# Place-onas: Shared Resource for Designing Body Tracking Applications

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## Abstract
Developments in computer vision technology have led to a plethora of new body tracking applications. These applications share a challenge in accounting for characteristics of the specific places in which they are intended to be used. We present the concept of Place-onas, representations of "typical" places, as a shared resource to support multidisciplinary team discussions during the development of body tracking applications. We present an example Place-ona drawn from ASSESS MS, a computer vision application that supports the clinical assessment of Multiple Sclerosis. We describe its usage, drawing out how it supported design work, and conclude with a discussion of future work.

## Author Keywords
Place-ona; Body Tracking; Health; Computer Vision; Kinect

## ACM Classification Keywords
H.5.m. Information interfaces and presentation

## Introduction
Recent developments in computer vision technology for tracking body movement, such as the Microsoft Kinect depth camera, have led to a plethora of new applications. These body tracking applications enable

novel ways to engage with the digital world that range from new genres of entertainment:  physical games [6] crowd-games [14], interactive cooking [16] and magic shows [13] -- to serious healthcare applications: touchless image manipulation in surgery [15], rehabilitation [2], and clinical assessment [17]. A substantial challenge for designers of body tracking applications is accounting for the specific places in which they are used. Characteristics of a place, from lighting to attitudes of social distance, influence the robustness of the tracking and consequently the opportunities for the interaction design. Understanding the constraints inherent in "typical" places can support application designers in addressing the limitations of computer vision technology while meeting the interaction goals of the application.

We present the idea of *Place-onas* to support the design of body tracking applications. Based on the widely known concept of Personas, Place-onas are representations that serve as "hypothetical archetypes" of places [3]; as concrete surrogates for thousands of similar places [8]. They concisely summarize, visually and verbally, observational research data of real places in which the envisioned application is expected to be used. As a shared resource, Place-onas can provides a common language for stakeholders to discuss important design trade-offs in a productive way [5].

In this paper, we present an example Place-ona created during our research to develop a body tracking application to support the clinical assessment of Multiple Sclerosis (MS).

## Characterizing Place

Computer vision technology is becoming increasingly robust, but remains sensitive to environmental factors. Common issues for the Kinect camera, for example, include lighting, configuration of objects/furniture in the space, other people, and the placement of other sensors [12,15]. While technical advances are likely to increase the reliability of these technologies across use settings, some susceptibility to the environment will remain. Those who've deployed sensing systems 'in the wild' argue that it is best to design the interaction to absorb this uncertainty, seeing it as an element of the interaction rather than a glitch or bug in the technology [1].  To do so, designers need to have an understanding and appropriate representations of the places in which the body tracking application will be used.

There are many ways one might characterize place. Seminal work on this topic in HCI emphasizes the distinction of space and place [9]. Space, the authors argue, is the material and geometric properties of a location, and place, the human activities that take place there. This distinction was originally made to encourage new approaches to the design of virtual environments, however it is also relevant to physical environments. Relating it to body tracking technologies, space might be the configuration of furniture in the use setting, while place the social rules about where the furniture is placed and whether it can be moved. In a later paper, these authors combine the notions of space and place into a discussion of designing for embodied experience [4].

This work provides theoretical guidance on the characterisation of place – the capture of elements of a

**Figure 1.** *Photographs of typical examination rooms in two different clinics*

place, both its geometric properties and contained activities, that influence the embodied experiences possible. These then must be interpreted to specific issues of the body tracking application, e.g. standardized input required for movement classification. Our example Place-ona provides one possible characterization of place in line with this theoretical perspective.

## Clinical Assessment of Multiple Sclerosis

The example presented here comes from the research project, ASSESS MS, which is exploring the potential of computer vision technology to help clinicians more accurately monitor the progression of Multiple Sclerosis (MS), a neurological disease that affects 2 million people. MS can affect many systems in the body, but clinicians have a particular concern with the increase in cerebellar dysfunction as manifested in changes in movement patterns. This project aims to create a body tracking application to detect these changes more rapidly, objectively and accurately than human assessors.

The system uses a Kinect camera to capture depth images of nine movements drawn from a standard neurological examination. Carried out in a normal examination room with patient bed and doctor's desk, the patient is positioned about 1.6 meters in front of the Kinect and instructed in the movements. These include stretching out one arm to the side and then touching the nose and walking on a pretend tight rope. The captured depth images are then processed offline to remove background artefacts and standarise the image sequence before being inputted into a classification algorithm to suggest level of disability.

The project is a collaboration between machine learning researchers, HCI researchers, clinicians in two countries, and employees of a large pharmaceutical company interested in developing the technology. Still in its first year, amongst this multidisciplinary team there is much discussion and negotiation about how to best achieve the overall aim of the project. Common topics include: which neurological examination movements should be used, how should the interaction with the system be designed to support optimal positioning of the patient, should we take a supervised machine learning approach using the neurological scoring system we would like to replace? The answers to these questions are surprisingly dependent, requiring a substantial amount of knowledge sharing across disciplines to achieve optimum trade-offs.

## Place-ona Example

*System Requirements*

At the beginning of the research project, the multidisciplinary team discussed system requirements for the ASSESS MS system. After much negotiation, the minimum requirements for it to work from each participant's point of view were the following:

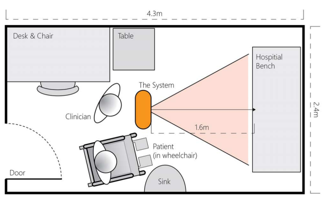
- System should be usable with few or no adjustments in the majority of MS clinical assessment centers throughout the world (Pharmaceutical perspective)

- System should be suitable for MS patients up to the EDSS scale 7, which includes those who are wheelchair bound and have difficulty shifting onto a bed (Clinical perspective)

**Place-ona**

**Name**: Typical small neurological examination room

**Diagram:**



See Figure 2 for larger image

**Properties:**

Rooms have the same furniture, but may be in a different configuration

Clinicians change examination rooms throughout the day

There is a hurried atmosphere with no time for rearranging furniture or setting up equipment.

