Mirrorshades: Phase 1 Investigation

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1 The Case for Mobile XR

This investigation compares two scenarios for interaction with a real location & a corresponding virtual location.

1. **Stationary scenario** - interacting with the virtual location from a fixed real location, then subsequently interacting with the real location.
2. **Mobile scenario** - using the Mirrorshades platform to interact with both the real location & the corresponding virtual location in tandem, whilst moving around both environments.

The locations in question are St Salvator's chapel & a virtual reconstruction of the chapel as it stood in 1450-1460. The stationary scenario is representative of how virtual reality technologies, including both CAVEs & HMDs, have previously been used for dissemination of virtual reality content in cultural heritage contexts [1] & thus this investigation serves to compare Mirrorshades with previous applications virtual reality content to these contexts.

1.1 Process

- Participants complete a pre-task questionnaire, which provides calibration for their subsequent responses by enquiring about age, gender identity, previous experience with VR hardware & previous interactions with either the real or virtual chapel. This questionnaire is included as Appendix A.
- Participants familiarise themselves with the experience of using the Oculus Rift DK1 HMD & the Xbox 360 controller by interacting with the 'Tuscany demo' prepared & maintained by the Oculus VR team. This is performed from a seated position.
- Participants complete the stationary scenario.
- After completing the stationary scenario, participants complete the System Usability Scale (SUS) [2] questionnaire, included as Appendix B & a 12-item questionnaire, included as Appendix C.
- Participants complete the mobile scenario.
- After completing the mobile scenario, participants complete the SUS questionnaire & the 12-item questionnaire again.
- Finally, the participant is engaged in a short structured interview. Interview prompts are included as Appendix D.

In addition to SUS, the 12-item questionnaire & the structured interview, quantitative data is logged by the Mirrorshades platform when a participant is interacting with virtual content in the first scenario & at all times during the second scenario.

1.2 The Scenarios

Both scenarios that participants complete for this investigation are designed to mimic the style of exploration & interaction that visitors to the chapel display, which was observed over several occasions. Visitors enter the chapel from the North/West corner then proceed to walk Eastwards along the nave, pausing to look around after passing through the rood screen, before continuing along the nave toward the altar. Visitors pause in front of the alter upon reaching the end of the pews & then walk North toward the tomb where they pause again to inspect it. Participants are instructed to imagine that they are performing a similar

visit to the chapel & to follow a similar path, pausing after the rood screen, at the end of the pews & in front of the tomb. Participants are shown the map included as figure 1.1 to explain the scenario better.

In the stationary scenario, participants interact with the virtual chapel using the Rift & Xbox controller, whilst in a sitting position. After completing the path, they remove the headset & then walk the same path in the real chapel. This scenario alludes to how virtual reality technologies have previously been applied to cultural heritage situations, allowing visitors to experience a virtual reality reconstruction or reimagination of the real environment from a fixed position & with their view of the real environment wholly occluded by their view of the virtual environment.

In the mobile scenario, participants wear the HMD, hold the Xbox controller in their right hand & the smartphone in their left, with the laptop & battery pack in a satchel worn over the right shoulder. They then walk the same path, but this time with the ability to transition at any time between viewing the real environment & the virtual environment from the same vantage point.

In this first investigation phase, only one transition is available to participants. Preliminary experiments involving the researchers' colleagues that allowed hard transitions, linear interpolated transitions & analogue selectable opacity, indicated that the linear interpolated transition was preferred to either the hard transition or the analogue selectable opacity & thus this is the transition available to participants in this first phase investigation.

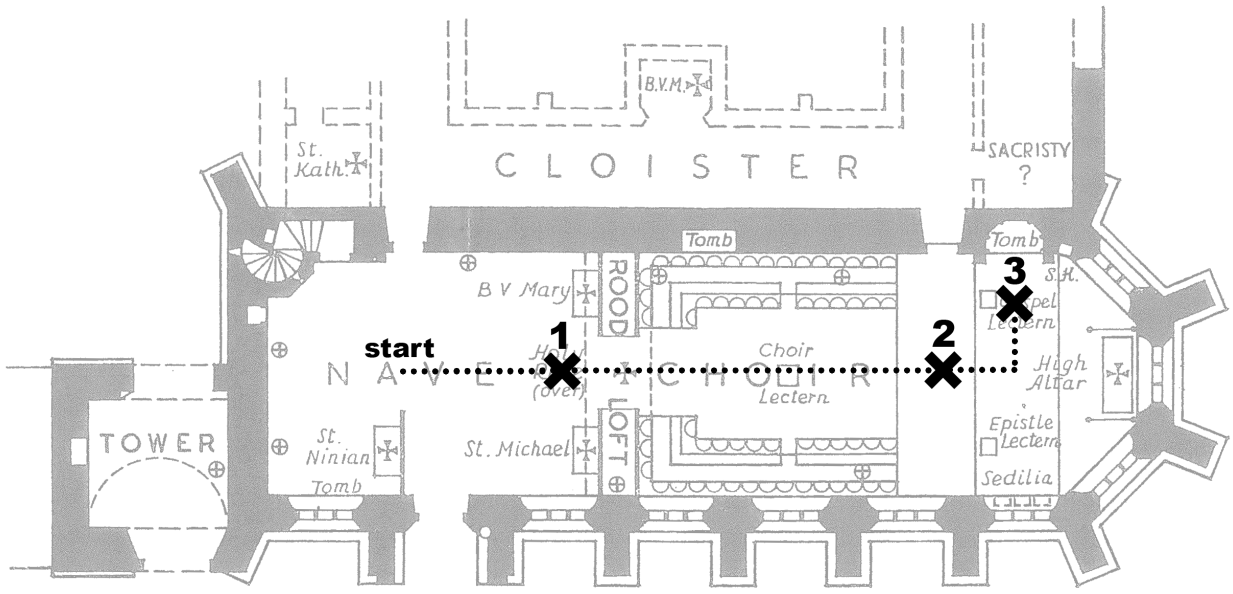

Figure 1.1: The path & positions within the chapel that participants are instructed to attend to.

1.3 Hypotheses

The aim of the mobile scenario is to improve participant engagement with & understanding of the relationships between the real & virtual environments, by addressing the problems of spatial & temporal separation inherent with the 'traditional' stationary scenario, by imparting upon the participant the ability to transition between equivalent vantage points within the real & virtual environments at will.

While we expect participants to report that the mobile scenario does indeed allow them to better compare & contrast the real & virtual environments, identify differences between the real & virtual environments & gain a better understanding of how the real & virtual environments relate to each other, we expect some

participants to report that having to 'split' their attention between the two environments in the mobile scenario leads to lessened engagement & understanding & that the visual quality of the real view through the headset/cameras leads to some participants preferring to interact with the real environment without the headset.

We expect the cumbersome nature of the mobile scenario & the reduced quality of viewing the real environment via the headset/cameras to have a noticeable effect upon participants movement (both position & head orientation) in the mobile scenario.

Addressing these issues, such that participants don't find viewing the real through the headset to be such a reduction in quality compared to just seeing real, such that participants feel as though they can move & look around themselves as much in the mobile scenario as in the stationary scenario & such that participants transition between real & virtual at any time instead of avoiding transitions in situations in which they think that they will be unpleasant/jarring, is key & what the next stage will focus on.

