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JourneyCam: Exploring Experiences of Accessibility and Mobility among Powered Wheelchair Users through Video and Data

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ABSTRACT

Recent HCI research has investigated how digital technologies might enable citizens to identify and express matters of civic concern. We extend this work by describing JourneyCam, a smartphone-based system that enables powered wheelchair users to capture video and sensor data about their experiences of mobility. Thirteen participants used JourneyCam to document journeys, after which the data they collected was used to support discussions around their experiences. Our findings highlight how the system facilitated the articulation of complex embodied experiences, and how the collected data might have particular value in surfacing these experiences to help inform urban design and policymaking. Participants valued the ways in which JourneyCam's moving image and sensor data made hard-to-express sensations apparent, as well as how it enabled them to surface previously unrecognised issues. We conclude by highlighting future opportunities for how such tools might enable citizens to inform and influence civic governance.

CCS CONCEPTS

• **Human-centered computing** → **Field studies; Empirical studies in HCI; Ubiquitous and mobile computing systems and tools**; • **Social and professional topics** → **People with disabilities**.

KEYWORDS

Disability; mobility; place; accessibility; powered wheelchair users; civic technology; community technology; digital civics

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1 INTRODUCTION

Digital technologies offer the opportunity for members of the public to have a stronger voice in the provision of government services and the design of public spaces. Under the rubric of 'digital civics', HCI researchers have explored tools and processes by which this might be achieved [57], and have designed technologies to facilitate place-based conversations and bring experiential concerns into urban planning processes in relation to housing [7] and transport infrastructure [2]. Work in this spirit has also explored how digital tools and data are utilised and appropriated within civic engagements [31, 44].

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Careful consideration must be given to the design of such tools and processes, paying close attention to how different communities may face specific challenges in articulating their experiences. This is especially the case with disabled people, whose interests are not always meaningfully taken into account in the design of public services or spaces [10, 11]. In our prior work, we highlighted the ways that disabled people—and in particular users of powered (electric) wheelchairs—face substantial challenges in substantiating and conveying their complex lived experiences of accessibility and mobility to others [62]. The physical size and weight of powered wheelchairs is ill-suited to many supposedly ‘accessible’ environments, while users face distinct issues that manual wheelchair users do not have to contend with such as reliability and battery life, and how these factors influence interactions with other citizens. We observed how the accessibility issues they face are often nuanced, with subtleties that were difficult to express, and that often their testimonies were not taken seriously as evidence by authorities [62].

As such, tools that allow the capture and elucidation of disabled experiences of accessibility and mobility are a necessary first step in wider processes of socio-political engagement. Recent work has identified the potential for adapted smartphones to support the capture of video and data by wheelchair users to document urban accessibility issues [37]. However, such systems have not yet been implemented in ways to support self-directed (rather than semi-automated and ongoing) data capture by users, nor address wider issues of urban mobility beyond physical access. Building on this prior work, we conducted a study of JourneyCam, a smartphone-based video and data recording tool designed to capture representations of the experiences of powered wheelchair users as they move in and through public spaces. Mounted on participants’ chairs and operated by a one-click Bluetooth remote control, it enables them to record short clips of video and sensor data both prospectively and retrospectively. This allows for the capture of things which had just happened, as well as things that participants anticipated were about to happen. We studied the use of JourneyCam by 13 people on journeys in and around the areas they lived and/or worked, and on public transport. The data they collected was then used to support semi-structured interviews that explored participants’ experiences of these journeys, and to assess the value of technologies like this to facilitate the identification and expression of accessibility issues. We found that JourneyCam prompted participants to reflect not only about accessibility issues of immediate concern, but also about how their experiences of being disabled are mediated through technologies and data.

Our findings offer three contributions to the growing HCI literature on digital civics and community technologies. First, through the use of JourneyCam we identify issues around

embodied mobility and access as experienced by powered wheelchair users. Second, we contribute insights related to the use of novel digital tools to support people in collecting and articulating complex experiences of place and disability. Finally, we extend prior work on civic technologies and life-logging by highlighting the value of video and place-centered data in facilitating conversations on the embodied experiences of marginalised groups. In particular, we explore how these technologies might enable disabled citizens to reflect upon issues of concern to them, and how such reflections might be a necessary first step towards civic conversations to bring about change.

2 RELATED WORK

Disability, Accessibility, and Wheeled Embodiment

There is significant literature on the (in)accessibility of the built environment and transport in planning, urban studies, and disability studies. In contrast to dominant narratives of disability¹ as a ‘personal tragedy’ to be overcome, such work typically extends a social understanding of disability [4, 55]. It explores the broader structural dimensions of disablement in a society designed by and for non-disabled people, and highlights the challenges faced by disabled people in the built environment [21, 26]. Disabled people are spatially excluded through inadequate provision of facilities, such as accessible toilets, which even where they are available are often poorly designed [40]. Urban spaces can resemble obstacle courses, denying access to these citizens [30, 52]. Disabled people are also often narrowly conceptualised as ‘wheelchair users’, a homogenisation which fails to acknowledge diverse bodies or potentially conflicting individual mobility requirements [27]. This is reflected in development processes that are insensitive to, and ignorant of, diverse needs [29], and which are characterised by professional specialization that privileges technical expertise over experiential concerns [28]. There is therefore a pressing need to bring disabled people’s perspectives into the design of places, as an essential step towards ‘enabling geographies’ [22: 65–70]. Approaches such as participatory mapping are one way to bring these voices and concerns into civic conversations on accessibility [39].

