

Social Acceptance of Nomadic Virtual Reality

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ABSTRACT

The following paper provides an overview on the reviewed social acceptance of nomadic virtual reality devices in a university environment. Within the scope of a field study data regarding fears and desires was collected via a questionnaire and the results of its examination the so-called WEAR scale. Three different cases (Smartphone, Oculus Rift without gesture control, Oculus Rift with gesture control) have been reviewed. In this case the smartphone served as a comparative. Considered given is the fact that a smartphone is already accepted as an everyday object because of its widespread use in society. An actor and an actress that both created situations with using all of the three cases, became rated by overleaf passerbys based on above-mentioned scale in form of questionnaires. The evaluation shows that virtual reality devices in general are accepted. A difference can be found in the contemplation between smartphone and the usage of a VR device in combination with performing gestures with a VR controller. It shows that gesture control in this context is still less familiar and something that makes people feel more uncomfortable compared to the handling of ordinary wearables.

CCS CONCEPTS

- Computer systems organization → Embedded systems; Redundancy; Robotics;
- Networks → Network reliability.

KEYWORDS

virtual reality, social acceptance, nomadic, field study

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1 INTRODUCTION

New presentation forms such as VR experience are a growing trend as alternatives to conventional displays in different end devices e.g. tablets or mobile phones. Although the latter can double as a VR-Device with extra parts to hold it in place etc.. This was disregarded here due to the major difference in looks and usage to a mobile phones common usage. These devices are always improving in size, functionality, and appearance, to support the mobility of todays life and constant availability. Due to this development process never standing still VR devices might be prospectively used in the same way we already use mobile phones today, at any time and everywhere. To achieve a broad utilization, it is not only important to focus on the unique user and establish hardware with high usability for the users themselves, but also something that fits all the tangentially involved people and their needs for well-being, comfort, and privacy. The fear of interfering with your own privacy and also data theft makes the question about the current state of social acceptance of VR devices in public spaces an important issue to examine. Before spreading out this type of gear and gaining the possibility of high sales output it is essential to find out if those devices are already accepted by society and what impact they have on society.

Several researchers already tried to investigate this potential issue regarding the social acceptance. Under laboratory conditions they tried to find out more about their test persons opinions, feelings, and reactions about being confronted with pictures and videos of users wearing VR devices in public spaces [4]. By only looking at pictures, people will always keep a certain emotional distance to the context shown. The spontaneous and direct confrontation with a previously completely unexpected situation in daily life might change the view of things and the way people accept certain circumstances under different conditions. VR devices might be fully accepted by society, but it can also

71 be, that they evoke discomfort because people are not used 122
 72 to not seeing each other's eyes while passing by, or sitting 123
 73 next to them on a park bench. Although Sunglasses act simi- 124
 74 lar, todays VR glasses still cover almost half of the wearers 125
 75 face which is why it cannot be generalized and needs to be 126
 76 examined more accurately. In this paper, we examined the 127
 77 topic of social acceptance of VR devices using a field study 128
 78 to achieve a high external validity. 129
 130

79 2 RELATED WORK

80 Previous work already dealt with social acceptance and mo- 132
 81 bile devices. Gesture control has also been investigated. In 133
 82 the following, three papers will be analyzed that already 134
 83 tried to gather information about how devices of that kind 135
 84 are accepted in a social context. 136

85 One work dealing with gesture control and mobile devices 137
 86 and their social acceptance is a work by J. Rico and S. Brew- 138
 87 ster [2]. They mainly observed the extent to which social 139
 88 acceptance can be measured. They found out that the social 140
 89 acceptance of technology use depends on embarrassment or 141
 90 politeness and a combination of factors ranging from appear- 142
 91 ance and social status to culture. It was also stressed that 143
 92 gesture-based user interfaces face acceptance problems as 144
 93 they require users to evaluate a range of new actions. This 145
 94 would require the user to define new standards for social 146
 95 acceptance. In a survey, they found that location and audi- 147
 96 ence have a significant impact on whether a user wants to 148
 97 perform gestures. They conclude that users would be more 149
 98 likely to use gesture-controlled mobile devices at home. Two 150
 99 other areas that were defined were the semi-public space, 151
 100 i.e. with a restricted but not necessarily familiar audience, 152
 101 and the public space, i.e. the sidewalk. They then carried out 153
 102 another experiment to see how participants behave when 154
 103 they make gestures on a busy street. 155