1.3.1 SUS

SUS scores for the mobile scenario are expected to average lower than those for the stationary scenario, due to the cumbersome nature of the platform when performing the mobile scenario; during the stationary scenario, participants are seated, whilst during the mobile scenario they are required to carry a satchel over one shoulder & hold a smartphone in their left hand. Participants who are able to overcome this cumbersomeness are expected to respond more favourably to the mobile scenario than those who cannot overcome it.

1.3.2 12-item Questionnaire

- Participants will find it easier to compare & contrast real & virtual environments in the mobile scenario than in the stationary scenario (q2)
- Participants will experience a greater sense of 'being in' the virtual environment in the mobile scenario than in the stationary scenario (q4, due to physical movement/embodiment)
- Participants will have a greater sense of 'being in the past' in the mobile scenario than in the stationary scenario (q7)
- Participants will maintain greater awareness of both real & virtual environments in the mobile scenario than in the stationary scenario (q5)
- Participants will gain a better understanding of what the chapel was like in the past in the mobile scenario than in the stationary scenario (q12)

1.3.3 Log data

- Head movement (pitch & yaw) will be more restricted in the mobile scenario compared to the stationary scenario
- Aversion to looking around (even at real) when moving in the mobile scenario
- Head movements will be larger discrete changes in the stationary scenario compared to the mobile scenario
- Tendency to only look at virtual when looking around

1.3.4 Interviews

- mobile scenario makes it easier to spot differences
- mobile scenario reveals differences that stationary didn't
- stationary does not reveal differences that mobile doesn't
- mobile scenario is preferred & is user-reported as 'more engaging'

1.4 Results

1.4.1 Pre-task Questionnaire

For n=5 ages ranged from 21-26, 3x female & 2x male, all reported previous experience using a games console controller, 1x reported previous use of a HMD, 2x reported having previously visited the chapel, none had previously interacted with the virtual chapel model.

1.4.2 SUS

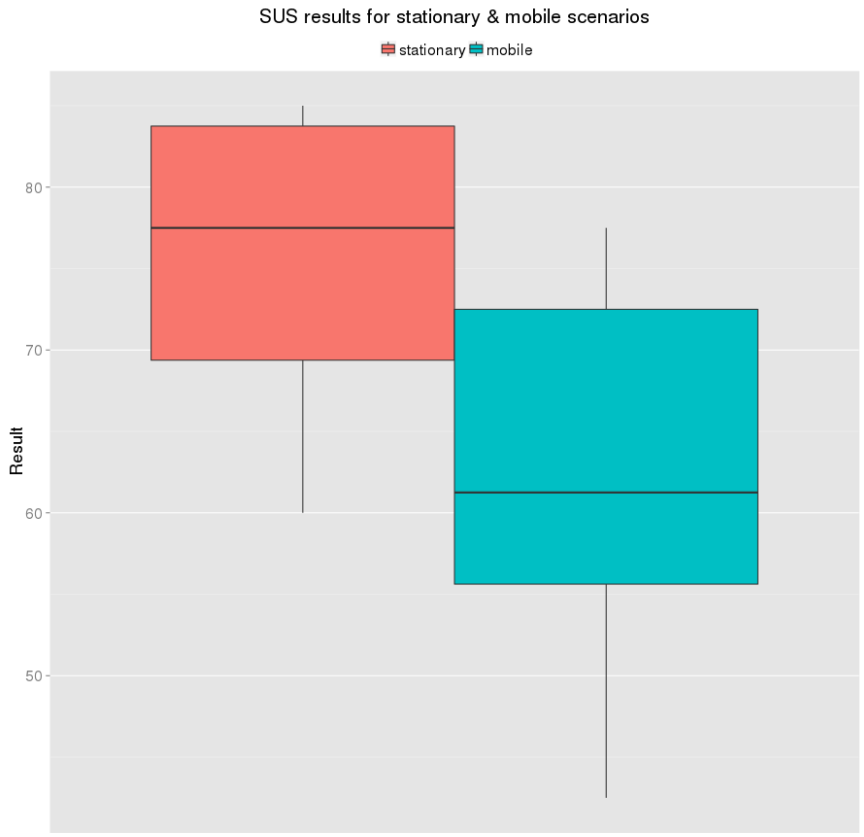

Figure 1.2: SUS results.

As expected, the SUS scores for the mobile scenario are lower than those of the stationary scenario, although not drastically so. Furthermore, although scoring lower on SUS, the mobile scenario came out above the stationary scenario when looking at the results of q8 in the 12-item questionnaire which asked participants if they thought they would have preferred a conventional computer monitor.

1.4.3 12-item Questionnaire

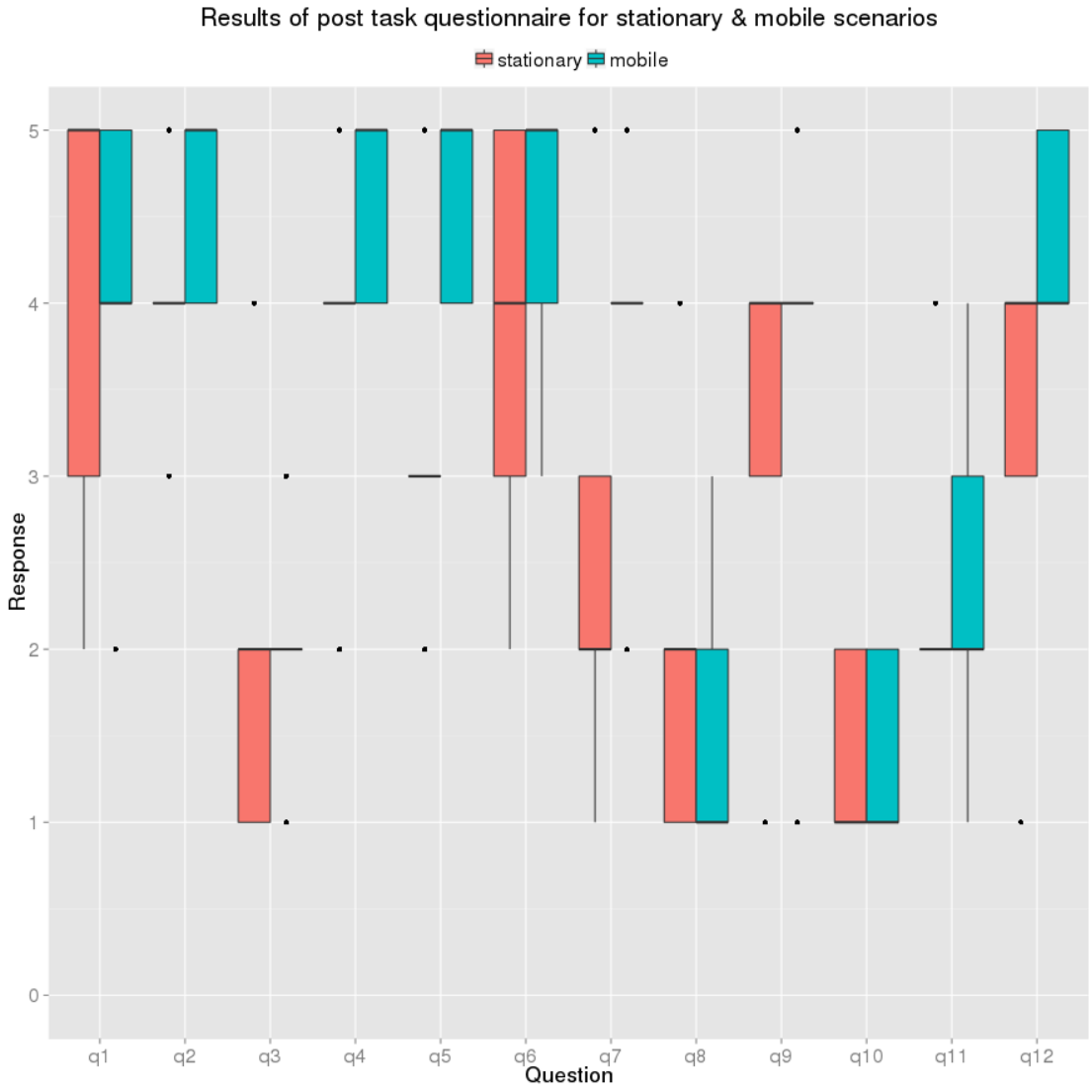

Figure 1.3: 12-item questionnaire results.

