Data underlying the project: TECHNOLOGY IN MOTION – AUGMENTED REALITY FOR UPPER EXTREMITY ASSESSMENT (TIM-AR-UE)

Paulina J.M. Bank, Marina A. Cidota, P.W. (Elma) Ouwehand, Stephan G. Lukosch

Related publication:

Bank PJM, Cidota MA, Ouwehand PW, Lukosch SG. Patient-tailored augmented reality games for assessing upper extremity motor impairments in Parkinson's disease and stroke. *J Med Systems.* doi: 10.1007/s10916-018-1100-9.

Funding sources:

This dataset was created as part of a larger study on developing patient-friendly techniques for objective quantification of motor (dys)function in patients with neurological disorders. This work was supported by the Netherlands Organisation for Scientific Research (NWO) [Technology in Motion research programme, project 628.004.001]. The funding party played no role in the study design, in the collection, analysis and interpretation of data, or in the decision to submit the dataset or related manuscripts for publication.

Data collectors, location and time period:

Paulina JM Bank, Marina A Cidota, PW (Elma) Ouwehand.
All data was collected in the Leiden University Medical Center, between 12 June 2017 and 14 September 2017.

Project description:

Data was collected within the Technology in Motion project (protocol registered by CCMO as NL54281.058.15), aimed at developing innovative techniques to characterize motor function in patients with neurological disorders. Augmented reality (AR) systems with contactless tracking of the hand and upper body offer opportunities for objective quantification of motor (dys)function in a challenging, engaging and patient-tailored environment. We therefore explored the potential of AR for evaluating *1)* speed and goal-directedness of movements within the individually determined interaction space; *2)* adaptation of hand opening to objects of different sizes; and *3)* obstacle avoidance in healthy individuals (*N*=10) and two highly prevalent neurological conditions (*N*=10 patients with Parkinson's Disease [PD] and *N*=10 stroke patients). This dataset contains data from 10 PD patients, 10 stroke patients and 10 age- and sex-matched controls. For each participant we provide the raw data (recorded during reachable workspace assessment and during the 3 AR games), consisting of *i)* LeapMotion data 3D-coordinates of hand 'joints' (e.g., hand palm and finger tips) at a sampling rate of 60 frames per second (obtained by means of Leap Motion sensor and Leap Motion Orion Beta software development kit [SDK]); *ii)* 3D-coordinates of body points (e.g., wrist, elbow and shoulder) at a sampling rate of 30 frames per second (obtained by means of Kinect™ v2 sensor and Kinect for Windows SDK version 2.0); and *iii)* game-specific parameters (e.g. positions of virtual objects and timestamps of events). We additionally provide an SPSS file and a csv-file with general participant characteristics, disease-specific clinical characteristics, scores on user-experience questionnaires (individual items and total scores) and outcome

parameters calculated from the raw data for each of the AR games (e.g. time per object, movement speed, success rate).

Sample and sampling procedures:
We recruited 10 patients with PD fulfilling the UK PD Brain Bank criteria and 10 chronic stroke patients (> 12 weeks post stroke) with reduced function of the upper extremity as determined by the Fugl-Meyer Upper Extremity Scale. Patients were recruited from the outpatient clinics of the Department of Neurology and the Department of Rehabilitation Medicine of the Leiden University Medical Center and from a list of patients who were discharged from the Rijnlands Rehabilitation Center between January 2013 and June 2014. Patients were excluded if they had disorders of the central nervous system or other conditions that could affect motor function of the upper extremity supplementary to PD or stroke. All patients were allowed to take their routine medications at the time of the experiment. Ten healthy controls, who were sex-matched and age-matched (±3 years) at group level to the patients, were recruited through advertisements and from a database of volunteers who had participated in previous studies. Controls had normal or corrected to normal vision and hearing and had no history of disorders affecting the function of the upper extremities.

Data description:
This dataset contains data from 10 PD patients, 10 stroke patients and 10 age- and sex-matched controls. We provide for each participant the raw data (recorded during reachable workspace assessment and during the three AR games that are described in the related publication) as well as an SPSS-file and a csv-file (delimiter: semicolon) with general participant characteristics, disease-specific clinical characteristics, scores on user-experience questionnaires (individual items and total scores) and outcome parameters calculated from the raw data for each of the AR games (e.g. time per object, movement speed, success rate).