Powered wheelchair users are one group of disabled people for whom access may be particularly challenging. Wheeled mobility devices, including powered wheelchairs and scooters, support independent mobility and improved quality of life [13, 53, 67], but people’s experiences are also heavily

¹A note on terminology: we use the term ‘disabled’ as a verb rather than a noun, emphasizing that people ‘are [being] disabled’ by society, rather than to describe the effect of their impairment. We recognise and acknowledge different conventions (for example, that ‘person-first’ is often used in the United States), but given the focus of this paper on disabling barriers as experienced by our participants, feel that this term emphasises the active processes of disablement in society.

influenced by their physical, social, and attitudinal environment. The complex role that powered wheelchairs have in people's lives has been described as a 'dynamic duality' [61]. Despite enabling independence, there are challenges associated with their use relating to their size and weight, which can compound existing environmental barriers, as well as limitations imposed by battery life and their potential for breakdown or failure [41]. Moreover, there are many types of powered wheelchairs, with diverse specifications targeted at users with differing requirements (see, e.g. [68]). These issues can further constrain access to particular spaces or modes of transport [5, 62].

Feminist and critical disability scholars have also emphasised how individual diversity, situatedness, and bodily difference can shape the experiences of disabled people [63]. Without returning to a discriminatory, 'medicalised' characterisation of disability, such work emphasises how embodiment and its relationship with the wider environment affects disabled people's experiences. They have sought to understand disability as contextual, as well as how technologies can reproduce boundaries between disabled and non-disabled people [54]. Questioning totalizing narratives of disability, they have recognised the significance of both embodiment and affect in disabled experiences [65]. Garland-Thomson's notion of 'misfitting', which highlights the juxtaposition between disabled bodies and unyielding environments, underlines the importance of understanding diverse bodies in their interactions with the wider world [19]. Work in this vein emphasises the 'normality of doing things differently' [23], while a focus on embodiment stresses the social and political context in which disabling environments are produced and maintained [18]. Asymmetric power relations are integral to the social construction of disabled people's mobility and their citizenship [17].

Collectively, this work on built space, disablement and disabled bodies challenges us to think differently about how those categorised by society as 'disabled' experience public space. It highlights how accessible environments are highly significant for disabled citizens, as they enable full participation in society and grant access to employment, education, and social opportunities that many non-disabled people take for granted. It also emphasises the importance of listening closely to, and finding ways of expressing, the diverse embodied experiences of disabled people. It is therefore important to understand the needs of disabled citizens as 'users' of space, both to guide the design and development of more inclusive spaces, but also to rethink and challenge societal assumptions around the capabilities and values of disabled bodies. Our work attempts to design technology to support these goals, through enabling disabled people to capture and articulate their experiences of accessibility and mobility.

Place-based Civic Engagement with Video and Imagery

A growing body of research in HCI and related fields has explored the ways digital technologies might support processes of civic engagement in relation to planning and the built environment (e.g. [2, 7, 57]). Recent examples have begun to develop best practices for community engagement through technology [3], and explored ways of facilitating place-based discussions, for example to inform community decision-making [32].

Mindful that embodied, place-based experiences may be better understood *in situ*, others have investigated digitally supported walks to enable political discussion of urban futures, unearthing the complex relationships between physical and political spaces [6]. The ubiquity of mobile devices and geo-located media has also helped 'bring place into' civic discussions in HCI, for example through studies investigating the collection and use of participatory cycling route data about the built environment [44]. Similarly, 'Spokespeople', a tool which captures 'annotated routes', enables cyclists to augment GPS traces of their journeys with on-the-go audio comments or post-journey textual descriptions for reflection, discussion, and civic discourse [51]. Images have been used to log place-based maintenance issues with civic agencies [14], an approach that has been investigated in the context of wheelchair users [37, 66]. Kirkham et al. used sensor-triggered video segmentation to semi-automate the logging and mapping of accessibility barriers for manual wheelchair users [37]. However, downward- and rear-facing video clips alone were found to be lacking important contextual information that would assist with the interpretation of access barriers. Moreover, automatically preselecting clips for 'dispassionate' post-journey review, and conceiving them only as a form of 'objective' evidence, explicitly precludes important emotional or affective aspects of people's embodied experiences, and limits their agency in determining what matters to them in-the-moment. By contrast, participatory media and storytelling has been used to widen engagement in planning, via storyboarding and commissioning citizen narratives through phone-based video clips [50]. Through its ability to enable storytelling amongst citizens, participatory video was found to help to stimulate conversations about place, including in formal processes of civic engagement [50]. In their portability and ability to capture video and audio, mobile devices thus have the potential to generate rich data around people's lived experiences of place and mobility.

Work on 'life-logging' has likewise explored the role of mobile photography and videography for capturing and reflecting upon everyday lived experiences. Studies of Microsoft's SenseCam have shown that it is not a simple analogue to memory, but rather enables participants to tell evocative

stories about even prosaic events in their daily lives [25]. Lindley et al. found that wearable life-logging tools support the telling of ‘small stories’, through the topics that users chose to recall and the narratives and identities constructed around them [48], while also enabling new insight into everyday routines [46]. These works highlight how the type and qualities of data affect the reflective practices undertaken around them, and underline the importance of narratives constructed around media in processes of sense-making.

Prior work has explored post-capture practices of users in relation to digital photographs and video [35, 36, 45]. Of particular relevance to our focus on people’s journeys is work which examines how the time of capture is relevant to subsequent image organisation and sense-making. Digital image management practices are often driven by time and event (and, as a side-effect of this, location) [36]. Similarly, timelines can support users in conveying narratives through the exploration of media related to past experiences [69]. The rediscovery of forgotten photographs in photo collections likewise serves to trigger a reinterpretation of their meaning [16]. Important to consider here are the *active* processes by which people retrospectively make sense of visual media. Frohlich et al. [15] highlighted how digital imagery can support in-person sharing as well as storytelling with non-present others. Images can thus serve as a resource for knowledge claims, verifying ‘what happened’, as well as supporting asymmetric conversations between the photo-taker and others. Noting that storytelling is subject to ‘recipient design’, they emphasise how narratives are tailored to the recipients of stories; moreover, as photos can prompt memories of *related* events, not all stories that are told relate to specific photos at hand. Kirk et al. [35] describe lightweight and heavyweight ‘videowork’: the former being ephemeral clips captured spontaneously to augment co-present experiences with others; the latter involving purposeful capture of good quality footage to record major life events.