104 In this context another paper criticized that there was 156
 105 no robust model to explain the underlying factors why a 157
 106 device was socially acceptable [3]. Therefore, the devices 158
 107 were regarded as social objects and it was examined whether 159
 108 the stereotypical content model (SCM) could be applied to 160
 109 them. The focus of this work was whether mobile applica- 161
 110 tions themselves are stereotypically perceived. This has 162
 111 been investigated in two studies. In the first study it was
 112 shown that different devices have a different impact on the 163
 113 person wearing them. LED glasses, for example, were re- 164
 114 viewed negatively. In the work, this was associated with low 165
 115 warmth and low competence. Medical devices, on the other 166
 116 hand, were rated more positively or warmer. VR headsets 167
 117 were rated well in terms of being more competitive, but they 168
 118 overall were received as contemptuous. It was also found 169
 119 that devices systematically trigger emotions when people 170
 120 use them. This may allow the SCM to explain the results of 171
 121 older work, as the social acceptance of highly competitive 172

122 devices such as smart glasses depends on the stereotype of 123
 123 the person wearing the device. Here the comparison was 124
 124 made between older people wearing a VR headset and other 125
 125 people. A weaker attraction in terms of the SCM was also 126
 126 measured for VR glasses than for other devices. This revealed 127
 127 that the SCM can be used to measure the social acceptance 128
 128 of a mobile device. These assumptions were supported in a 129
 129 second study. In this study no images of human stereotypes 130
 130 were used and since it showed no significant difference to 131
 131 the stereotype device combinations of the first study, it was 132
 132 assumed that a possible effect of human stereotype images 133
 133 is negligible. In addition, it was supported once again that 134
 134 VR glasses are assigned a certain competence and that they 135
 135 are perceived more competitively. 136

136 Schwind et. al. investigated the acceptance of VR glasses 137
 137 [4]. It was assumed that mobile VR glasses are less frequently 138
 138 used in public because they are not socially accepted. To 139
 139 investigate this, an online experiment was conducted to inves- 140
 140 tigate the acceptance of VR glasses in six different contexts. 141
 141 Prior work worked out that it depends on the environment 142
 142 the device is used in. It seems to be more acceptable to use 143
 143 VR glasses in bed, a train or the subway. In public places, 144
 144 on the other hand, or when the user is supposed to interact 145
 145 with a person in the environment, they are less acceptable. 146
 146 In the online experiment, the test person was shown pic- 147
 147 tures of people wearing VR glasses. They were asked to 148
 148 answer a number of questions. In addition, different places 149
 149 and persons of different sexes were shown with VR glasses. 150
 150 Subsequently, the subjects were asked to assign one of eight 151
 151 statements, which stood for Awkward, Normal, Appropriate, 152
 152 Rude, Uncomfortable, Distracting, Useful and Unnecessary, 153
 153 to the respective images. 154

154 If a gesture is performed in a public place, this would be 155
 155 seen as less appropriate. One should also assume that more 156
 156 inappropriate the usage of VR glasses in a certain context is 157
 157 the less comfortable people feel while performing gestures 158
 158 with this type of device. The SCM can be used as a classifi- 159
 159 cation. The VR glasses are assigned competence but also a 160
 160 certain coolness, i.e. separation. 161

162 3 STUDY: ACCEPTANCE OF NOMADIC VIRTUAL REALITY

163 The specific goal of this study was to examine more about 164
 164 the current state of social acceptance in the open field by 165
 165 confronting unprepared bystanders with this topic in dif- 166
 166 ferent real-life scenarios. This was done with the help of a 167
 167 field study because of our research question if VR devices 168
 168 will be accepted by society in public spaces due to direct 169
 169 confrontation and missing emotional distances. 170