The hypotheses seem to hold, in particular;

- *Participants will maintain greater awareness of both real & virtual environments in the mobile scenario than in the stationary scenario* is supported by the responses to q5
- *Participants will have a greater sense of 'being in the past' in the mobile scenario than in the stationary scenario* is supported by q7 (thanks to embodiment?)
- *Participants will gain a better understanding of what the chapel was like in the past in the mobile scenario than in the stationary scenario* is supported by q12

It is worth highlighting the responses to q10 in relation to those to q2. Participants reported finding it easier to compare features from the past & present (q2) during the mobile scenario, however did not report a difference between not noticing differences between the real & virtual environments (q10).

1.4.4 Log data

***stats here (see R output files)

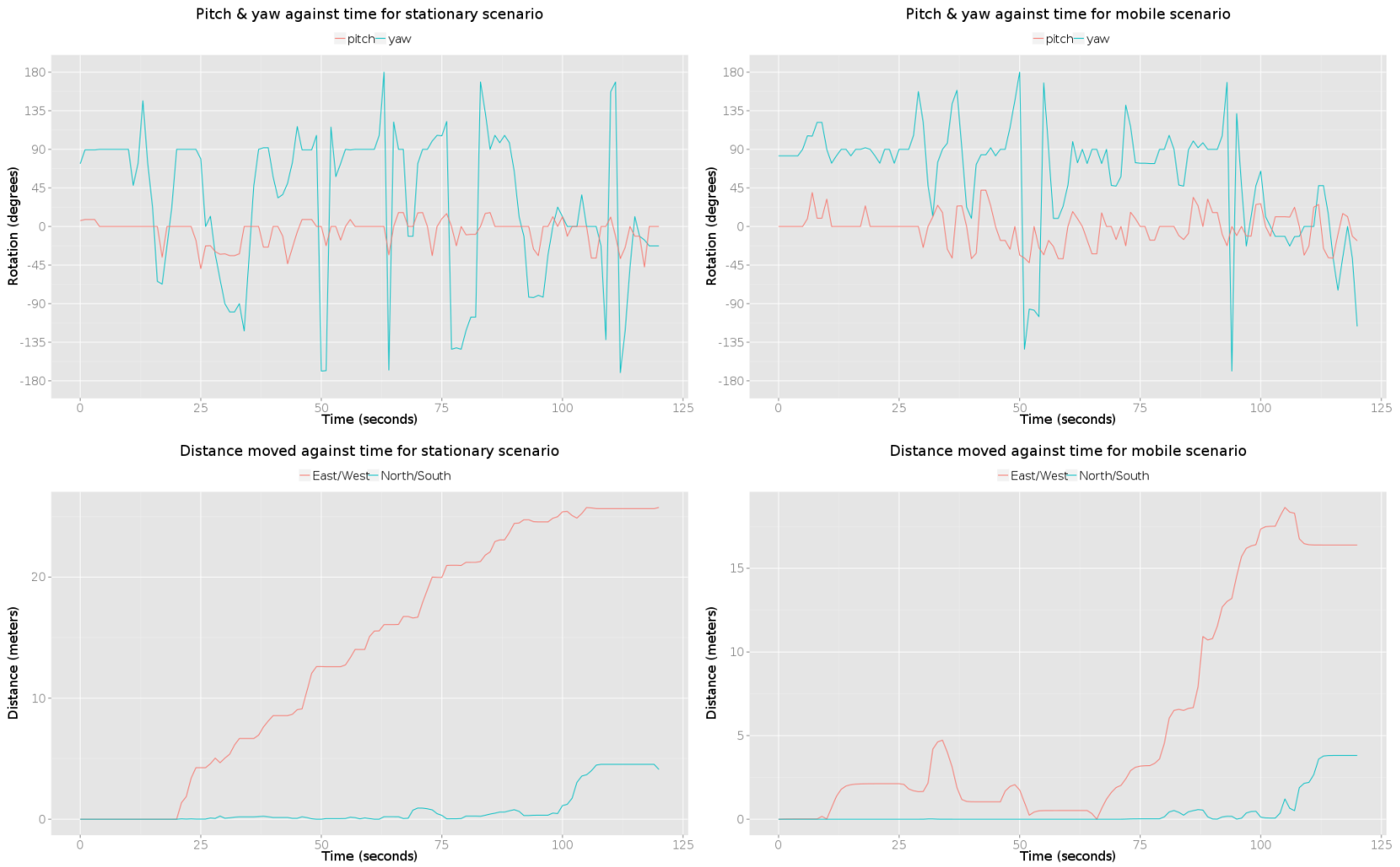

Figure 1.4: Participant 1

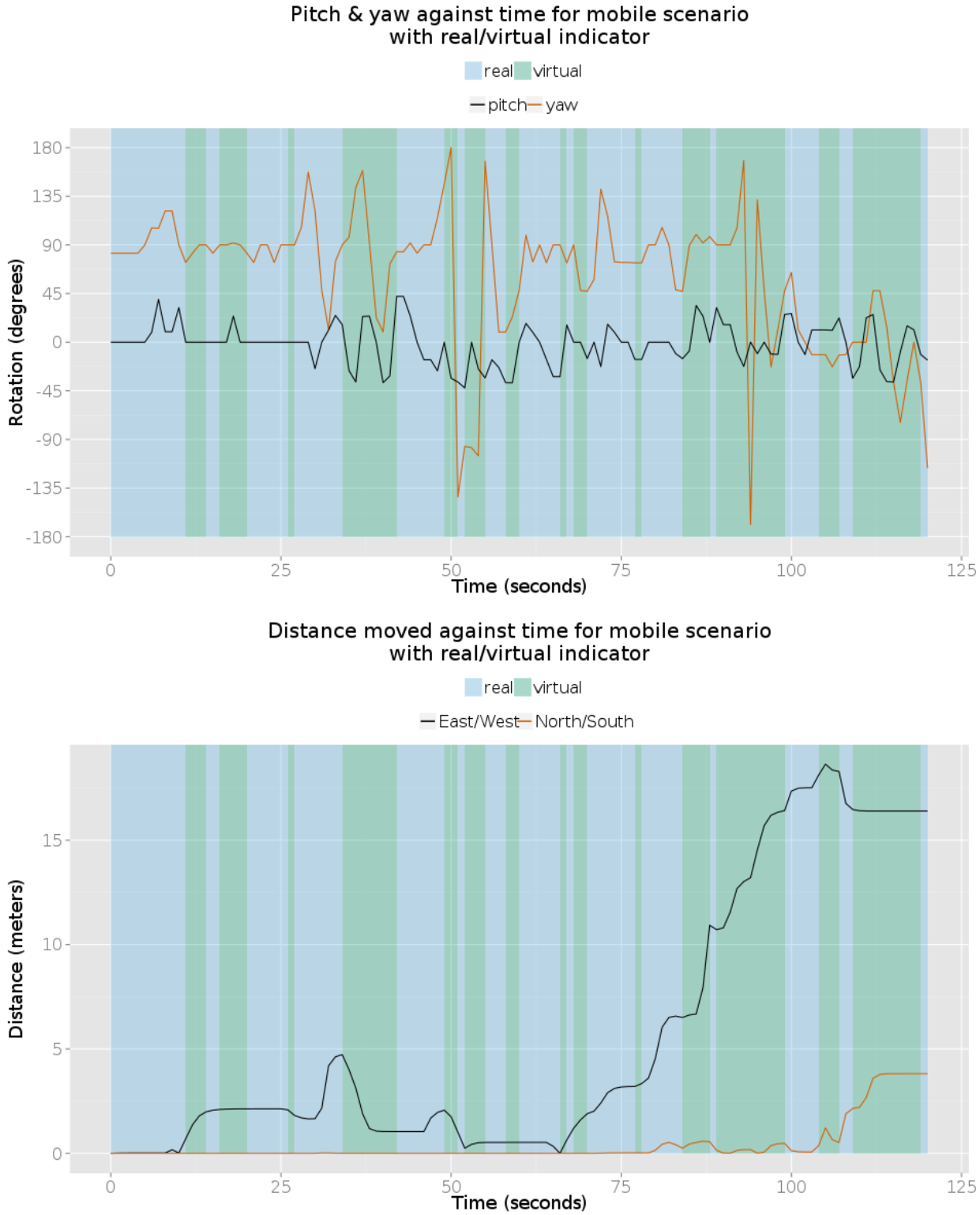

Figure 1.5: Participant 1

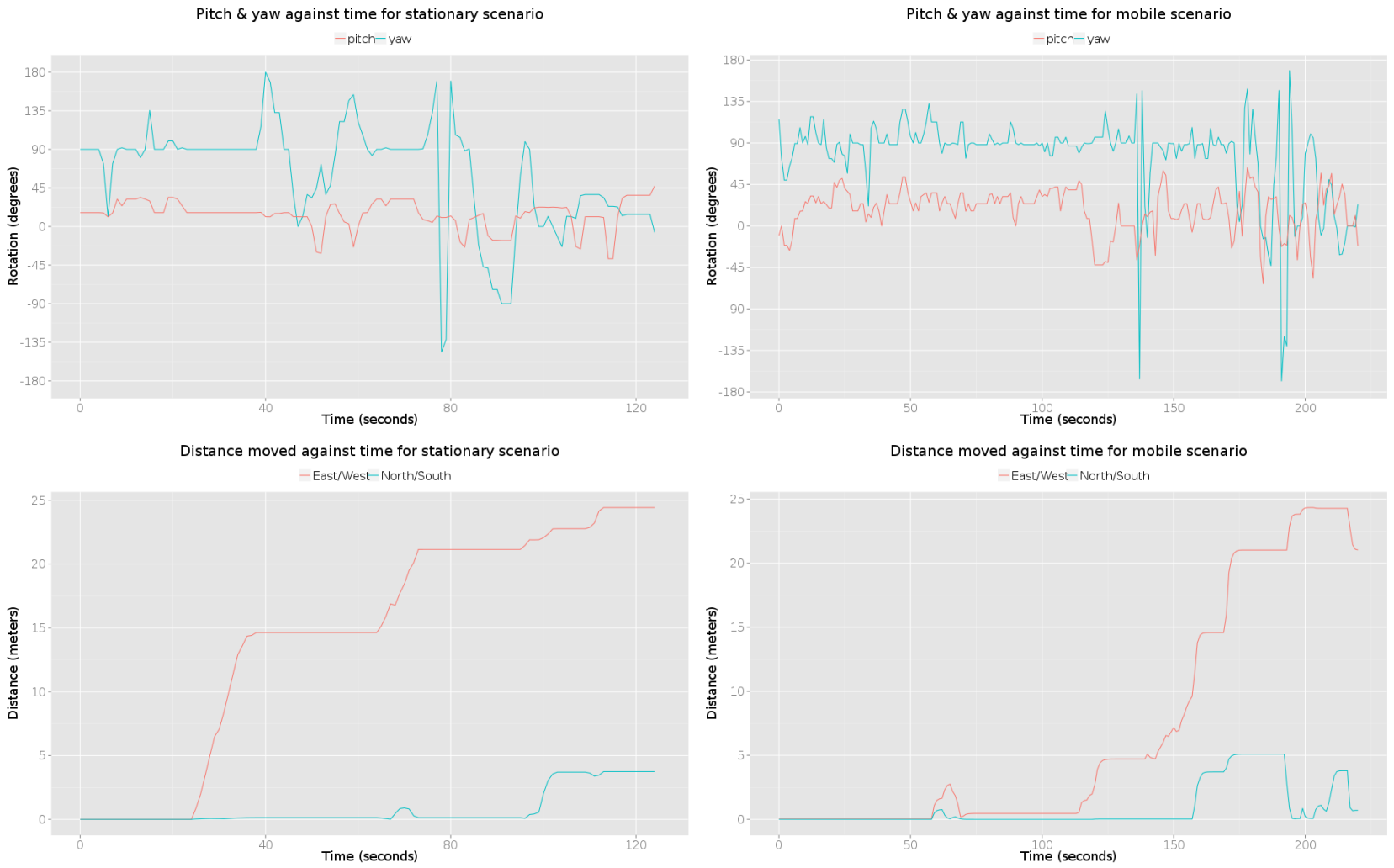

Figure 1.6: Participant 2

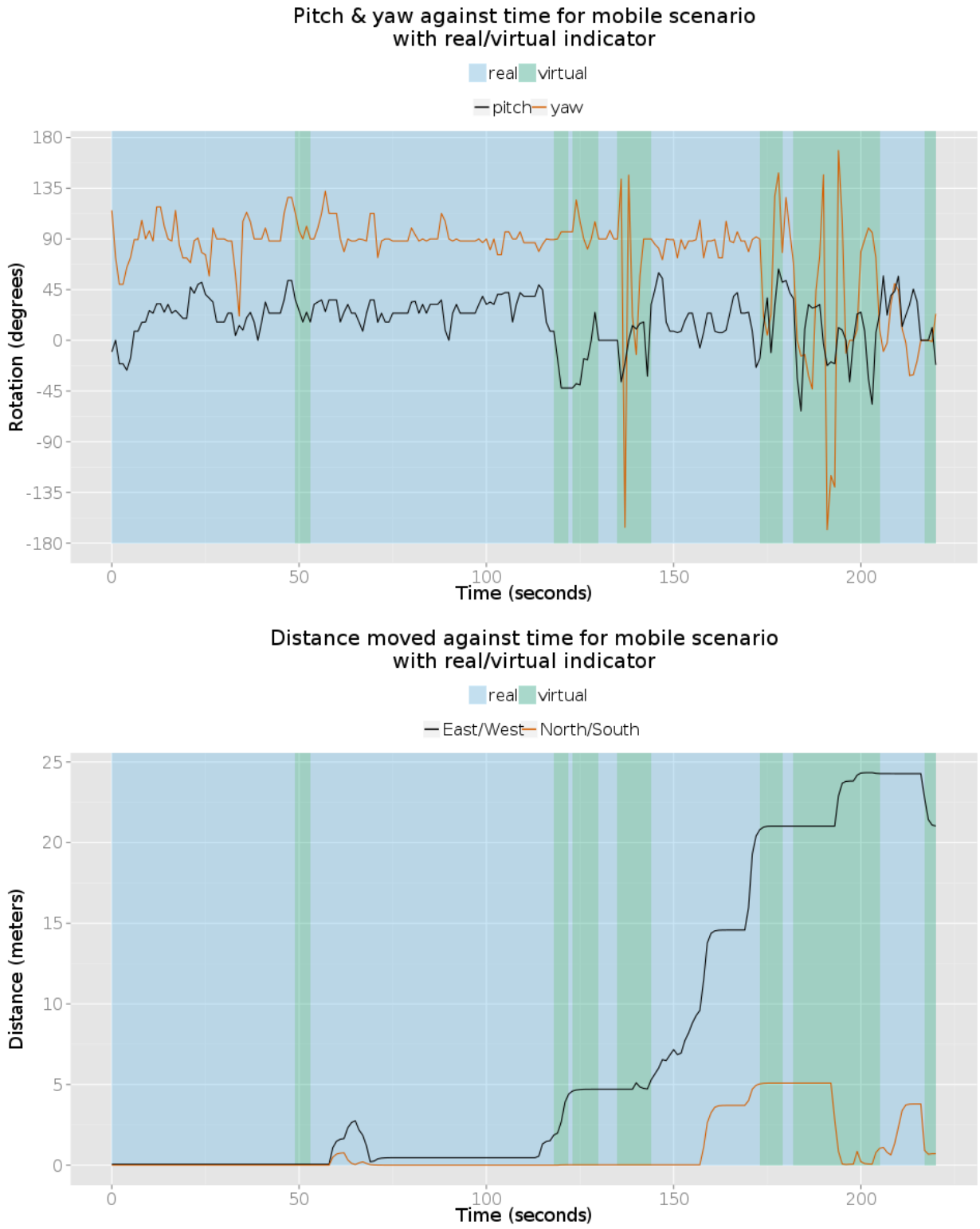

Figure 1.7: Participant 2

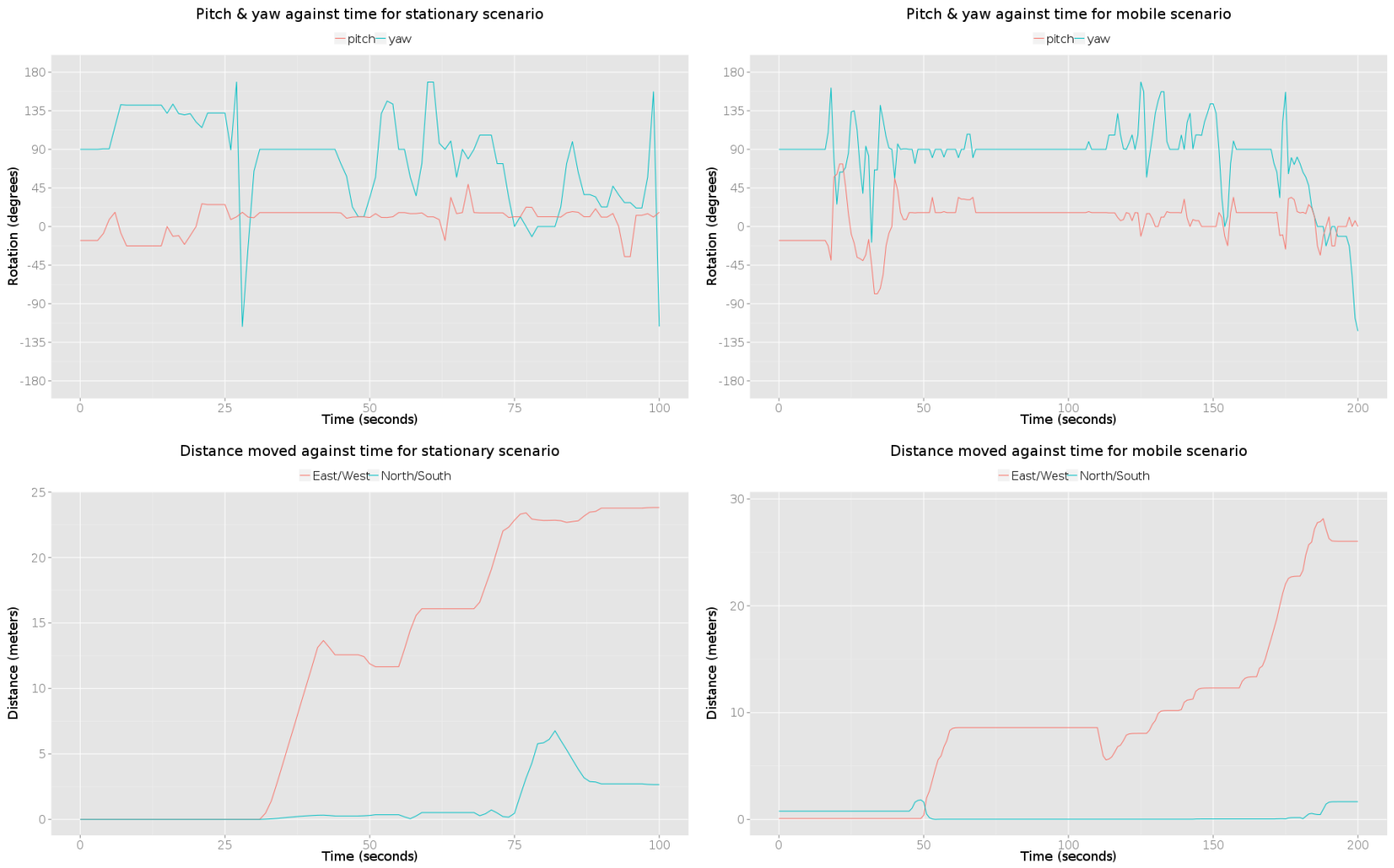

Figure 1.8: Participant 3

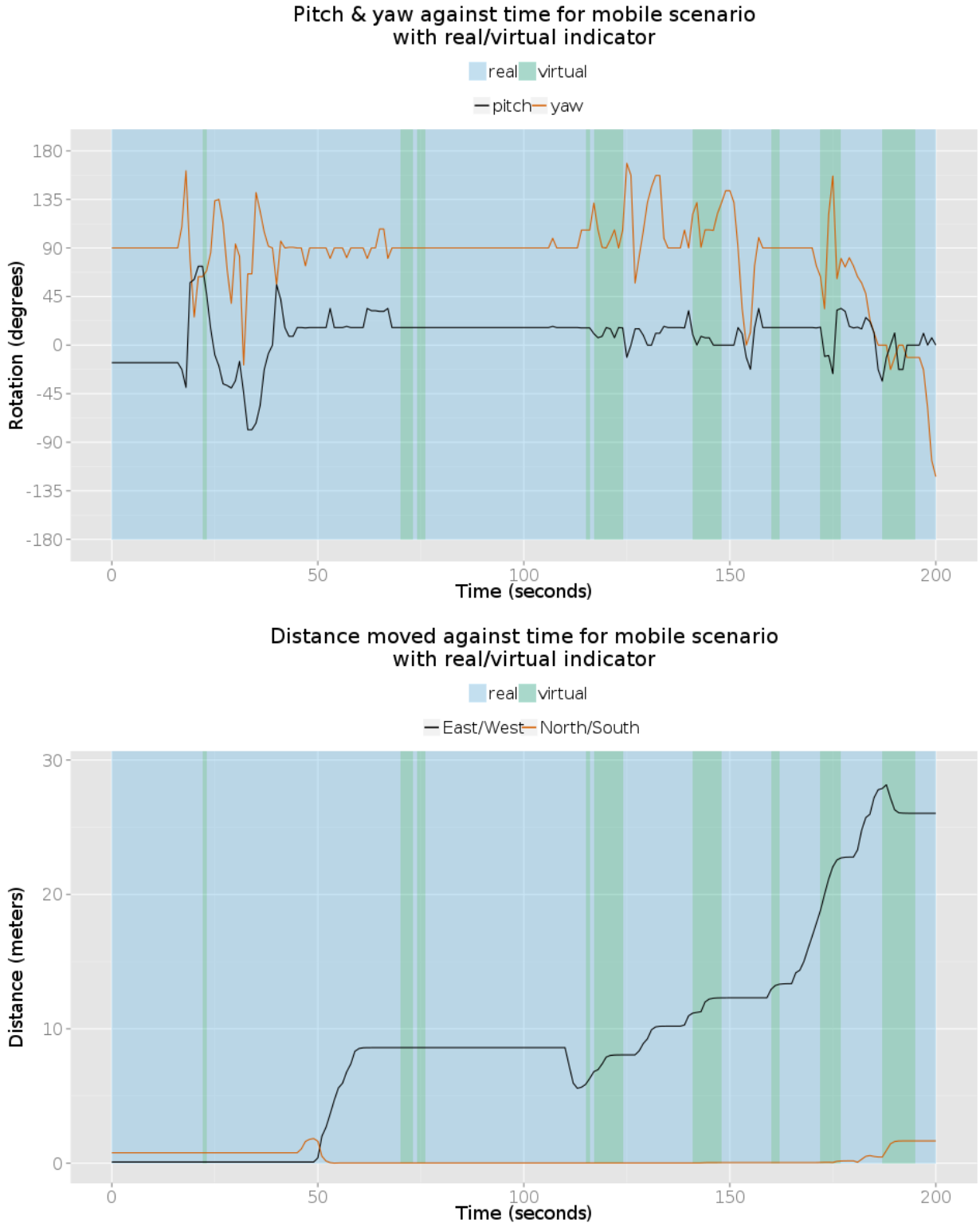

Figure 1.9: Participant 3

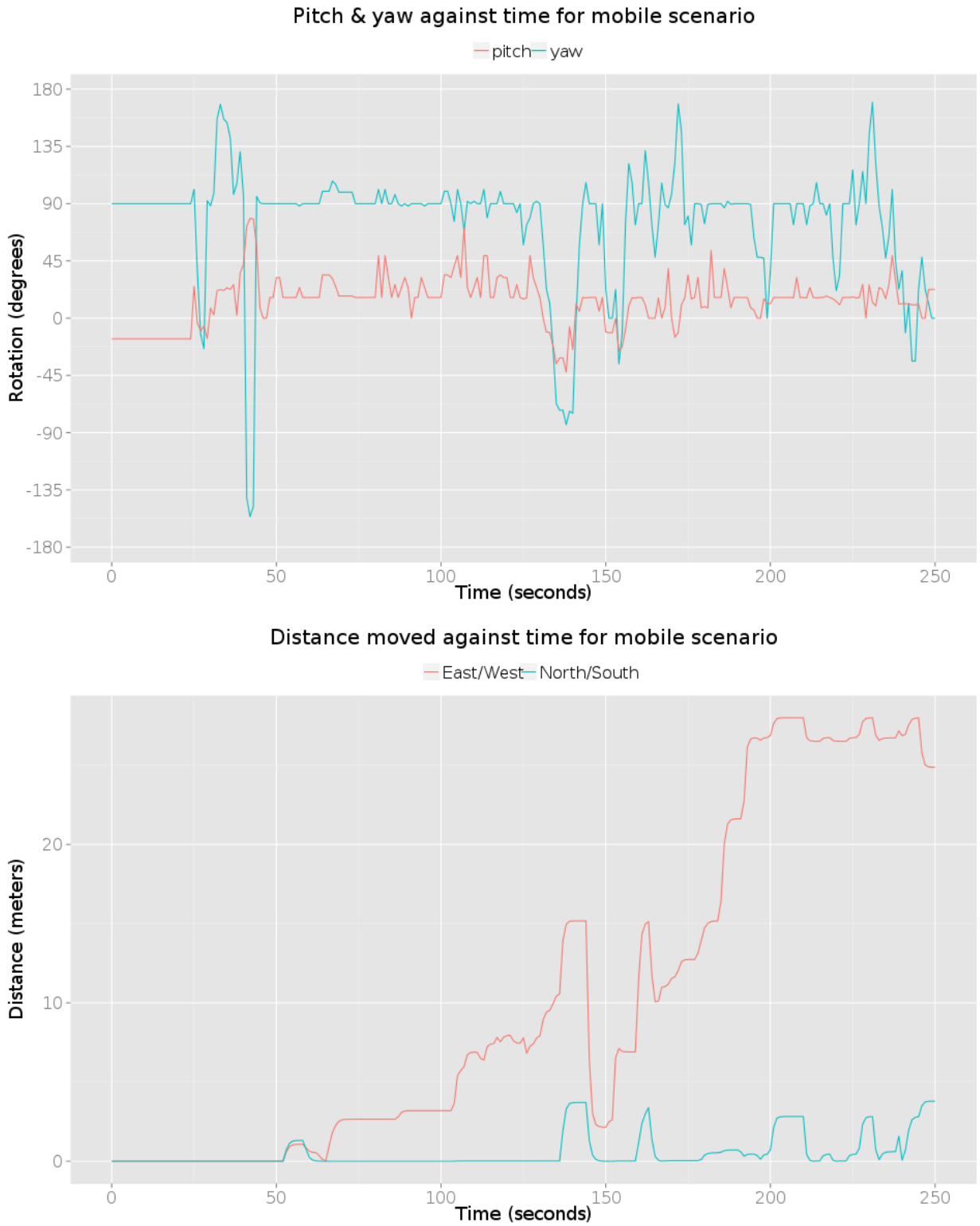

Figure 1.10: Participant 4

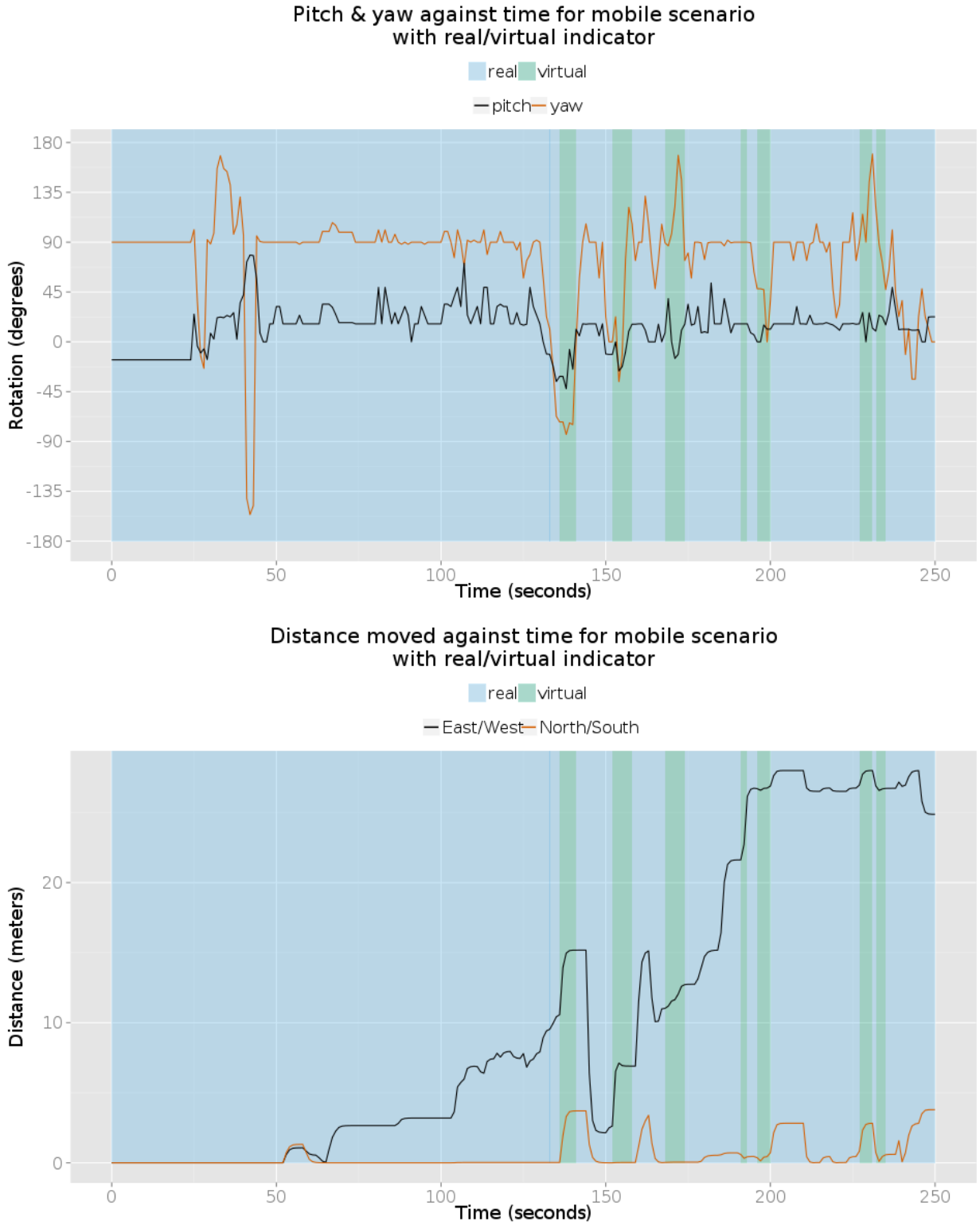

Figure 1.11: Participant 4

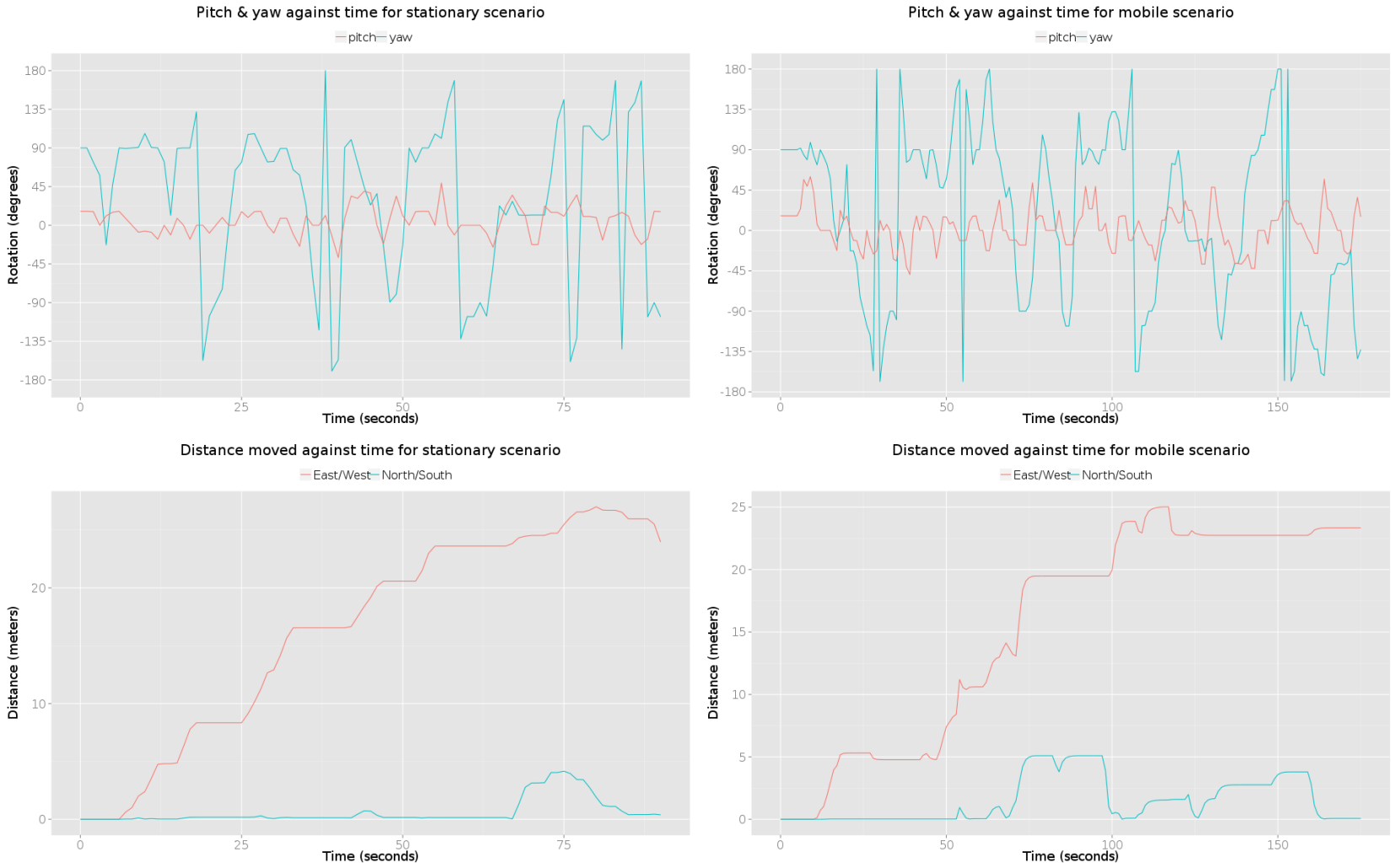

Figure 1.12: Participant 5

1.4.5 Interviews

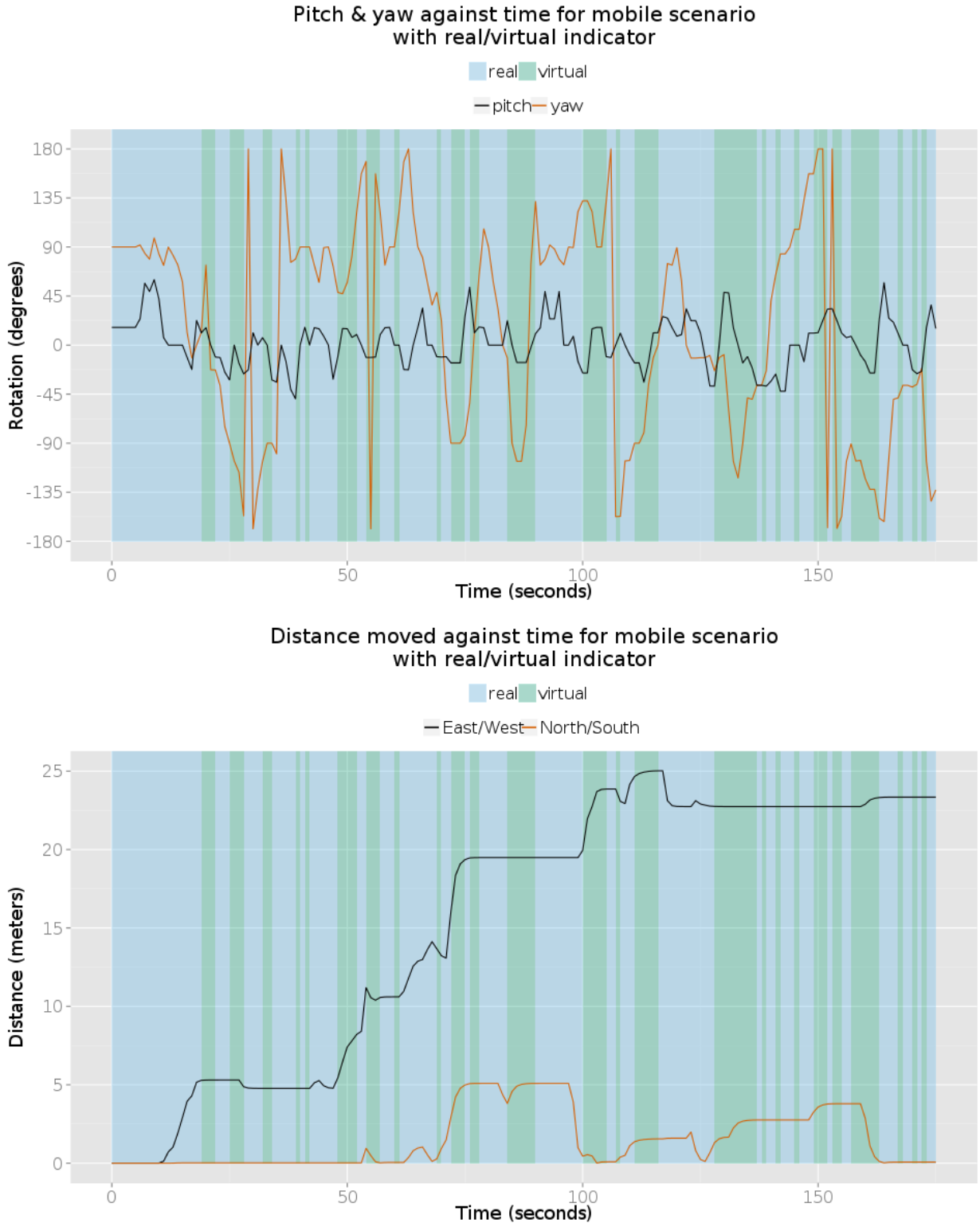

Figure 1.13: Participant 5

Bibliography