Motivations for taking photos or short video clips on camera phones are both individual and social, including sharing experiences, supporting reflection or reminiscing, and enabling functional tasks [34]. Video is also used to demonstrate to others that the taker was actually present: the ‘been there’ phenomenon [60]. These qualities have long been used in anthropology and sociology to elicit rich reflection (e.g. [24]), and have also been applied in HCI research [70]. Images provoke more detailed accounts of both the images themselves and of the context in which they were taken than traditional interviews. They can refresh or even contradict participants’ memories, and unearth latent patterns of behaviour. As Van House concluded, viewing images with participants ‘gave us details and meanings that we could not have developed on our own’ [70: 1467]. We extend previous work on processes of place-based civic engagement

and life-logging, by building technology to explore powered wheelchair users’ experiences of place and mobility. We seek to understand both these experiences themselves, and the use of life-logging tools to capture and convey these embodied experiences. This is a first step in exploring how collaborative sense-making with powered wheelchair users might highlight accessibility issues, as well as their meaning and importance in the lives of this group of citizens.

3 JOURNEYCAM

JourneyCam is designed to allow powered wheelchair users to capture data about the journeys they undertake, through digitally mediated ‘go-alongs’. During preliminary work, participants expressed the desire to record video of aspects of their everyday experiences. However, many existing tools for on-the-go video and data capture are not fully accessible, especially for people with impairments that necessitate the use of powered wheelchairs. Dedicated hardware, such as GoPros, often have small and fiddly user interfaces. Mainstream mobile phone camera applications can likewise be hard to use for those who cannot swiftly manipulate the phone interface or hardware to commence recording, and typically do not capture supplemental data such as GPS traces. We designed JourneyCam to address these accessibility barriers.

We built on insights from human geography and mobilities, which highlight how *in situ* methods like ‘go-alongs’ or ‘walking ethnographies’ allow access to people’s complex lived experiences of place and mobility [43]. Although used in a range of contexts, sometimes with digital technologies [12], they have only rarely been adapted as ‘wheeling’ methods to explore wheelchair users’ experiences [58].

JourneyCam is also inspired by other video-based ‘life-logging’ technologies used as evidence in the context of transport, such as ‘dash cams’. These mounted cameras record a journey from the view point of a vehicle driver [59]. A dash cam ‘eliminates the burdens of users having to decide whether a particular incident is worth capturing, as well as the need to manually prepare and operate a capture device’ [33]. However, continuous recording of entire journeys poses practical and ethical problems. Not only are there privacy concerns about ‘sousveillance’ [49] but there is also a problematic history of research done ‘on’ disabled people rather than ‘with’ or ‘for’ them, highlighting the need for emancipatory research practices which empower disabled people (see [38, 56]). We thus wanted to enable participants to take an active role in initial video capture (in contrast to [37]), through a purposeful interaction to start recording.

While users may pre-emptively start a recording in anticipation of an imminent incident while on a journey, unanticipated events can still occur which participants may wish to capture. JourneyCam is therefore designed to achieve a balance: allowing accessible, purposeful recording of both



Figure 1: JourneyCam hardware, clockwise from left: clamp and phone mount; iPhone; Bluetooth trigger



Figure 2: Example JourneyCam mounting positions

anticipated and unanticipated events, while limiting unnecessary recordings. It stores a short temporary ‘loop’ of video, which is discarded unless explicitly saved by the user via a trigger button. The explicit intent of initiating a recording also acts as a natural marker for indexing and later retrieval.

JourneyCam consists of hardware (*Figure 1*) and software tools: a smartphone application to record video clips and other data, and data processing and visualisation software to support post-journey sharing and discussion. The phone is physically attached to participants’ powered wheelchairs with a mount, usually at the height of the wheelchair control stick (*Figure 2*). Due to the diverse design of participants’ wheelchairs, and individual preferences, it was sometimes positioned at their head or leg height.

Once configured, participants start the application and begin their journey. For the duration of the trip, JourneyCam records GPS and accelerometer data. The latter captures acceleration magnitude which can be graphed over time to provide a visual indication of uneven movement of the wheelchair. The GPS trace adds context to the video and movement data, giving location and velocity. A short ‘loop’



Figure 3: Visualisation of participant’s route, with videos at waypoints along the journey where they had captured data

of ‘pre-roll’ video footage is captured on an ongoing basis to enable retrospective recording, which saves data immediately before the moment of activation. A Bluetooth button, held by the participant or mounted in an accessible location, is clicked to capture a short clip of video comprising both the pre-roll and a short period after activation. Initial testing with two participants led us to set the former as 60 seconds, and the latter as 20 seconds. Recording duration is extended by additional button presses to allow capture of an ongoing event as a single recording.

After the journey, video and sensor data were transferred to the lead author’s password-protected laptop and processed to generate tracks of the location over time, one per journey, stored as KML files (a standard file format for geographic annotation data). To quickly identify specific clips, timestamped thumbnail images of video events were geolocated along the GPS routes. Finally, the accelerometer magnitude data was stored as an additional data track alongside the location and time. This allowed us to import participants’ journeys into Google Earth, with the GPS trails plotting the route of each journey, and clips of collected videos located at the relevant waypoints on the journey (*Figure 3*). This structured post-journey interviews around the data that participants had collected, with multiple channels of information for them to draw upon in their reflections. It also enabled participants to consider how they might collate and present data collected by JourneyCam, as well as how they could subsequently review and share that data with others if they so desired.