170 Study Design

171 The design of the study is a two-factorial within-subject
 172 design and conducted with the independent variable CASE
 173 which included three different peculiarities (Using a smart-
 174 phone, wearing VR glasses without performing gestures and
 175 wearing VR glasses with performing gestures). Since VR de-
 176 vices often rely on some level of gestures for interaction,
 177 gesture control of connected controllers is essential for the
 178 use of most common VR devices. This is due to a lack of
 179 other controllers apart from the direction of the users gaze.
 180 This includes the Oculus Rift which is used to perform this
 181 study. Since performing those gestures might have a big im-
 182 pact on the acceptance, this also was an important issue to
 183 test to find out more about the general acceptance and how
 184 people react when being confronted with this situation. For
 185 the investigation, it is important to choose an experimen-
 186 tal group with almost equal gender distribution in order to
 187 exclude potential gender effects. For the same reason two
 188 actors were asked to play the part of the devices wearer, one
 189 male and one female. The questionnaire used was the 14 item
 190 WEAR-Scale [1], a questionnaire to quantify how acceptable
 191 a device is with regard to e.g. aesthetic, personal attitude
 192 and the wearers impression on the participant. We used this
 193 scale with a 5-point Likert scale translated for ease of use
 194 and the avoidance of language barriers in a german univer-
 195 sity setting (translations: strongly agree="sehr"=5, somewhat
 196 agree="ziemlich"=4, neither agree nor disagree="mittel"=3,
 197 hardly agree="kaum"=2, don't agree="gar nicht"=1) instead
 198 of the, for this questionnaire normal 6-point Likert scale, due
 199 to an oversight.

200 Conditions

201 In earlier research pictures and videoclips have been used
 202 for probing [4]. Since we wanted to extend those results and
 203 test their external validity we used confrontations in real life
 204 situations in the open field rather than representations of it.

205 We tested the glasses in combination with controllers and
 206 gesture controls which is our stimulus. In this study we
 207 combined those three peculiarities to receive as much infor-
 208 mation as possible about peoples reactions on different types
 209 of situations.

210 Survey Procedure

211 After handing out the informed consent, the randomly cho-
 212 sen participants answered a short demographic questionaire
 213 in which we request allegations to gender and age. After-
 214 wards we handed out another Questionnaire to measure the
 215 acceptability of wearable devices [1]. After going over the
 216 questionnaire with the participants each of them received a
 217 little thank-you gift.

