

SPRINGER BRIEFS IN  
HUMAN-COMPUTER INTERACTION

John N.A. Brown  
Anton Josef Fercher  
Gerhard Leitner

# Building an Intuitive Multimodal Interface for a Smart Home Hunting the SNARK

# **Human–Computer Interaction Series**

SpringerBriefs in Human-Computer Interaction

## **Series editors**

Desney Tan, Microsoft Research, USA

Jean Vanderdonckt, Université catholique de Louvain, Belgium

More information about this series at <http://www.springer.com/series/15580>

John N.A. Brown · Anton Josef Fercher  
Gerhard Leitner

# Building an Intuitive Multimodal Interface for a Smart Home

Hunting the SNARK

 Springer

John N.A. Brown  
Advertiser User Experience Research Group  
Adecco at Google  
San Bruno, CA  
USA

and

Interactive Systems Group  
Alpen-Adria-Universität Klagenfurt  
Klagenfurt, Carinthia  
Austria

and

Centre Tecnològic de Recerca per a la  
Dependència i la Vida Autònoma  
Universitat Politècnica de Catalunya  
Catalonia  
Spain

and

Signal Processing & Telecommunications  
Group, Department of Electrical,  
Electronic, Telecommunications  
Engineering and Naval Architecture  
University of Genoa  
Genova  
Italy

Anton Josef Fercher  
Interactive Systems Group  
Alpen-Adria-Universität Klagenfurt  
Klagenfurt, Carinthia  
Austria

Gerhard Leitner  
Interactive Systems Group  
Alpen-Adria-Universität Klagenfurt  
Klagenfurt, Carinthia  
Austria

ISSN 1571-5035

Human-Computer Interaction Series

ISSN 2520-1670

ISSN 2520-1689 (electronic)

SpringerBriefs in Human-Computer Interaction

ISBN 978-3-319-56531-6

ISBN 978-3-319-56532-3 (eBook)

DOI 10.1007/978-3-319-56532-3

Library of Congress Control Number: 2017937117

© The Author(s) 2017

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer International Publishing AG

The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Contents

<b>1</b>	<b>“...A Lesson in Natural History”: Introduction to the Smart Home</b> . . . . .	<b>1</b>
	1.1 Smart Environments . . . . .	2
	1.2 The Smart Home . . . . .	2
	1.3 Casa Vecchia: Making an “Old House” Smart . . . . .	4
	References . . . . .	5
<b>2</b>	<b>“...If I Had but the Time and You Had but the Brain...”: Computer-Centered Computing</b> . . . . .	<b>7</b>
	2.1 Human-Computer Interaction . . . . .	8
	2.2 A Gesture of Goodwill . . . . .	9
	2.3 Speech and Sound . . . . .	11
	References . . . . .	14
<b>3</b>	<b>“Just the Place for a Snark!”: An Introduction to Calm Technology</b> . . . . .	<b>17</b>
	3.1 Calm Technology: “...As Refreshing as Taking a Walk in the Woods” . . . . .	17
	3.2 Understanding Calm . . . . .	18
	3.3 Is “Calm” Necessary? . . . . .	18
	References . . . . .	19
<b>4</b>	<b>“What I Tell You Three Times Is True”: The S.N.A.R.K. Circuit</b> . . . . .	<b>21</b>
	4.1 A New Paradigm Part 1—The Bellman’s Protocol . . . . .	22
	4.2 A New Paradigm Part 2—The B.O.O.J.U.M . . . . .	22
	4.3 A New Paradigm Part 3—The S.N.A.R.K. Circuit . . . . .	23
	References . . . . .	24