For each participant, raw data is stored in a directory following the naming convention P0xx, S0xx or C0xx for PD patients, stroke patients and controls, respectively, with xx being the assigned patient number. This directory contains 4 subfolders:

- “G0 RWA”: Game 0, Reachable workspace assessment
- “G1 B”: Game 1, Balloons
- “G2 MC”: Game 2, Melody Cubes
- “G3 HS”: Game 3, Hungry Squirrel

Each folder contains tab-separated files with 3D position data of body (kinect-body.tab; all games G0-G3) and/or hand (leapmotionorion-hand.tab; AR games G1-G3) and relevant game parameters. Column headers are included in each file (first row) and are described in following sections.

Common fields in Kinect-body.tab and leapmotionorion-hand.tab

Each data row has the data of a single skeleton (body or hand) at a certain Unity frame.

Four fields are common to both kinect-body.tab and leapmotionorion-hand.tab:

RelativeFrameNumber and **RelativeSkeletonNumber.** Both numbers start counting from zero when the application starts writing the data. The RelativeSkeletonNumber is relative to the frame, so it starts from zero with each new frame.

FrameCount is directly from Unity: http://docs.unity3d.com/ScriptReference/Time-frameCount.html It is usually a fixed offset larger than the RelativeFrameNumber, throughout the entire TAB file.

TimeStamp is the number of milliseconds, calculated from January 1st, 1970.

Kinect-body tab file specification

Contains 3D-coordinates of body points (e.g., wrist, elbow and shoulder) at a sampling rate of circa 30 frames per second (obtained by means of Kinect™ v2 sensor and Kinect for Windows SDK version 2.0). A Kinect body tab file consists of 216 columns, as follows:

RelativeFrameNumber	*Common field*	int (0...N)
RelativeSkeletonNumber	*Common field*	int (0...N)
RelativeTime	*From BodyFrame.RelativeTime* Timestamp of the frame	Time (in milliseconds)
FloorClipPlane0	*From BodyFrame.FloorClipPlane (x)*[#]	float
FloorClipPlane1	*From BodyFrame.FloorClipPlane (y)*[#]	float
FloorClipPlane2	*From BodyFrame.FloorClipPlane (z)*[#]	float
FloorClipPlane3	*From BodyFrame.FloorClipPlane (w)*[#]	float
FrameCount	*Common field*	int
TimeStamp	*Common field*	int
TrackingId	*From Kinect.Body* *	int
LeftHand_State	*From Kinect.Body.HandLeftState* *	int (HandState)
LeftHand_Confidence	*From Kinect.Body.HandLeftConfidence* *	int (TrackingConfidence)
RightHand_State	*From Kinect.Body.HandRightState* *	int (HandState)
RightHand_Confidence	*From Kinect.Body.HandRightConfidence* *	int
IsRestricted	*From Kinect.Body* *	bool
IsTracked	*From Kinect.Body* *	bool
Joint0_Position0	*From Kinect.Joint.Position (x)*[§]	float
Joint0_Position1	*From Kinect.Joint.Position (y)*[§]	float
Joint0_Position2	*From Kinect.Joint.Position (z)*[§]	float
Joint0_Orientation0	*From Kinect.JointOrientation (x)*[§]	float
Joint0_Orientation1	*From Kinect.JointOrientation (y)*[§]	float
Joint0_Orientation2	*From Kinect.JointOrientation (z)*[§]	float
Joint0_Orientation3	*From Kinect.JointOrientation (w)*[§]	float

Joint0_TrackingState	*From Kinect.Joint.TrackingState*	int (TrackingState)
…	…	…
Joint24_Position0	…	…
Joint24_Position1	…	…
Joint24_Position2	…	…
Joint24_Orientation0	…	…
Joint24_Orientation1	…	…
Joint24_Orientation2	…	…
Joint24_Orientation3	…	…
Joint24_TrackingState	…	…

[#] Find details at https://msdn.microsoft.com/en-us/library/windowspreview.kinect.bodyframe.floorclipplane.aspx FloorClipPlane0, FloorClipPlane1, FloorClipPlane2, and FloorClipPlane3 are the (x, y, z, w) of BodyFrame.FloorClipPlane: the floor clip plane of the body frame in hessian normal form. The (x,y,z) components are a unit vector indicating the normal of the plane, and w is the distance from the plane to the origin in meters. Used to convert joint coordinates from Kinect-based coordinate framework to real-world based coordinate framework.