4 STUDY DESIGN

Our study had four stages: i) participant recruitment, ii) initial meetings with participants, iii) accompanied journeys using JourneyCam, and iv) reflective data interviews with participants.

Participant Recruitment

Following University ethical approval, the research was advertised UK-wide via a project website and dedicated Twitter and Facebook accounts. It was also publicised via the i) social media channels of relevant national charities and ii) patient registries for people with conditions that affect mobility. We did this to ensure breadth amongst participants and diversity of journeys, as access and mobility issues affect disabled people nationwide [9]. We adopted a sensitive recruitment process, as we sought to empower those with whom we worked. Potential participants were invited to email the lead author, after which an informal phone conversation was arranged to discuss the research and address any questions. These conversations also enabled fieldwork logistics to be planned for participants' convenience. 15 people took part: 13 current powered wheelchair users, one who was no longer a powered wheelchair user due to the effects of their impairment, and one who used a manual chair with power-assisted wheel hubs. Participants were aged 19 to, by their own explanation, "over 60". While some had been powered wheelchair users their whole lives, others had previously been ambulant or used manual wheelchairs.

Initial Meetings and Accompanied Journeys

The lead author met each participant at a location of their choice, often their home, to review the study procedure and ensure they were comfortable with using JourneyCam. In these initial, informal, and unrecorded meetings, participants discussed not only the research itself but often reflected, unprompted, on their wider experiences of accessibility.

The lead author then accompanied the participant on a journey of the latter's choice, observing their experiences and their use of JourneyCam, and taking field notes for later reflection. This enabled the provision of any additional support necessary, and importantly also allowed us to observe their *in situ* experiences and use of the device by 'going along' with them [13, 44, 59]. When asking them to consider what they would like to show us, we emphasised that we wanted to understand their experiences of getting about as broadly as possible. Once journeys with participants were completed, the lead author and participant first returned to an appropriate space (usually the participant's home or their choice of a quiet public space such as a café) to download and process the data. At this stage, the lead author briefly discussed with participants their experience on the journey. Wherever possible, the reflective interview was planned for the subsequent day, a procedure settled upon for the comfort of both participant and researcher. Occasionally, however, this was not possible, and interviews were conducted immediately following the journey.

Reflective Interviews

The semi-structured reflective interviews were conducted by the lead author, and were structured around the data captured by the participant on their journey. With the GPS track open in Google Earth, the interviewer 'wheeled through' the journey, playing one video clip at a time and inviting the participant to explain what was going on and why they had captured that particular clip. This provided a chronological structure to the discussion, from the start to the end of the journey. It also meant that the conversation flowed from specific clips to broader issues, building up a rich understanding of experiences.

The procedure was well understood and adopted by participants, who narrated the clips as they played. Starting 'from the data' was highly productive: participants usually expanded on their initial description of 'what' was going on without further prompting, discussing their feelings, their bodily experiences, and the (a)typicality of that experience in their lives. In this way the data helped to scaffold a broader discussion of wider issues.

Following the discussion of the journey data, the interview was structured to discuss their experiences and perceptions of JourneyCam. This often prompted detailed reflections, especially on the qualities of the video clips, and how these related to their own feelings and experience. Finally, the interview finished with more general questions about their experiences of accessibility. Interview lengths ranged from 55 to 265 minutes, although most were completed in 90-150 minutes (1.5-2.5 hours). While the above structure was the preferred and most common ordering of our study, on three occasions this wasn't possible. Two participants were unable to undertake journeys for health reasons, so their interview data is not included in this analysis (though their comments broadly aligned with those of JourneyCam users). For logistical reasons, a third participant discussed their general experiences via Skype before undertaking JourneyCam data gathering at a later date.

Data and Analysis

Data collected included transcripts of the recorded interviews, the lead author's field notes, and JourneyCam data (timestamped video clips, GPS traces, and graphed accelerometer and elevation data in Google Earth). We wanted to understand how JourneyCam was used and what issues were captured, but also to gain an understanding of what these issues meant to the people who captured them. We thus undertook i) a quantitative analysis of JourneyCam usage; ii) an inductive content analysis of the video clips; and iii) a thematic analysis of the interviews. The latter was informed by the lead author's fieldnotes and reflections of observing and interacting with participants as they used JourneyCam.

Table 1: Participant and video clip characteristics

ID	Gender	Age	Clips	Total duration <i>h:mm:ss</i>	Range <i>mm:ss-mm:ss</i>
C3	M	54	40	0:53:09	01:01 - 01:44
C4	M	42	32	0:48:54	01:03 - 03:17
C8	M	58	39	0:25:55	00:31 - 00:51
C10	M	34	14	0:09:48	00:25 - 01:24
C13	F	19	15	0:21:54	01:18 - 01:57
C14	F	51	17	0:24:24	01:18 - 02:04
C20	M	28	30	0:40:08	01:02 - 01:29
C28	F	43	29	0:41:00	01:16 - 01:52
C29	F	62	7	0:17:51	01:19 - 09:30
C30	M	60s*	52	1:12:57	01:02 - 02:44
C32	F	30	8	0:10:33	01:19 - 01:20
C33	F	55	17	0:24:30	01:19 - 02:02
C34	F	34	6	0:13:03	01:18 - 05:55
			306	6:44:04	—

* This participant declined to provide their precise age.

5 FINDINGS

Quantitative Findings of JourneyCam Usage

Participants collected 306 substantive video clips across 13 journeys (*Table 1*). There was a large variation in the number of clips participants captured (6-52), with this being loosely associated with journey length: the 7 journeys of under 140 minutes averaged 16 clips each, whilst the 6 journeys over this length average 33 clips each.