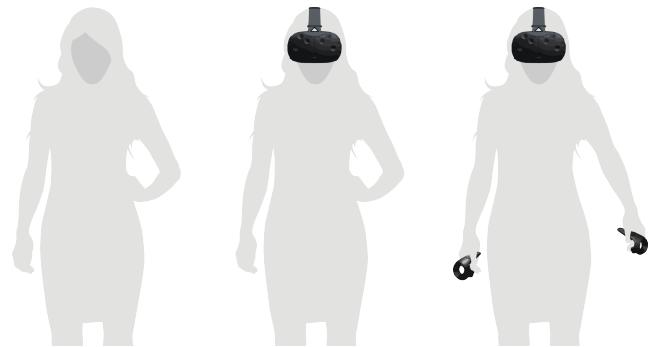


Figure 1: Three different female stimuli

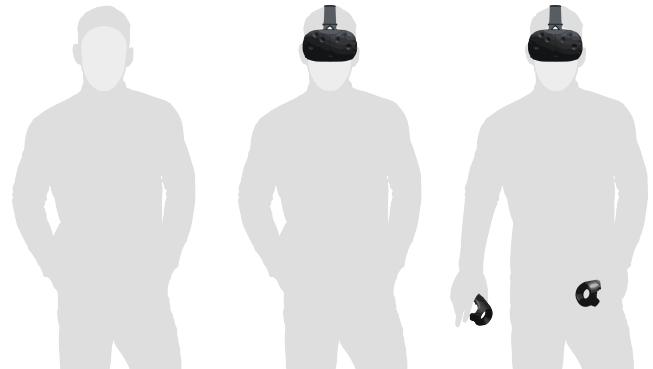


Figure 2: Three different male stimuli

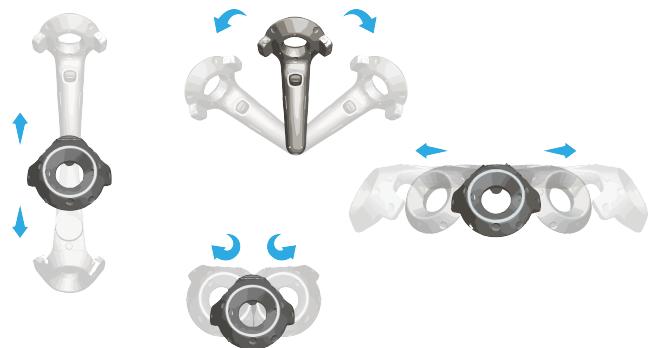


Figure 3: Used VR gestures

Participants

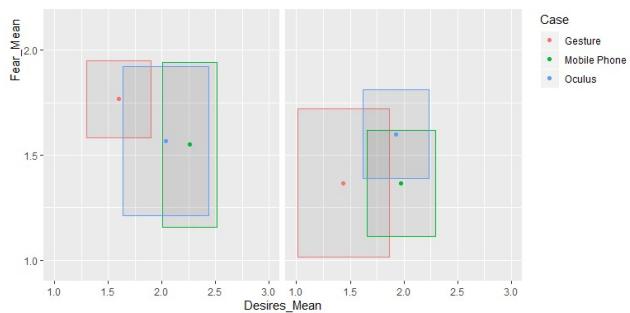
We examine this Acceptance Rating by collecting real life reactions and the opinions. For this type of field study it was essential to acquire unpremeditated pedestrians in their daily life to receive an unbiased output. We acquired 60 Participants (33 female, 27 male) for the study. Their age ranged from 19 to 28 ($M = 22.65$, $SD = 2.92$).

225 4 RESULTS

226 An analysis of variance (ANOVA) was conducted to deter-
 227 mine the effects of the CASE (mobile phone as control, VR
 228 Glasses no gestures, VR-Glasses with gestures) on the AC
 229 CEPTABILITY. Statistically significant effects of CASE on
 230 DESIRES, a part of the WEAR-Scales overall metric, $F = 5.714$,
 231 $p < 0.00561$, were found. In contrast effects of CASE neither
 232 on FEAR nor WEAR revealed any significant results (FEAR: F
 233 = 0.341, $p > 0.712$; WEAR: $F = 3.048$, $p > 0.0557$). The effects of
 234 the actors gender has also been analyzed and showed no sta-
 235 tistically significant effects either (DESIRES Actor: $F = 1.525$,
 236 $p > 0.22221$; FEAR Actor: $F = 1.869$, $p > 0.177$; WEAR Actor:
 237 $F = 2.917$, $p > 0.0934$). Due to this t-tests were conducted
 238 in pairs between the three CASEs, showing a significant
 239 difference between the acceptance of mobile phones and VR-
 240 Glasses with the usage of gestures, $t = -3.3343$, $df = 36.391$,
 241 $p\text{-value} = 0.001976$. Between wearing a mobile phone and
 242 wearing VR glasses the results where: $t = 0.7791$, $df = 36.82$, $p\text{-}$
 243 value = 0.4409. The results of the t-test between wearing VR
 244 glasses and wearing VR glasses while making gestures are: t
 245 = -2.3739 , $df = 37.96$, $p\text{-value} = 0.02276$. Solely on DESIRES
 246 the CASEs have a significant effect. Significant differences
 247 in ACCEPTANCE only exist between smartphone and the
 248 wearing of VR glasses while performing gestures.

249 5 MAPPING AND MODEL

250 Using the WEAR scale, data to research acceptance on differ-
 251 ent wearables can be determined by their relative locations
 252 on a 2D map with the dimensions DESIRE and FEAR.