* find details at https://msdn.microsoft.com/en-us/library/microsoft.kinect.body.aspx

[§] find details at https://msdn.microsoft.com/en-us/library/microsoft.kinect.joint_members.aspx

The joints are numbered as follows: 0 = SpineBase; 1 = SpineMid; 2 = Neck; 3 = Head; 4 = ShoulderLeft; 5 = ElbowLeft; 6 = WristLeft; 7 = HandLeft; 8 = ShoulderRight; 9 = ElbowRight; 10 = WristRight; 11 = HandRight; 12 = HipLeft; 13 = KneeLeft; 14 = AnkleLeft; 15 = FootLeft; 16 = HipRight; 17 = KneeRight; 18 = AnkleRight; 19 = FootRight; 20 = SpineShoulder; 21 = HandTipLeft; 22 = ThumbLeft; 23 = HandTipLeft; 24 = HandTipRight; 24 = ThumbRight.

HandState: 0 = unknown, 1= not tracked, 2 = hand open, 3= hand closed, 4 = hand in lasso state.
TrackingConfidence: 1 = high, fully tracked; 0 = low, not tracked.
TrackingState: 0 = not tracked, no data; 1 = inferred, confidence in position data is very low; 2 = tracked, data can be trusted.

Leapmotionorion-hand tab file specification

Contains 3D-coordinates of hand 'joints' (e.g., hand palm and finger tips) at a sampling rate of circa 60 frames per second (obtained by means of Leap Motion sensor and Leap Motion Orion Beta SDK – for details see https://developer-archive.leapmotion.com/documentation/csharp/devguide/Leap_Overview.html).

A Leapmotionorion-hand tab file consists of 164 columns, as follows:

RelativeFrameNumber	*Common field*	int (0...N)
RelativeSkeletonNumber	*Common field*	int (0…N)
FrameId	*From Leap.Frame.Id* A unique ID for this frame. Consecutive frames processed by the Leap Motion software have consecutive increasing values	
FrameCount	*Common field*	int
TimeStamp	*Common field*	int
Id	*From Leap.Hand* … A unique ID assigned to this hand object, whose value remains the same across consecutive frames while the tracked hand remains visible	int
Confidence	*From Leap.Hand* … Confidence about estimated hand pose	float (0,1]
BodySide	*From Leap.Hand*	char (L, R, ?)
WristPositionX	*From Leap.Hand* … The position of the wrist of this hand	float (in m)
WristPositionY	…	float (in m)
WristPositionZ	…	float (in m)
HandDirectionX	The direction from the palm position toward the fingers	float
HandDirectionY	…	float
HandDirectionZ	…	float
PalmNormalX	The normal vector to the palm	float
PalmNormalY	…	float
PalmNormalZ	…	float
PalmPositionX	The center position of the palm in meters from the Leap Motion Controller origin	float (in m)
PalmPositionY	…	float
PalmPositionZ	…	float
PalmRotationX	The rotation of the palm - *ConvertToVector4Rotation from \Assets\LeapMotion\Scripts\Utils\LeapUnityExte*	float

	nsions.cs from Unity package for LeapMotionOrion	
PalmRotationY	…	float
PalmRotationZ	…	float
PalmRotationW	…	float
Joint0_BoneBasisX	The orientation of the corresponding Bone.Basis	float
Joint0_BoneBasisY	…	float
Joint0_BoneBasisZ	…	float
Joint0_BoneBasisW	…	float
Joint0_JointPositionX	The position (in m) of each joint	float
Joint0_JointPositionY	…	float
Joint0_JointPositionZ	…	float
…	…	float
Joint19_BoneBasisX	…	float
Joint19_BoneBasisY	…	float
Joint19_BoneBasisZ	…	float
Joint19_BoneBasisW	…	float
Joint19_JointPositionX	…	float
Joint19_JointPositionY	…	float
Joint19_JointPositionZ	…	float

The joints are numbered as follows: 0 = ThumbBase; 1 = ThumbJoint1; 2 = ThumbJoint2; 3 = ThumbTip; 4 = IndexBase; 5 = IndexJoint1; 6 = IndexJoint2; 7 = IndexTip; 8 = MiddleBase; 9 = MiddleJoint1; 10 = MiddleJoint2; 11 = MiddleTip; 12 = RingBase; 13 = RingJoint1; 14 = RingJoint2; 15 = RingTip; 16 = PinkyBase; 17 = PinkyJoint1; 18 = PinkyJoint2; 19 = PinkyTip.

