Supplementary Material (Calculations of Gesture Complexity) for "iFAD Gestures: Understanding Users' Gesture Input Performance with Index-Finger Augmentation Devices"

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In this supplementary material, we provide detailed information for [3] about the calculation of the complexity of the 40 iFAD gestures used in our experiment. Drawing from the information presented in Xia *et al.*'s [5, p. 37:17] survey on designing gesture vocabularies, we compute the complexity of a gesture as an integer score by starting from 0 and adding +1 for (i) each finger, other than the index, or body part required to perform the gesture, (ii) the number of segments of the gesture, and (iii) the number of "unusual" constituents[1] of the gesture, respectively. These three criteria were presented in Xia *et al.*'s [5, p. 37:17] discussion of gesture complexity and have been used in the scientific literature for the purpose of describing, calculating, or estimating gesture complexity, and we combine them into one numerical score.

The number of segments of a gesture is determined according to the iFAD gesture category, as follows:

- For the finger-level ❶ and hand-level ❷ gestures from our set, the number of segments can be either 1 (for atomic movements, e.g., "pull") or 2 (for the gestures that involve a repetition, e.g., "pull twice").
- For the arm-level ❸ gestures that represent symbolic stroke gestures performed in mid-air, the number of segments is given by Isokoski's [1] geometric complexity defined as the minimum number of straight lines necessary to represent the shape of the gesture so that it would be recognizable by a human observer. For example, 4 is the minimum number of straight lines to represent letter "M," one straight line is need for "swipe left," and 6 straight lines for "heart." These values are in line with those reported by prior work [4, p. 215:3] for similar gesture types.
- For body-level ❹ gestures, which are ballistic directed movements of the hand, we calculate the number of segments in terms of regions of McNeill's [2] "gesture space" traversed by the hand: *center*, *periphery*, and *extraperiphery*. For example, to perform the "left ear" gesture, the hand traverses the *center* and *periphery* regions, resulting in two segments for this gesture.

We also counted +1 for each of the following "unusual" constituents[1] of a gesture: the hand adopts a specific hand pose, other than fist or open shape (following recommendations from [2, p. 385]), synchronization is needed between hand pose and movement, and the hand needs to move at the back of the body, respectively. Table 1 presents detailed calculations for each gesture from our set.

Important note: The complexity of a gesture is a difficult measure to define and evaluate and, as Xia *et al.*'s [5] survey revealed, different researchers have proposed and employed different methods in the scientific literature, without an established consensus. In this context, we calculate and report the complexity

[1]Term used by Xia *et al.* [5].

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Table 1. Gesture complexity calculation details.

Gesture name	Complexity	Calculation details
1 finger-level iFAD gestures		
1. Tap	2	+1 (one finger taps the iFAD) +1 (one segment)
2. Double tap	3	+1 (one finger taps the iFAD) +2 (two segments: tap is performed twice)
3. Back tap	2	+1 (one finger taps the iFAD) +1 (one segment)
4. Double back tap	3	+1 (one finger taps the iFAD) +2 (two segments: tap is performed twice)
5. Twist left	4	+3 (two fingers grasp the iFAD, wrist) +1 (one segment)
6. Twist right	4	+3 (two fingers grasp the iFAD, wrist) +1 (one segment)
7. Twist left-right	5	+3 (two fingers grasp the iFAD, wrist) +2 (two segments: left and right)
8. Twist right-left	5	+3 (two fingers grasp the iFAD, wrist) +2 (two segments: right and left)
9. Pull	3	+2 (two fingers grasp the iFAD) +1 (one segment)
10. Pull twice	4	+2 (two fingers grasp the iFAD) +2 (two segments: the iFAD is pulled twice)
2 hand-level iFAD gestures		
11. Fist	1	+1 (one segment)
12. Vertical palm	1	+1 (one segment)
13. Horizontal palm	1	+1 (one segment)
14. Lateral palm	1	+1 (one segment)
15. Pinch	3	+1 (thumb) +1 (pinch pose) +1 (one segment)
16. Pinch twice	4	+1 (thumb) +1 (pinch pose) +2 (two segments: pinch is performed twice)
17. Shake	2	+1 (wrist) +1 (one segment)
18. Shake twice	3	+1 (wrist) +2 (two segments: shake is performed twice)
19. Knob rotate left	5	+3 (thumb, middle finger, wrist) +1 (grasp pose) +1 (one segment)
20. Knob rotate right	5	+3 (thumb, middle finger, wrist) +1 (grasp pose) +1 (one segment)
3 arm-level iFAD gesture		
21. Circle	5	+5 (at least five straight lines to be minimally different from triangle and square)
22. Square	4	+4 (four straight lines)
23. Heart	6	+6 (at least six straight lines, similar calculation as in [4, p. 215:3])
24. Letter “X”	2	+2 (two straight lines)
25. Letter “M”	4	+4 (four straight lines)
26. Letter “S”	3	+3 (at least three straight lines, similar calculation as in [1, p. 360])
27. Check	2	+2 (two straight lines)
28. Question mark	3	+3 (at least three straight lines)
29. Swipe left	1	+1 (one straight line)
30. Swipe right	1	+1 (one straight line)
4 body-level iFAD gestures		
31. Left ear	3	+1 (arm) +2 (center and periphery)
32. Right ear	3	+1 (arm) +2 (center and periphery)
33. Mouth	3	+1 (arm) +2 (center and periphery)
34. Elbow	2	+1 (arm) +1 (center)
35. Back neck	4	+1 (arm) +2 (center and periphery) +1 (hand movement at the back of the body)
36. Trousers front pocket	3	+1 (arm) +2 (center and periphery)
37. Trousers back pocket	4	+1 (arm) +2 (center and periphery) +1 (hand movement at the back of the body)
38. Shirt pocket left	2	+1 (arm) +1 (center)
39. Shirt pocket right	2	+1 (arm) +1 (center)
40. Join hands	4	+2 (both arms) +1 (center) +1 (synchronization required)

score of a gesture as an informative measure with the sole purpose to describe the diversity of the iFAD gesture types that we selected from the iFAD gesture taxonomy for our evaluation experiment.

ACKNOWLEDGMENTS

This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI-UEFISCDI, project number PN-III-P4-ID-PCE-2020-0434 (PCE29/2021), within PNCDI III.

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