253 **Figure 4: Desire-Fear-Plot by CASE and GENDER, Male ac-
 254 tors results on the left, female actress' resuls on the right.
 255 The colored boxes represent the three different cases (mo-
 256 bile phone as control, VR-Glasses no gestures, VR-Glasses
 257 with gestures). The dot in the middle of each square locates
 258 the mean of the particular case. The box itself shows the
 259 horizontal (DESIRES) and vertical (FEARS) variance of the me-
 260 assurements.**

261 As the plot shows the genders show only minimal dif-
 262 ferences in the acceptance of the three CASEs they tested.
 263 Looking at the x-axis you might realize that both the means
 264

265 and the variances differ only minimally. Only when looking
 266 at the y-axis with represents the FEARS, you can see
 267 strong distinctions between the two sexes regarding using
 268 the Oculus Rift with gestures and without.



269 **Figure 5: Female actress - Oculus Rift - without gestures**

270 As long as our female actress only wore the VR glasses
 271 without performing any gesture the interviewees were quite
 272 agreed about their FEARS. In contrast the results for the male
 273 actor were exactly the opposite. This might have psycholog-
 274 ical and social reasons. Even if this is still more of a cliché
 275 nowadays and no longer corresponds to the truth, men of
 276 known dimensions are still considered to be technically more
 277 affine than women. This could explain why the variance of
 278 the acceptance of using gestures with VR devices in public
 279 spaces with a male actor less scatters. Overall the results
 280 show that VR-Glasses are, when not gesture controlled, com-
 281 parable to a mobile phone in social acceptability, leading us
 282 to thinking that should they be more prevalent atleast in
 283 this setting people would get used to seeing them, possibly
 284 increasing the social acceptability further.

285 Considering only the case of wearing, the differences could
 286 be explained by the fact that men are quickly considered to be



Figure 6: Male actor - Oculus Rift - with gestures

a freak when using unknown and technically looking objects in an unusual context whereas the observer might pay more attention to looks in women, which could simply distract from such details like VR glasses.

6 DISCUSSION

The results show only that VR-GLASSES WITH PERFORMING GESTURES reduces the desire of bystanders to be like the user compared to the smartphone using actor, which leads us to the conclusion that there is less bias towards VR-Glasses than one might casually suspect, at least measurably in a University environment. The significance of these results can be debatable due to the lack of personal background in the form of major or occupation in this study, in our opinion it is still a proof of concept, showing that in a neutral public to semi-public environment VR-Glasses can be accepted if no social interaction is expected of the user. The lack of other statistically significant results supports that, though a bigger sample size could reveal different results, if so it stands to reason that the differences in the acceptability of a CASE to the baseline grow more distinct and pronounced, especially with a higher age range, as this study had a rather limited reach there with the ages between 19 and 28. Different levels of education and age groups, as well as differences in experimental setup in terms of location and time, have a major impact on the outcome of this or similar studies, be it in the field or in a laboratory, so repeats of this study in a different setting might lead to completely different results. Specifically the performing of gestures warrants extra attention, as this lead to the only significant difference in our study, though not for reasons of social anxiety or simply accidents that could happen when moving your arms and hands in a public environment without seeing, but more from the concept of

DESIRE, which leads us to believe that it is the self-image of the people that would play the biggest role in this regard.¹

7 FUTURE WORK

Any future work building on this should prevent the mistakes that were made here first and foremost, the lack of a background in the form or occupation or major in case of students and the proper scaling for the questionnaire just to be comparable with other results delivered by this scale. Past that, a change of setting or variables could deliver a lot more interesting information, be it in a more social setting like a restaurant or cafe, or a more cramped space like most public transport which are both examples of places VR-Devices could get more and more prevalent given time and social acceptance. Even a repeat of this study in a setting that's not a university could warrant very different results, though we were unable to do that due to issues with permissions a mall would be probably the best space to get sample of most social groups.¹

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5	Female actress - Oculus Rift - without gestures	5

¹GitHub Repository with all data for any future work or more details: <https://github.com/tomNedorost/MMI>

355 6 Male actor - Oculus Rift - with gestures

6