Game-specific files

Game 1: configValidDirections.tab

Contains general game parameters and results from the first part of Game 1, in which interaction space was determined from the furthest points of intersection between the index finger and a virtual line from the participant's estimated shoulder position towards a faraway balloon (positioned at the ipsilateral/contralateral side of the body and above/below the shoulder). Positions of virtual objects in the other games were based on this individually determined interaction space.

Row 1: armLength – float (in m) as measured with the ruler

Row 2: whichHand (bool) TRUE (right); FALSE (left)

Row 3: estimated shoulder position

Rows 4-7:

Rotation angle X	Rotation angle (in degrees) around the estimated shoulder position (-25 for upper corners, +15 for lower corners)	int
Rotation angle Y	Rotation angle (in degrees) around the estimated shoulder position (±25 for contralateral corners, ±40 for ipsilateral corners; negative values for the left side, positive values for the right side)	int
Rotation angle Z	0	int
max distance between (index_tip,shoulder)	Maximum reaching distance (in m); maximum distance between the visual feedback of the index finger tip and the shoulder in the indicated direction.	float (in m)
distance between (index_tip, LeapMotion)	Distance between tip of the index finger and the LeapMotion sensor corresponding to **max distance between(index_tip,shoulder)**	float (in m)

Game 1: Task1_info_balloons.tab

Contains game parameters from the second part of Game 1 (Balloons). This file consists of 13 rows (one header + one row for each of the 12 balloons) and 18 columns, as follows:

Balloon No	Balloon number	int
FrameCountWhenCreated	Frame count when balloon was created	int
TimeStampWhenCreated	Timestamp when balloon was created	int
FrameCountWhenFirstVisible	Frame count when balloon became first visible in head-mounted device (HMD)	int
TimeStampWhenFirstVisible	Timestamp when balloon became first visible in HMD	int
FrameCountWhenDestroyed	Frame count when balloon was destroyed	int
TimeStampWhenDestroyed	Timestamp when balloon was destroyed	int
Touched	TRUE or FALSE, indicates whether the balloon was successfully touched with the index finger tip	bool

BalloonWorldPosX	Position of the balloon	float (in m)
BalloonWorldPosY	…	float (in m)
BalloonWorldPosZ	…	float (in m)
IndexTipWhenFirstVisibleLocalPosX	Position of index finger tip at the moment that balloon and fingertip were both visible in HMD	float (in m)
IndexTipWhenFirstVisibleLocalPosY	…	float (in m)
IndexTipWhenFirstVisibleLocalPosZ	…	float (in m)
IndexTipWhenDestroyedLocalPosX	Position of index finger tip at the moment that balloon was destroyed (i.e., upon touch in successful trials)	float (in m)
IndexTipWhenDestroyedLocalPosY	…	float (in m)
IndexTipWhenDestroyedLocalPosZ	…	float (in m)
ScaleDistanceBalloon 0.7-1.1	Scaling factor (random value between 0.7 and 1.1) that determined the depth position of the balloon based on the measured interaction space	float

Game 2: Task2_info_cubes.tab

This file consists of 13 rows (one header + one for each of the 12 cubes) and 7 columns, as follows:

CubeNo	Cube number	int
CubeId	Cube size (0 = 10 cm red cube, 1 = 7.5 cm blue cube, 2 = 5 cm green cube)	int (0, 1, 2)
FrameCountWhenFirstGrasped	Frame count when cube was first grasped	int
TimeStampWhenFirstGrasped	Timestamp when cube was first grasped	int
FrameCountWhenDestroyed	Frame count when cube was destroyed	int
TimeStampWhenDestroyed	Timestamp when cube was destroyed	int
Skipped	TRUE or FALSE, indicates whether cube was skipped	bool

Game 2: Task2_cubes_positions.tab

Contains positions of cube (i.e., its center), index finger tip and thumb tip, from the moment that a cube was grasped for the first time until its destruction. FrameCount can be used for synchronization with the kinect-body and leapmotionorion-hand data. This file consists of 10 columns, as follows:

FrameCount	*Common field*	int
CubePosX	Position of cube	float (in m)
CubePosY	…	float (in m)
CubePosZ	…	float (in m)
IndexTipLocalPosX	Position of index finger tip	float (in m)
IndexTipLocalPosY	…	float (in m)
IndexTipLocalPosZ	…	float (in m)
ThumbTipLocalPosX	Position of thumb tip	float (in m)
ThumbTipLocalPosY	…	float (in m)
ThumbTipLocalPosZ	…	float (in m)

Game 3: Task3_info_walnuts.tab

This file consists of 17 rows (one header + one for each of the 16 walnuts) and 9 columns, as follows:

WalnutNo	Walnut number	int
FrameCountWhenFirstGrasped	Frame count when walnut was first grasped	int
TimeStampWhenFirstGrasped	Timestamp when walnut was first grasped	int
FrameCountWhenDestroyed	Frame count when walnut was destroyed	int
TimeStampWhenDestroyed	Timestamp when walnut was destroyed	int
Skipped	TRUE or FALSE, indicates whether walnut was skipped	bool
TouchedObstacle	TRUE or FALSE, indicates whether obstacle was touched	bool
Case	Scenario 0 = no obstacle, 1 = visible obstacle, 2 = surprise obstacle	int (0,1,2)
UnexpectedObstacleVisible	TRUE or FALSE, only relevant for case 2 (surprise obstacle), indicating whether surprise obstacle did become visible as intended.	bool

Game 3: Task3_walnuts_positions.tab

Contains positions of walnut (i.e., its center), index finger tip and thumb tip, from moment that a walnut was grasped for the first time until its destruction. FrameCount can be used for synchronization with the kinect-body and leapmotionorion-hand data. This file consists of 10 columns, as follows:

FrameCount	*Common field*	int
WalnutPosX	Position of walnut	float (in m)
WalnutPosY	…	float (in m)
WalnutPosZ	…	float (in m)
IndexTipLocalPosX	Position of index finger tip	float (in m)
IndexTipLocalPosY	…	float (in m)
IndexTipLocalPosZ	…	float (in m)
ThumbTipLocalPosX	Position of thumb tip	float (in m)
ThumbTipLocalPosY	…	float (in m)
ThumbTipLocalPosZ	…	float (in m)

SPSS-file / csv-delimited file: TIM-AR-UE.sav / TIM-AR-UE.csv

Contains general participant characteristics, disease-specific clinical characteristics, scores on user-experience questionnaires (individual items and total scores) and outcome parameters calculated from the raw data for each of the AR games (e.g. time per object, movement speed, success rate). Column headers are included in each file (first row). Missing values are denoted by empty cells. For scenario SO (surprise obstacle) of Game 3, missing values in outcome measures are denoted by the values '999' or '0' (for movement speed, relative pathlength, and T_{walnut}). Variable descriptions and labels are included in the SPSS file. A brief overview of included variables is provided in the following table:

Name	Participant identifier
Group	Control (1), Parkinson's disease (PD, 2) or stroke (3)
Pnum	Participant number
Sex	Male (1) or female (2)
Age	Age in years
Disease_duration	Disease duration in years (since onset of first symptoms)
Hand_Dominant	Hand dominance, left (1), right (2) or no preference (3)
Hand_Measured	Measured hand: left (1) or right (2)
MOCA…	Montreal Cognitive Assessment, individual items
MOCA_Total	Total score on the Montreal Cognitive Assessment, reflecting cognitive function
Pain_Before	Pain (0-10, no-max) before experiment
Pain_During	Pain (0-10, no-max) during experiment
Taskload	Perceived task load (0-10, no-max) during experiment
AR_duration	Duration (in min) of Augmented reality part of experiment
CT_duration	Duration (in min) of Clinical Tests part of experiment
Total_duration	Total duration (in min) of experiment
Q_Gx_A…	NASA-TLX for each game separately (G1-G3); items 1-6 : strongly disagree (1), disagree (2), slightly disagree (3), neutral (4), slightly agree (5), agree (6), strongly agree (7)
Q_Gx_B…	Game Experience Questionnaire (GEQ)-subset for each game separately (G1-G3); items 1-14: strongly disagree (1), disagree (2), neutral (3), agree (4), strongly agree (5).
Q_C…	Presence questionnaire; items 1-21: strongly disagree (1), disagree (2), slightly disagree (3), neutral (4), slightly agree (5), agree (6), strongly agree (7)
Q_D…	System Usability Scale (SUS); items 1-10: strongly disagree (1), disagree (2), neutral (3), agree (4), strongly agree (5).
NASATLX…	NASA-TLX total score per game (average of all items, after inversion of Q3)
GEQ…	GEQ domain score per game: COmpentence (average of Q2 &