<b>5</b>	<b>“Do All that You Know, and Try All that You Don’t...”:</b>	
	<b>Models of Intuitive Interaction</b> . . . . .	27
5.1	The Voice-Centered Method . . . . .	28
5.2	The Gesture-Centered Method . . . . .	32
5.2.1	Interaction Scenario . . . . .	32
5.2.2	The Three Gestures. . . . .	33
	References . . . . .	35
<b>6</b>	<b>“The Method Employed I Would Gladly Explain...”: Set up,</b>	
	<b>Location and Protocol</b> . . . . .	37
6.1	Participants. . . . .	37
6.2	Familiarization . . . . .	38
6.3	Testing Protocol. . . . .	39
6.4	Technological Set up . . . . .	40
	References . . . . .	41
<b>7</b>	<b>“...They Are Merely Conventional Signs...”:</b>	
	<b>Measuring Intuitive Interaction</b> . . . . .	43
7.1	Intuitive Transition Between Devices. . . . .	43
7.2	Seamless Transfer Between Modalities . . . . .	44
7.3	Perception of the Home as a Single, Holistic Entity. . . . .	45
7.4	Data Extraction and Analysis. . . . .	46
	References . . . . .	47
<b>8</b>	<b>“How Do You Do?”: Quantitative Results</b> . . . . .	49
8.1	First Attempts: A High Standard of Failure . . . . .	49
8.2	Second and Third Attempts: Measuring Intuitiveness. . . . .	53
	References . . . . .	54
<b>9</b>	<b>“How Do You Feel?”: Qualitative Results</b> . . . . .	55
9.1	Likert Scales: Perception of the System. . . . .	56
9.2	The System Usability Scale . . . . .	57
9.3	Anthropological Methods and Our Conclusions. . . . .	57
9.3.1	Intuitive Transition Between Devices . . . . .	58
9.3.2	Seamless Transfer Between Modalities . . . . .	58
9.3.3	Seamless Transfer Between Modalities Within Methods . . . . .	59
9.3.4	Seamless Transfer Between Modalities Across Methods . . . . .	59
9.3.5	Perception of the Home as a Single Holistic Entity . . . . .	60
	Reference . . . . .	60
<b>10</b>	<b>“...But Much yet Remains to Be Said”: A Discussion</b>	
	<b>of Our Failings and Success.</b> . . . .	61
10.1	Limitations. . . . .	61
10.2	King Midas’ Ring . . . . .	62

- 10.3 Background Noise . . . . . 62
  - 10.3.1 Reflections and Limitations. . . . . 63
- 10.4 The S.N.A.R.K. Was not Really a S.N.A.R.K.:  
Triple Redundancy. . . . . 64
- 10.5 Lack of Full Customization and Language Limitations . . . . . 64
- 10.6 Unfamiliar Territory. . . . . 65
- References . . . . . 65
- 11 “Yet, Still, Ever After...”: Future Work. . . . . 67**
  - 11.1 “È un posto da Squili!” . . . . . 67
  - 11.2 “The Moment One Looked in His Face” . . . . . 69
  - 11.3 “And Seemed Almost Too Good to Be True” . . . . . 71
  - 11.4 “...Bellowing on to the Last”. . . . . 73
  - 11.5 “It Is Ages Ahead of the Fashion” . . . . . 77
  - References . . . . . 78



# List of Figures

Figure 4.1	The S.N.A.R.K. Circuit: where any 3 recognized commands ( <i>A, B, C</i> ), detected within a small space of time, are compared to see if they hold the same meaning. If two of the recognized commands match, user confirmation is sought. If three match, the command is generated. . . . .	23
Figure 5.1	The participant could name their invisible butler . . . . .	28
Figure 5.2	<i>m<sub>v</sub></i> : voice-centered interaction . . . . .	29
Figure 5.3	Acknowledging the call to attention and asking which butler is being called . . . . .	29
Figure 5.4	Acknowledging preparedness to follow orders . . . . .	30
Figure 5.5	Acknowledging the last command and preparedness for the next . . . . .	31
Figure 5.6	Clarifying that the last spoken command was not understood . . . . .	32
Figure 5.7	One participant, relaxed, during gesture-centered interaction . . . . .	33
Figure 5.8	The mental model of using a magic wand, and the gesture for “state change”. . . . .	34
Figure 5.9	Mental model of <i>left-to-right</i> progression and the gestures for “less” and “more”. . . . .	35
Figure 6.1	The living lab at Alpen-Adria-Universität Klagenfurt as seen through our surveillance camera. . . . .	38
Figure 6.2	The living lab schematic. . . . .	39
Figure 6.3	The internal state model of the C.A.S.A. T.E.V.A. app . . . . .	41
Figure 8.1	Mean success ratios according to interaction method . . . . .	51
Figure 9.1	Participants’ opinion of C.A.S.A. T.E.V.A. features (mode values) . . . . .	56
Figure 9.2	Participant evaluation of C.A.S.A. T.E.V.A. usability, according to the SUS . . . . .	57
Figure 11.1	Illustrates a possible AR—based scenario. . . . .	72