[1] Maria Roussou. Virtual Heritage : From the Research Lab to the Broad Public. In *VAST 2000 Euro-conference*, pages 93–100. BAR International Series 1075, Oxford, Archaeopress, 2002.

[2] John Brooke. SUS-A quick and dirty usability scale. *Usability evaluation in industry*, 189:194, 1996.

A Pre Task Questionnaire

03

University of St Andrews

Pre Task Questionnaire

What is your age? *(leave blank if you prefer not to disclose)*	_____	
How do you identify your gender? *(leave blank if you prefer not to disclose)*	_____	
Do you have previous experience using a games console controller? *(circle applicable answer)*	Yes	No
Do you have previous experience using a Head Mounted Display (HMD)? *(circle applicable answer)*	Yes	No
Have you previously visited St Salvator's chapel? *(circle applicable answer)*	Yes	No
Have you previously interacted with the virtual reconstruction of St Salvator's chapel? *(circle applicable answer)*	Yes	No

Researcher's use only

Date	
Time	

B Post Task Questionnaire (SUS)

06

University of St Andrews

Post Task Questionnaire

Please tick one box for each question

	Strongly disagree				Strongly agree
I think that I would like to use this system frequently	1	2	3	4	5
I found the system unnecessarily complex	1	2	3	4	5
I thought the system was easy to use	1	2	3	4	5
I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
I found the various functions in this system were well integrated	1	2	3	4	5
I thought there was too much inconsistency in this system	1	2	3	4	5
I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
I found the system very cumbersome to use	1	2	3	4	5
I felt very confident using the system	1	2	3	4	5
I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Researcher's use only

Date	
Time	

C Post Task Questionnaire (Own)

06b