	Q9), Immersion (Q1 & Q4), Flow (Q5 & Q10), Challenge (Q12 & Q14), Positive Affect (Q11 & Q13), Negative Affect (Q3 & Q7), Tension and Annoyance (Q6 & Q8), and GEQ total score per game (average score over all domains after inversion of NA and TA)
PresenceTotal	Presence total score (1-7; average of all items)
SUStotal	SUS total score (= sum of SUS Q1 to SUS Q10 (after inversion of Q2,Q4,Q6,Q8 and Q10) *22.5)
SUSabove68	SUS above threshold for good usability? No (0) or Yes (1)
G0_RWA_Q…	Game 0: Reachable Workspace Area for ipsilateral upper quadrant (Q1), ipsilateral lower quadrant (Q2), contralateral upper quadrant (Q3), contralateral lower quadrant (Q4).
G0_MRD_Q…	Game 0: Maximum reach distance for ipsilateral upper quadrant (Q1), ipsilateral lower quadrant (Q2), contralateral upper quadrant (Q3), contralateral lower quadrant (Q4).
G1_successrate	Game 1: Successs rate (%)
G1_Tballoon_median	Game 1: Time per balloon (s, median over all balloons)
G1_relpath_avg	Game 1: relative path length (fraction of shortest possible, mean over all balloons)
G1_movspeed_avg	Game 1: movement speed (cm per sec, mean over all balloons)
G2_HOgrasp…_avg	Game 2: avg handopening at first grasp (in m), for cube 1(L = 10 cm), cube 2 (M = 7.5 cm) and cube 3 (S = 5 cm).
G2_HOint…_avg	Game 2: avg handopening during interaction (in m), for cube 1(L = 10 cm), cube 2 (M = 7.5 cm) and cube 3 (S = 5 cm).
G2_movspeed…_avg	Game 2: avg speed during interaction (in m/s), for cube 1(L = 10 cm), cube 2 (M = 7.5 cm) and cube 3 (S = 5 cm).
G2_Tcube..._med	Game 2: time from start to finish (in s), for cube 1(L = 10 cm), cube 2 (M = 7.5 cm) and cube 3 (S = 5 cm).
G2_nrinteractions…_med	Game 2: median nr of interactions from start to finish, for cube 1(L = 10 cm), cube 2 (M = 7.5 cm) and cube 3 (S = 5 cm).
G3_[up/low]_movspeed[NO/VO/SO]_avg	Game 3: avg speed during interaction (m/s) towards upper (up) or lower (lo) targets, in scenario NO (no obstacle), VO (visible obstacle) or SO (surprise obstacle)
G3_movspeed[NO/VO/SO]_avg	Game 3: avg speed during interaction (m/s) averaged over upper and lower targets, in scenario NO (no obstacle), VO (visible obstacle) or SO (surprise obstacle)
G3_[up/low]_relpath[NO/VO/SO]_avg	Game 3: actual path as fraction of shortest path towards upper (up) or lower (lo) targets, in scenario NO (no obstacle), VO (visible obstacle) or SO (surprise obstacle)

G3_relpath[NO/VO/SO]_avg	Game 3: actual path as fraction of shortest path averaged over upper and lower targets, in scenario NO (no obstacle), VO (visible obstacle) or SO (surprise obstacle)
G3_[up/low]_Twalnut[NO/VO/SO]_med	Game 3: time (s) from start to finish per object towards upper (up) or lower (lo) targets, in scenario NO (no obstacle), VO (visible obstacle) or SO (surprise obstacle)
G3_Twalnut[NO/VO/SO]_med	Game 3: time (s) from start to finish per object averaged over upper and lower targets, in scenario NO (no obstacle), VO (visible obstacle) or SO (surprise obstacle)
G3_successrate[VO/SO]	Game 3: success rate (%) in scenario VO (visible obstacle) or SO (surprise obstacle)
TotalTime_balloon	Game 1: overall median Tballoon (in s)
TotalTime_cube	Game 2: overall median Tcube (in s)
TotalTime_walnut	Game 3: overall median Twalnut (in s)
Hoehn_Yahr	Score on the Hoehn and Yahr scale, reflecting the overall severity of motor symptoms in PD patients.
SPES...	Score on individual items of the SPES/SCOPA, reflecting motor function and disability in PD patients
SPES_clinical	SPES total clinical score (sum score of part A)
SPES_ADL	SPES total ADL score (sum score of part B)
SPES_complications	SPES total motor complications score (sum score of part C)
SPES_total	SPES/SCOPA total score
mRS	Score on the Modified Rankin Scale, reflecting overall disease severity/disability in stroke patients
FM-UE_total	Total score on the Fugl-Meyer Assessment of the Upper Extremity, reflecting the severity of upper-limb motor symptoms in stroke patients