To give an overview of the types of issues identified, we assigned one or more categories to each clip (*Table 2*). Categories were based on issues clearly visible in the clip, and/or those explicitly articulated by the participant at that point in the journey or later when reviewing the video. The most common were notably uneven surfaces, kerbs or bumps, and interactions with non-wheelchair users.

Most videos included several issues: only 27 (8.8%) included one issue, while more than three quarters of clips (235, 76.7%) included 2 to 4 issues (*Table 3*). This hints at the interconnected nature of accessibility, with different issues often experienced in parallel. For example, a clip of crossing a busy road to pass a vehicle blocking the pavement would highlight several different but linked access barriers.

These data show that participants encountered a wide range of issues relating to i) physical aspects or environmental barriers (e.g. ramps, shop clutter, or modes of transport); ii) wider environmental factors like the weather; and iii) other people, including members of the public and transport staff. However, the categories demonstrate the limitations of taking these data at face value: they do not provide insight into the reasons why participants chose to capture video

Table 2: Content of video clips by category

Category	Clips	
	Count	%
Surface	279	91%
Kerb or bump	145	47%
Members of the public	121	40%
Traffic	110	36%
Blocked path	48	16%
Parked vehicle	41	13%
Train	37	12%
Transport company staff	35	11%
Ramp	29	9%
Rain or weather	29	9%
Shop clutter	27	9%
Bus	20	7%
Steepness of incline	18	6%
Tube (metro system)	10	3%
Lift	8	3%
Buggy (pushchair)	7	2%

Table 3: Number of issues highlighted in each video clip

Number of issues in video clip	Number of video clips	Proportion of overall clips
7	3	1.0%
6	7	2.3%
5	34	11.1%
4	68	22.2%
3	98	32.0%
2	69	22.5%
1	27	8.8%

of particular incidents, nor to the meaning they ascribe to them. It was therefore critical for us to understand the our participants' perspectives on the data they gathered. We discuss this below where we report on our interview and observational findings.

Qualitative Findings of JourneyCam Usage

Thematic analysis was conducted on the interview data [6], coded at the sentence and paragraph level for semantic and latent meaning. After 7 interviews were coded, tentative themes were developed by clustering related and contrasting data, before coding remaining interviews based on the refined themes. We discuss three overarching themes: i) how participants engaged with JourneyCam; ii) the evidential value of data; and iii) how JourneyCam helped to support participants reflect upon their everyday, embodied activities.

Engaging with JourneyCam. Overall, all participants appeared to find pleasure in using JourneyCam, making comments such as “*I think the technology was great*” (C28) and “*I loved it... I’d actually like to do more of it!*” (C14). Enabling participants to choose their own journey gave them the opportunity to show us what they felt was most important to them. This was reflected in their choices of journey destination, route followed, mode of transport taken, and the particular things they captured with JourneyCam and discussed en route. Journeys were thus highly diverse, lasting between 50 and 195 minutes (3.25 hours).

Longer journeys were typically broken up with a natural stop for coffee or a meal, and often involved travelling via a mode of transport the participant expressly wanted to show us. Destinations varied significantly: some participants showed us a regular commute to or from their workplace or local shops within a conurbation; others took us on ‘occasional’ (even relatively long-distance) journeys between towns and cities; and others kept to their local neighbourhood. As such, we travelled through a wide range of urban and suburban environments, as well as sometimes through rural or semi-rural areas.

Sometimes, usually during the pre-fieldwork discussion, they explained that they would show us specific routes or places to demonstrate known access barriers, such as a bad pavement or a mode of transport that had previously caused problems. Yet participants also valued the ‘retrospective’ capture mode, which was frequently used when an unexpected event occurred – often when a barrier was more difficult to traverse than anticipated. Some participants chose routes to highlight a mixture of environments, as C3 explained: “*I was going on the bits that I knew were bad... [but] I wanted to show both sides of it really*” (C3). This intent to show us a ‘fair’ or balanced experience was also described by C28, who “*tried to plan a route without wanting to sway the research one way or the other*” (C28). They explained how they had done this instead of taking the lead author only to places where they had previously had a negative experience. Another person expressed satisfaction with what they felt was the representative nature of the journey and clips they had captured:

“I’m glad what it shows, you know, ‘cause I think ‘yeh, that’s everyday, that’s everyday life really, it’s not added on to dramatise it, it’s the way it is”” (C14).

Participants’ journeys were rich and complex, and included experiences relating to their corporeal experience of physical environments, the sociality of interacting with others, and their view or perspective on events which unfolded. As mentioned above, participants mainly captured data relating to aspects of the physical environment, such as the surfaces on which they travelled, or spaces such as modes



Figure 4: Perspectives afforded by JourneyCam mounted at (from left to right) head, hand, and footplate height

of transport or lifts. Clips were often captured at moments of transition, particularly when entering or leaving environments or modes of transport. Participants independently judged similar things, often barriers, to be ‘interesting’ or ‘worthwhile’ capturing. An unusually smooth journey therefore challenged participants’ notions of what they felt they should be doing. As C10 said:

“I’d have felt happier if maybe some things didn’t go so easy [laughs]... We’d have evidence to show people, you know, the struggles I encounter... I was kind of hoping for something to go a bit wrong!” (C10).

Choices of routes, transport modes, and captured data were thus closely linked to how participants framed the aims of the research, and how they understood JourneyCam as a tool to collect ‘evidence’ around the barriers they faced in their everyday lives. We return to this in the next section.