**Figure 2a.** *Place-ona of typical small examination room*

- System should have the ability to have a background recording with no people in it before or after each group of movements - sitting, standing, walking – to support preprocessing of images (Machine Learning perspective)

*Place-ona Development*

The HCI team observed examinations and gathered photographs and measurements from typical examination rooms in two MS clinics in different countries. Two photographs from this exercise are shown in Figure 1. These rooms have a range of different shapes, some are long and narrow while others had a shape closer to a square. Each has its own set of furniture – a desk for the clinician, a wardrobe for assessment paraphernalia, a sink for hand hygiene, and a movable patient bed. Each room has the same components, but they are often arranged differently. This led to individual rooms in the same hospital having their own spatial characteristics. Clinicians often have little choice about which room they use for a particular examination and they change rooms throughout the day. Moving of furniture was impractical and discouraged.

We created a Place-ona of a typical small examination room, depicted in Figure 2a & b.

*Place-ona Usage*

We first used the Place-ona to assess whether it was feasible to meet the three system requirements detailed above. The diagram of the room illustrates that it is not possible for the wheelchair to pass while the system is in place. Consequently, it is not possible to do background recordings for those in a wheelchair

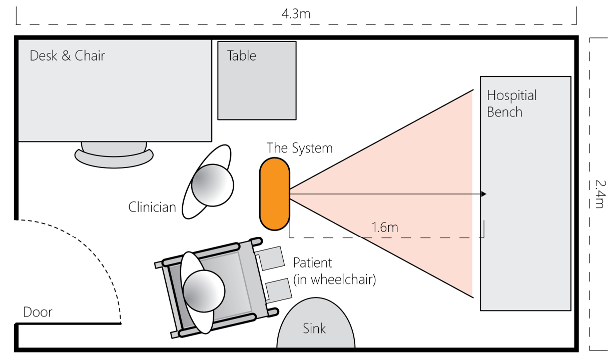



**Figure 2b.** *Diagrammatic representation of a typical small examination room for Place-ona example*

without modifying a typical examination room. The Place-ona further indicates that moving furniture is not a practical solution due to room usage flux and the pace of clinical work.

*Multidisciplinary Discussion*

The Place-ona was then used to facilitate a multi-disciplinary discussion of system requirement trade-offs. The team decided that it was preferable to specify some characteristics of the room in future deployments rather than narrow the user base. An important distinction was also made between clinical assessment rooms and clinical trial assessment rooms. The latter, often planned and paid for in advance, could be altered to suit a system, unlike the former.

*Design Activity*

Not least, the Place-ona supported further design work. It provided the starting point for further sketches which led to a new form-factor for the system, as seen in

Figure 3. The new design swivels the monitors out of the way without moving the camera so that a wheelchair might pass and background recordings can be made.

## Discussion

We have articulated the concept, *Place-ona,* and illustrated it with an example from the ASSESS MS project. This Place-ona provided a representation of a "typical" small neurological examination room that supported a multi-disciplinary team in discussing trade-offs in the design of a body tracking application. Our team was able to use the Place-ona to prioritize system requirements, articulate different types of places that have the same spatial dimensions but different usage properties, and develop a new design solution.

The example shown here is just one situation in which a shared resource representing place is helpful. We would suggest that similar shared resources would facilitate the design of other body tracking applications. What constitutes place however, may alter slightly depending on whether the application is for  urban gaming [14] or home rehabilitation [7]. We would postulate however, that the basic ingredients of a Place-ona will remain constant: a name, diagrammatic representation of the place, and important social and cultural norms that shape the way that the place is used. As with personas, beyond these common themes, the content of Place-onas is likely to vary with the needs of the project [5].

Place-onas are only one tool available for designing for embodied interaction in specific places. The work of Loke and Robertson illustrate the range of other perspectives one can take when designing body-tracking applications. These include personas that

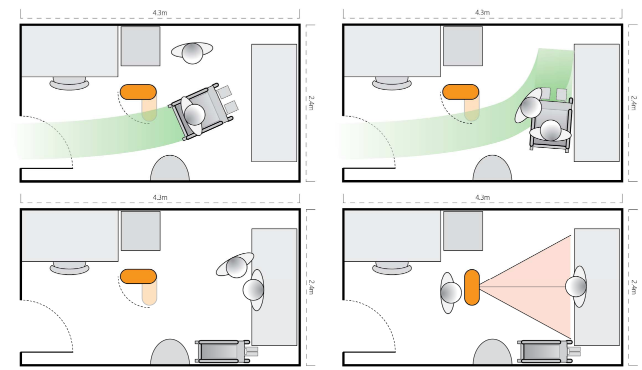


**Figure 3.** Design sketches using the place-ona

capture how people move through a space [10] and how people interact in particular spaces [11] to support the design of interactive installations.

As a work-in-progress, this is just the initial presentation of an idea. Further work is needed to create a robust concept that is transferable across body tracking applications. This future work is needed to determine what information would be most productively included in Place-onas as well as empirical studies of how they are used by multi-disciplinary teams in practice. We believe however, that this initial concept of Place-onas supports a trend of more real-world deployments of body tracking applications.

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