Technical information on files:

Tab-separated raw data files were created in Unity3D (version 5.6.0, Unity Technologies, San Francisco, USA). The SPSS file and csv-file with participant characteristics and outcome parameters for each AR game (dataset TIM-AR-UE.sav / TIM-AR-UE.csv [delimiter: semicolon]) were created in IBM® SPSS® Statistics 23.0 (IBM Corp., Armonk NY), after data had been processed using MATLAB (The Mathworks Inc., Natick MA, USA, version R2016a).

Data collection instruments:

User experiences

NASA-TLX questionnaire (1-7; high: worse), task load

Hart SG, Staveland LE (1988) Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In: Advances in psychology, vol 52. Elsevier, pp 139-183

Game Experience Questionnaire -subset (1-5; high: better), engagement

Cidota MA, Bank PJ, Ouwehand P, Lukosch SG (2017) Assessing Upper Extremity Motor Dysfunction Using an Augmented Reality Game. In: 2017 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), 2017. IEEE, pp 144-154 *(GEQ-subset)*

IJsselsteijn W, Van Den Hoogen W, Klimmt C, De Kort Y, Lindley C, Mathiak K, Poels K, Ravaja N, Turpeinen M, Vorderer P (2008) Measuring the experience of digital game enjoyment. In: Proceedings of Measuring Behavior, 2008. Noldus Information Technology Wageningen, Netherlands, pp 88-89 *(Original GEQ)*

IJsselsteijn WA, de Kort YAW, Poels K (2013) The Game Experience Questionnaire. Eindhoven: Technische Universiteit Eindhoven. *(Original GEQ)*

System Usability Scale (0-100; high: better), usability

Brooke J (1996) SUS-A quick and dirty usability scale. Usability evaluation in industry 189 (194):4-7

Questionnaire on presence (1-7; high: better), presence

See Online Resource 1of related publication, adapted from:

Gandy M, Catrambone R, MacIntyre B, Alvarez C, Eiriksdottir E, Hilimire M, Davidson B, McLaughlin AC (2010) Experiences with an AR evaluation test bed: Presence, performance, and physiological measurement. In: 9th IEEE International Symposium on Mixed and Augmented Reality (ISMAR), 2010. IEEE, pp 127-136

Cognitive function

Montreal Cognitive Assessment (0-30; high: better)

Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, Cummings JL, Chertkow H (2005) The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. Journal of the American Geriatrics Society 53 (4):695-699

Motor function and disability, PD patients

Hoehn and Yahr stage (0-5; high: worse), disease severity PD patients

Hoehn MM, Yahr MD (1998) Parkinsonism: onset, progression, and mortality. Neurology 50 (2):318-318

SPES/SCOPA motor examination (total score: 0-63; high: worse)

Marinus J, Visser M, Stiggelbout AM, Rabey JM, Martínez-Martín P, Bonuccelli U, Kraus PH, van Hilten JJ (2004) A short scale for the assessment of motor impairments and disabilities in Parkinson's disease: the SPES/SCOPA. Journal of Neurology, Neurosurgery & Psychiatry 75 (3):388-395

Motor function and disability, stroke patients

Modified Rankin Scale (0-5; high: worse)

Van Swieten J, Koudstaal P, Visser M, Schouten H, Van Gijn J (1988) Interobserver agreement for the assessment of handicap in stroke patients. Stroke 19 (5):604-607

Fugl-Meyer Upper Extremity Scale (0-66; high: better)

Fugl-Meyer AR, Jääskö L, Leyman I, Olsson S, Steglind S (1975) The post-stroke hemiplegic patient. 1. a method for evaluation of physical performance. Scandinavian journal of rehabilitation medicine 7:13-31.

For a description of data collection instruments and data pre-processing of AR games and motor tasks: see related publication.