One aspect of the footage, which was raised by several participants, was the perspective afforded by JourneyCam (Figure 4). Many participants described this, with sincerity, as giving ‘their perspective’ on how they saw and interacted with the world. Asked about the camera height, one replied:

“I think it was a very good reflection [of my experience]. Because it’s not just about what I see... [it] captured the bumpiness of the chair, it captured me moving in and out to get... into the right place on the bus... So no, I think I was happy with it where it was” (C28)

Others, however, made a more explicit distinction between their perspective and that of their wheelchair. They noted how JourneyCam gave the wheelchair’s perspective. They characterised this as desirable, rather than problematic:

C13: *“It was at the height of the wheelchair... it’s not like what I’m seeing”*

Researcher: *“[you] want to capture... the perspective of the wheelchair itself?”*

C13: *“Yeh. ‘Cause I feel like that’s... like, the bumpiness, the wheelchair gets battered by it most like the wheels”*

Despite these different understandings of the ‘perspective’ provided by JourneyCam, both participants felt the footage was faithful to their experience, which hints at the absolute centrality of the chair to their everyday embodiment.

The Evidential Value of Data. As already noted, participants approached JourneyCam as a tool to capture visual evidence of access barriers, speaking to their motivation for taking part in the research. Sometimes, this was explicit: one “loved the fact” that they could use it to “gather evidence. I think [it is] brilliant” (C8). This was despite us explaining that we were interested in their experiences of mobility and access broadly, not only in the barriers they faced. The fact that all participants expected to encounter barriers speaks both to their frequency and to their impact on people’s lives. Data was often conceptualised as ‘proof’ that would back up lived experiences. Frustrated that their repeated complaints about an issue were ignored, one person anticipated that data collected through a tool like JourneyCam might validate or substantiate their accounts:

“I think [the organisation] was implying that I was making it all up... If I had videos of every single incident [they] couldn’t get away with that... [the] evidence of my video, especially if it’s timestamped... is stronger. It’s about degrees of credibility. It’s less ignorable” (C8).

This sentiment was very common, as another participant put it: “I would feel more able to complain to the bus companies about their drivers if I had footage of how they were treating me” (C34). Visual data was strongly valued:

“I can say to people ‘this is really difficult’, but actually them seeing it... I’m thinking of that countryside path. I physically cannot turn... And if you can’t see the danger of it by looking at the video– if you don’t take my word for it... that’s just another way of showing it” (C14).

Participants explained how video literally ‘showed’ complex issues, typically physical barriers, and did so very concisely: “what you might have to say in a whole page of text, you could probably say in maybe five seconds of a video” (C28). Sometimes, the value of the clip to ‘show’ a specific feature was implicit. Having captured a cramped space at a local shop, one person commented: “I looked into that bit and I can’t get round that bit because it’s just too tight” (C3). Elsewhere the visual nature of the data was directly referenced. The same participant, drawing the lead author’s attention to a clip showing building works on a local street, compared it to their previous experience: “this [surface] is great now, well, they’re still working on it as you can see. It used to be all cobbles and it was awful and I did avoid the street” (C3). ‘Showing’ the researcher particular issues that a non-wheelchair user might not consider as ‘access barriers’ was also very common, such as one clip captured in a railway station by a participant in order “to show that [the accessible ticket] counter was closed” (C28).

The dynamic motion of video was of particular value in this process of ‘showing’, as it tapped into the experiential qualities of participants’ journeys. The ‘bad’ quality of the

video clip, with visible camera shake, highlighted the poor quality of the surface on which the participant was travelling. For example, C8 explained how “the pavements are bumpy and unpleasant... I wanted to make sure that was captured” (C8). Often the video quality was referenced in relation to things which changed during a clip: “we see the difference of the quality of the surface towards the end” (C20). Similarly, one person’s awkward ‘back and forth’ manoeuvring in the tight confines of a bus, as the seconds ticked by while others looked on, illustrated the value of video in expressing aspects of the temporal and dynamic nature of accessibility (*Video Figure*). By contrast, participants struggled to make sense of the graphs of accelerometer data that represented these issues quantitatively. This may partly have been because, as the data was collected over the entire journey, variations in the graph at the scale of individual video clips were difficult to discern in Google Earth. Although some participants thought graphed data was interesting, it seemed too abstract for most to engage with when compared to the visual impact of the camera shake.

Supporting Reflection on Everyday, Embodied Activities. In addition to its value as ‘evidence’, JourneyCam data also supported participants in reflecting on their lived experiences as powered wheelchair users. One explained how using JourneyCam encouraged them to pay unusually focused attention to aspects of their everyday experience:

“when you actually have to concentrate on what you’re doing... and actually when you sort of have think about ... sort of dodging something, it does make you realise how much you actually do it” (C13).

Such comments highlight not only how the avoidance of obstacles (and indeed general navigation through space) is part of the everyday embodied experience of being a powered wheelchair user, but also that the use of JourneyCam itself helped participants to surface and explain the nature of some of their interactions with the environment. Similarly, the data captured also served as a prompt for the researcher to ask about particular issues that appeared to be hidden to the participant themselves. For example, one participant was surprised to be asked how they felt about having to navigate carefully around a car on a residential road: “You know, I– without knowing it... I didn’t realise I’d done that. Until you’ve brought it up” (C14). Here, JourneyCam data enabled researcher and participant to collaboratively co-construct meaning around an ordinarily ‘invisible’ aspect of the latter’s everyday experiences of mobility. This points towards the value of the tool as a resource for reflection and discussion.

In talking around JourneyCam footage, participants often highlighted how others did not understand the experience of being a powered wheelchair user. As one put it, “I think it’s that ignorance again... they don’t know what it’s like, they



Figure 5: Pavement guttering, likened by C20 to a speed bump (L) view from JourneyCam (R) researcher photo

don't understand the problems" (C3). Here, JourneyCam data alone was felt to be insufficient to convey the complexity of people's experiences, and participants added explanatory narratives around video data. One explained they had captured a particular clip (Figure 5):

"to highlight how you had the guttering along this road... it's almost like a speed bump for a wheelchair user because you're driving along there and you've got to slow down, you've got to stop, you've got to go over it slowly, you've got to carry on going, slow down and so on... you can even see how the camera shifts and moves" (C20).