University of St Andrews

Post Task Questionnaire

Please tick one box for each question

	Strongly disagree				Strongly agree
I found the exploration an enjoyable experience	1	2	3	4	5
It was easy to compare features from the past & the present	1	2	3	4	5
I felt motion sickness/dizziness	1	2	3	4	5
In the virtual environment, I had a sense of being there	1	2	3	4	5
I was aware of both real & virtual environments	1	2	3	4	5
It was rewarding to explore the chapel in this way	1	2	3	4	5
It felt as though I was in the past	1	2	3	4	5
I think I would have preferred a conventional computer monitor	1	2	3	4	5
This experience changed my understanding of the chapel	1	2	3	4	5
I did not notice differences between the real & virtual environments	1	2	3	4	5
The visual quality of the headset was bad	1	2	3	4	5
I feel I now better understand what the chapel was like in the past	1	2	3	4	5

D Structured Interview Questions

09

Structured Interview

Encourage interviewees to elaborate on their answers to all questions (for example the response to question 1 should be more than just 'Scenario A' or 'Scenario B', question 4 should not be just 'yes' or 'no').

1. Which scenario did you prefer?
2. Which scenario did you find more engaging &/or rewarding?
3. Which scenario did you find made it easier to spot differences between the real environment & the virtual environment?
4. Did you notice any differences in scenario A that you did not notice in scenario B?
5. Did you notice any differences in scenario B that you did not notice in scenario A?
6. Did you experience any motion sickness/simulator sickness/dizziness whilst using the HMD? If so, was it better or worse in one scenario compared to the other?
7. Any further comments?