the natural world 6
4.2.3 Virtual reality 6
4.2.4 Augmented reality 7
4.2.5 Mixed reality 7
4.3 Modalities 7
4.3.1 Multi-modal and multimedia 7
4.3.2 Visual 8
4.3.3 Auditory 9
4.3.4 Haptic 9
4.4 Three dimensions 11
4.4.1 General 11
4.4.2 3D in specialized environments 11
4.4.3 3D in augmented environments 11
4.5 Issues with interactions in immersive environments 11
4.5.1 General 11

5 Guidance on some roles of immersive environments **12**
5.1 Roles of immersive environments 12
5.2 Escaping reality 12
5.2.1 General 12
5.2.2 Limiting the escape from reality 12
5.2.3 Recognizing that the user remains part of the real world 13
5.2.4 Ensuring that escaping reality does not change the real world 13
5.2.5 Re-entering the immersive environment 13
5.3 Enhancing reality 13
5.3.1 General 13
5.3.2 Managing the information provided when enhancing reality 14
5.3.3 Providing user control of how and when enhancements are presented 14
5.4 Changing reality 14
5.4.1 General 14
5.4.2 Distinguishing between actions that affect the immersive environment and those that affect the real world 14
5.4.3 Providing user access to information that supports interactions 14

6 Guidance on immersion **15**
6.1 Contributing to immersion 15
6.2 The completeness of the virtual or mixed reality 15
6.2.1 General 15
6.2.2 Supporting three-dimensional (virtual or mixed) space 15
6.2.3 Supporting realistic timings 15
6.3 The naturalness of the virtual or mixed reality 16
6.3.1 General 16
6.3.2 Maximizing the use of natural user interactions 16
6.3.3 Using perceptual illusions 16
6.3.4 Synchronization of the presentation of information 16
6.4 The involvement of the user in the virtual or mixed reality 16
6.4.1 General 16
6.4.2 Supporting the user's sense of presence 16
6.4.3 Supporting flow of user involvement 17
6.4.4 Supporting user trust 17
6.5 The production of an optimal user experience 17
6.5.1 General 17
6.5.2 Focusing on intended user experience 17
6.5.3 Handling interactions and experiences realistically 17
6.6 Avoidance of harm from use 17
6.6.1 General 17
6.6.2 Avoiding physical harm resulting from an immersive environment 17
6.6.3 Managing emotional effects of an immersive environment 18
6.6.4 Avoiding harm to the physical environment 18

7 Guidance on user interactions within an immersive environment **18**
7.1 User interactions with an immersive environment 18
7.2 Controlling properties of an immersive environment 19
7.2.1 General 19
7.2.2 Providing a suitable range of control 19
7.2.3 Transitioning between controlling the immersive environment and acting within it 19
7.2.4 Supporting the naturalness of the controls 19
7.3 Obtaining information within an immersive environment 19
7.3.1 General 19
7.3.2 The real-time nature of an immersive environment 20
7.3.3 Multi-modality in an immersive environment 20
7.3.4 Avoiding sensory overload in an immersive environment 20
7.4 Moving within an immersive environment 20
7.4.1 General 20
7.4.2 Providing a suitable set of movements 21
7.4.3 Supporting the naturalness of movements 21
7.4.4 Providing suitable feedback on the success of movements 21
7.5 Interacting with objects within an immersive environment 21
7.5.1 General 21
7.5.2 Providing a suitable set of interactions 22
7.5.3 Supporting the naturalness of the interactions 22
7.5.4 Providing suitable feedback on the success of interactions 22
7.6 Interactions with interactive objects in the immersive environment 22
7.6.1 General 22
7.6.2 Providing a suitable set of interactions 22
7.6.3 Recognition within the immersive environment 22

8 Guidance on supporting multiple users within an immersive environment **23**
8.1 User-user interactions within an immersive environment 23
8.2 Interacting with others within the immersive environment 23
8.2.1 General 23
8.2.2 Making expectations clear to real users 23
8.2.3 Modelling virtual people 23
8.3 Controlling an individual's location within the virtual environment 24
8.3.1 General 24
8.3.2 Maintaining the latest state of the environment 24
8.3.3 Avoiding disorientation caused by the actions of other users 24

8.4 Simultaneously interacting with an object within the virtual environment 24
8.4.1 General 24
8.4.2 Maintaining awareness of joint interactions 25
8.4.3 Managing joint interactions 25
8.5 Social interactions supported by the immersive environment 25
8.5.1 General 25
8.5.2 Support for social interactions 25
8.5.3 Awareness of social expectations 26
8.6 Personal interactions supported by the immersive environment 26
8.6.1 General 26
8.6.2 Support of personal interactions within an immersive environment 26

9 Guidance on context awareness of the immersive environment 26
9.1 General issues with context awareness 26
9.2 Modelling the immersive environment and updating this model in real time 26
9.2.1 Real-time modelling of the immersive environment 26
9.2.2 Real-time modelling of the user 27
9.2.3 Real-time responses to user interactions 27
9.3 Relating the physical and mental components of the immersive environment 27
9.4 Interacting with the real world 27
9.4.1 General 27
9.4.2 Awareness of the real world 27
9.4.3 Avoiding harm 27
9.4.4 Connecting with the real world 28
9.4.5 Providing appropriate transitions between realities 28
9.4.6 Dealing with boundaries 28

Annex A (informative) **Other ergonomic and related standards relevant to immersive environments 29**

Bibliography 34