All participants found uneven surfaces problematic, causing pain and discomfort. While a video might convey unpleasantness, participants vividly described the physical impact of such surfaces. They explained how it *"hugely affects my back" (C28)*, *"really plays havoc with your bones" (C14)*, and even had functional effects on their lives: *"rattling across an uneven surface, it hurts; it moves things, it can shift things; and put me in bed for a few days... It's a real problem" (C34)*. Bumps could be dangerous, as they could knock people out of position and result in them losing control of their chair. For this reason, some participants asked the researcher to put a hand on their body or chair to help steady them at specific points during journeys.

In these examples, JourneyCam data was used as an entry point for people to discuss their experiences, going beyond visible or self-evident issues in the clips. The importance of narrative in this process was vividly highlighted in relation to feelings of security, which could not be adequately conveyed by visual data alone. One person described how they disliked passing smokers in the street, as carelessly-held cigarettes dangled at face level:

"I will dodge them, because it's right in my face. So you've got the smoke... [feeling] 'am I gonna be burnt', things like that... I hate it. That is like a pet peeve" (C13).

They explained that although their physical movement of dodging the smoker would be visible in the video clip, as might the cigarette or smoke, the underlying reason for and emotions surrounding this would not be apparent. Similar comments were made about feeling unsafe in certain environments and at particular times, such as after dark.

Discussions that began around a video clip often went further, unearthing 'hidden' issues that were very insightful despite not being directly tied to the initial data captured. A clip of an inaccessible shop led to a participant explaining the conscious effort they had to expend when planning an accessible route and places to visit (this was a common theme). However, they also explained that as so few shops were accessible they had little choice of where to do their shopping. This had real financial implications:

"sometimes you've got to pay more because [that shop] is the only one you can get into... it's another one of those issues that people don't understand, that being disabled sometimes costs you money" (C3).

Another participant contrasted a well-built path outside new houses with the old, poorly maintained path it joined, using this specific issue to reflect on their broader experience of being disabled and their perceived worth in society:

"it just really reinforces the kind of view that actually you're not really appreciated, you're not really valued. You're floating between the responsibility of local government and... private contractors" (C20).

Elsewhere, it was the absence of something in the data, or a contrast between it and previous experiences, that prompted a participant to discuss a deeper issue:

"we were just really really lucky with the two buses that we got... [they were] the best buses in terms of width that I've ever been on! And I can guarantee if I go on a bus tomorrow, without you... it'll be really tight again" (C28).

Responding to the data, they compared the experience we had to their usual (more negative) experience. Similarly, participants sometimes identified issues that were not immediately apparent from the clip alone. One person noted of a footpath surface that *"it doesn't look that bad, really, but it is! Very uneven" (C3).*

JourneyCam thus supported deep reflection on the complexities of being a powered wheelchair user, helping to unearth and facilitate discussion around the meaning of particular experiences. While some of these may be apparent to even a casual observer, the significance of others were known only to the person themselves, or were latent and emerged through discussion. The process of using JourneyCam and reflecting on the data helped participants to surface embodied knowledge which augmented, but did not displace, their prior conception of JourneyCam as a tool for 'objective', 'evidential' data.

6 DISCUSSION

Working intensively with our participants to explore their experiences through JourneyCam generated a large amount of rich data. They viewed it as a worthwhile endeavour, unanimous in feeling it would be useful to capture a representation of their experiences of mobility, and ascribing particular value to the visual nature of JourneyCam data. This was both because it ‘evidenced’ particular issues, and because it served as a resource for detailed conversations about their experiences. This accords with prior work which has highlighted the veracity of video, which is felt to provide rich accounts of people’s personal experiences [10]. Our participants suggested that visual clips provided ‘proof’ to support their accounts of events, an understanding which appears to reflect the notion of a ‘participatory panopticon’ [42]. In addition, they felt that the visual clips might help engender empathy for their point of view as powered wheelchair users.

Below, we draw out four specific learnings and opportunity areas for life-logging technologies akin to JourneyCam, grounded in our findings.

Balancing specificity and openness in media capture

In its ability to capture and represent experience through visual data, there are parallels between JourneyCam and ‘life-logging’ technologies. Given our focus on experiences of mobility, the motion inherent in video clips was especially valued and commented upon by participants. Prior work has highlighted that the different qualities of data generated by life-logging tools, such as the ‘time-lapse’ nature of SenseCam, can affect the values people assign to the data they capture [47]. This was the case with JourneyCam, where the bumpiness of the videos was felt to represent participants’ experiences and so was prized, rather than rejected as being of poor quality. In addition, our findings support previous research on how different forms of data in life-logging can help to mediate memory in different ways, supporting both highly detailed recollection and inferential memories [33]. Considering the implications of using such tools for recollection, Sellen and Whittaker note that ‘collections of digital data can serve as cues to trigger autobiographical memory about past events but are not memories in themselves or in any way facsimiles of personal experience’ [64: 75]. Again, our work with JourneyCam supports this: clips prompted specific recollections, but also triggered far richer autobiographical narratives around powered wheelchair users’ experiences and lives more broadly.

As in [20], key to our participants experience of JourneyCam was that the specificity of contexts and situations captured in the video clips acted as a springboard to opening up broader discussion points about related situations participants had experienced and, indeed, wider social and environmental issues not necessary captured in the clips themselves.

As such, balancing the need for specificity (to provide specific examples) and openness (to connect to related and more general issues) is critical for life-logging systems that seek to promote dialogue around generated media and data.

Scaffolding and facilitating discussion around captured media

Building on the above point, a key distinction between our approach and that of life-logging tools was the purposeful nature of data capture we designed into JourneyCam, empowering participants to capture video and data of things they perceived as meaningful at the time of experiencing them rather than highlighting these later [33, 64]. This stemmed from our desire to understand people’s embodied, in-the-moment experiences and subsequent reflections on those experiences, rather than the post-hoc curation of selected moments from a journey. This also had a practical corollary: with journeys of several hours, post-hoc curation from a continuous recording could be very time-consuming.

However, the process of sense-making around the clips was not restricted to the moment of capture. Nor were videos alone sufficient; rather, they were at best an incomplete representation that could not convey many of the emotional or ‘invisible’ dimensions of experiences, nor the meanings attached to them. Rather, JourneyCam data formed part of a much broader collaborative process that began with informal discussions about the research, was followed up with data collection ‘go-alongs’, and ended with semi-structured interviews around the data. Data played several roles in scaffolding talk about experience and enabling the co-creation of meaning. It refreshed the memory of the participant (and researcher); prompted the participant to explain their purpose in capturing the event, in the process elucidating multiple layers of meaning and experience; and in some cases led the researcher to ask particular questions. Through collaborative sense-making, grounded in the physical places that the participant and researcher had experienced together (but differently) during data collection, participants were able to surface and discuss issues of concern. This suggests that when technology is used in an attempt to understand people’s experiences of place, there is less need for ‘more data’ per se than there is for the tools and processes to help structure discussion and dialogue around it. We might consider metadata around place-based experiences: rather than capturing data for annotation based on an action, behaviour or barrier—such as the bumpiness of a surface—we might instead annotate based on experiences (being “rattled about”, feeling “safe” or being “comfortable”). We could design visualisations to better support collaborative interpretation and sense-making of data (e.g. [1]) and investigate them in civic place-making contexts.

Joining and linking personally captured media to generate evidence for change

It was also clear from the accounts people provided, and the ways in which they drew upon their embodied experiences of their journeys, that powered wheelchair users feel their experiences are poorly understood by others. This lack of understanding was felt to be pervasive amongst members of the public and civic officials alike, and was believed to be at least partly rooted in the fact that these people were not wheelchair users themselves. Capturing experiences to convey to decision makers was therefore perceived as an important step towards accessible environments, and participants recognised that JourneyCam data (and the narratives they constructed around it) could have a potential role in these processes. This supports previous findings on the value of digital imagery in verifying factual accounts and in supporting conversations tailored to particular recipients [15]. Prior research has highlighted how video based evidence is relied on by civic decision makers as providing objective and factual accounts [37], and our own previous work noted the importance of meeting decision makers' expectations when evidencing accessibility issues [62]. As such, participants were aware of the need to go beyond individual 'stories', and draw links and contrasts with the experiences of others.

Our findings hint at how this might be achieved, through the ways that participants acknowledged diverse embodiments and needs. At one level, this might mean creating collaborative online environments where JourneyCam users view, annotate and link together clips collected by others—and perhaps in doing so start to articulate overlaps and commonalities between different people's embodied experiences in different locations. The collation of such material might be a useful starting point for generating an evidence base for change that could lead to meaningful engagement with civic decision makers. At the same time, such systems should facilitate an awareness that accessibility issues are complex and often come with tradeoffs between the needs of different members of a population. For example, several participants highlighted how tactile paving caused them discomfort as wheelchair users, yet recognised its importance for those with visual impairments. Such comments, surfaced in nuanced discussions around the particular clips people captured of their own experiences, suggest a starting point for collaborative civic conversations about accessibility and an awareness of the necessity of going beyond individual needs.

Overlaying and synchronising captured media and data

Finally, our findings highlighted some challenges participants had in making sense of the sensor (accelerometer) data captured by JourneyCam. Although they saw value in it, they

generally found it hard to relate to their lived experience. Instead, they relied more on the videos, and how they captured vibrations and movements speaking to surface quality, than they did the sensor data itself. This could be partly put down to the manner in which our data visualisation worked and how it may have been difficult to navigate to and through the accelerometry data. As such, ensuring this data is more easily accessible, and even overlaid directly onto other media when played back, would aid its access and make it more obviously scrutable to participants.

7 FUTURE WORK

Further work is necessary to explore how JourneyCam data, and the reflection and understandings it prompted, might be usefully brought into civic discourses and urban planning. Acknowledging this, we have facilitated follow-on Skype workshops between participants, where some of the data they have collected has been shared and discussed in a closed group as a resource for defining action points for future change. These workshops have explored what it might mean to form a 'public' around these issues [8], and participants identified a wide range of possible approaches to fostering civic dialogue with others that was grounded in their experiences. These included, for example, creating a documentary using the video data they had collected, additional development of JourneyCam to enable a public release, or even becoming involved in the education of the next generation of planning professionals.

However, participants were not naïve about the challenges associated with bringing about change. While developing these ideas and how to bring them about, they prioritised those they felt might be most effective and acknowledged logistical, financial, time, and structural constraints. They also anticipated how creating such publics around their data would inevitably involve issues such as a trade-off between their own privacy, the privacy of those who may be accidentally (or indeed purposely) captured in video clips, and the documentation and elucidation of the barriers they faced.

8 CONCLUSION

We conducted a field trial of JourneyCam, a mobile phone-based platform that enables powered wheelchair users to capture video and sensor data 'on the go'. This demonstrated how experiential data can be used as a resource to scaffold place-based conversations around mobility and accessibility, unearthing and highlighting nuanced and complex aspects of embodied experiences of particular environments. Most participants said they would use JourneyCam again, or commented that taking part had inspired them to record journeys in future. When asked why, the common theme was empowerment: showing their perspective on issues that matter to them, and enabling conversations around these

issues on their terms. One can imagine bringing different experiential accounts into dialogue, such that those with diverse needs could see things from one another's point of view. Building tools that support this emancipatory potential is critical. Place- or mobility-based civic technologies should seek to surface and engage with the embodied knowledges of marginalised citizens such as disabled people, to enable their full and equal participation in conversations around place and space.

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