

In-Car GPS Navigation Usage – An Ethnographic Study

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ABSTRACT

This study observed the practices of driving when assisted with GPS technology. The aim of the paper is to understand how GPS alters the ways people interpret their environment and navigate through it. This paper presents an ethnographic study of end-user behavior based on existing navigation systems. The study is grounded in observations of participants (both new as well as experienced users of GPS systems) driving with the help of GPS navigation and their common practices and experiences. By observing participant's usage of the GPS systems, the emphasis of safety, efficiency and enjoyment have been proposed in future design for automobile navigation systems to support richer experience of driving.

Keywords

Geographical Positioning System (GPS), social dynamics, cognitive maps, landmarks, ethnography, qualitative field study, embodied interaction.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Automobile GPS navigation technology is an excellent example of technology that adds value in daily life. GPS, an interactive map, is an innovative concept. GPS is a natural progression to mapping technology. First developed by the United States Department of Defense, GPS was officially named as NAVSTAR GPS. In 1983, President Ronald Reagan issued a directive making the system available for free for civilian use as a common good. Since then, GPS has become a widely used aid to navigation, map-making, land surveying, commerce and scientific usage. Even though it has been in general use for the last 25 years, only a fraction of drivers in the United States regularly use GPS units for in-car navigation. [19] However, many of those who do use GPS, embrace this technology. As, one of the users, Debasis mentions, "*It is just a lifesaver! I go out a lot now without the fear of losing my way.*"

One of the most demanding activities for drivers is navigating in an unfamiliar environment: studies have identified the difficulties that drivers have in planning and following efficient routes. [12] If drivers are unable to navigate successfully, there is a range of individual and societal consequences such as driver frustration and anxiety that may result in reduced mobility to travel in unfamiliar environments. In addition, there are potential increases in

congestion and pollution. An empirical study found that in the US up to 20% of the miles driven could be considered 'navigation waste'. [12]

With the regular use of GPS technology for in-car navigation, new practices for finding one's way in urban spaces, country roads as well as on the freeway have developed, and this has transformed the social dynamics involved in road trips to some extent. For example earlier the person sitting beside the driver in the passenger seat used to be the navigator with the help of a physical map but with GPS this has changed. GPS-based car navigation has the potential to open up new ways to navigate and interact with the environment. One of the main aspects of this study is to present the experiences of the participants, which have shaped their mindset and caused them to use GPS in their daily life. The study tried to capture the behavior of the user while using in-car GPS devices. These interactions comprises of navigating to a destination, maintaining orientation, socializing with other people inside the car and attention to other cars and road-signage outside.

This study presents how new as well as experienced users of GPS systems use it and their common practices and experiences. The paper is structured as follows: Section 2 presents the detailed account of the automobile navigation system followed by Section 3 describing the importance of cognitive maps and landmarks in navigation. Section 4 comprises of the method. Section 5 portrays the in-car navigation in both positive and negative light followed by the discussion section. Finally, the paper concludes with the future recommendation, design implications and conclusion.

GPS SYSTEM: AUTOMOBILE NAVIGATION

Typical systems use a combination of satellite GPS and digital map-matching to calculate an optimum route to a specified destination. An automotive navigation system is a satellite navigation system designed for use in automobiles. They then present a series of map overviews and turn-by-turn instructions to drivers, using a combination of auditory (verbal and non-verbal) and visual (text and graphics) information. A typical turn-by-turn instruction is an auditory instruction like 'right turn in 240 yards', It is accompanied by a visual right turn arrow plus a distance-to-turn countdown bar that reduces to zero as a maneuver is approached as shown in figure 1. Using the maps stored in database, the GPS can give directions to other locations along roads.



Figure 1: GPS interface displaying the next turn and the distance also its representation on the map. The other information provided on the screen are a) current speed, b) distance from destination, c) time to reach the destination and d) time of the beginning of journey.

Control Interface

For a driver (or passenger) to interact with a vehicle navigation system, there must be a means by which s/he can enter data (e.g. alphanumeric address), select from options (e.g. preset destinations), request/repeat information (e.g. voice directions), and move through the system (e.g. within and between menu screens).

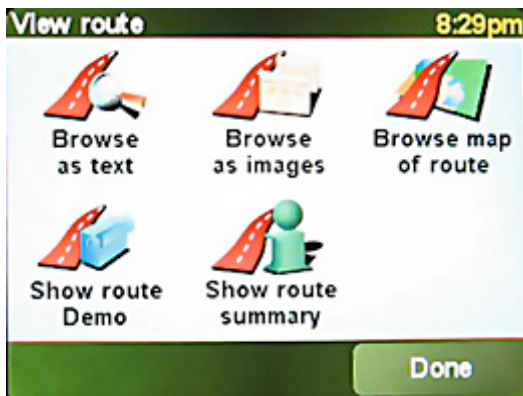


Figure 2: GPS interface displaying the options of representation of route.

GPS provides a few option such as a) avoid freeway or any specific street b) take least time, c) avoid traffic/toll roads. However, the user cannot exactly decide on the route s/he wants to travel. The GPS optimizes the path based on the criteria selected and provided destination. If one wants to take a certain route though the fields and countryside near the dam to reach a destination, GPS may not provide the route s/he is looking for. The GPS user here is the input feeder but the device is the decision maker in terms of the route it suggests.

The majority of current systems provide various types of manual control like finger joysticks, pushbuttons, toggle switches, etc. together with a menu-based display to enable user-system interactions. There are advantages and disadvantages of the different approaches, and many of the issues that concern the design of the control interface for vehicle navigation systems are equally applicable to most computer systems (e.g. menu hierarchies, coding of information, feedback mechanisms).

GPS: Modalities of Information presentation

Many usability evaluations of current generation turn-by-turn vehicle navigation systems have now been reported in the open research literature. The usability of turn-by-turn systems is generally greater than that achieved by drivers using paper maps for navigating. This is largely because turn-by-turn systems only present information, which is relevant to the oncoming maneuver, i.e. the system, filters information, rather than the driver [18]. Furthermore, the use of turn-by-turn information, which is largely verbal in nature, conflicts less with the predominantly visual-spatial task of driving.

The turn-by-turn systems does not attain the level of usability as achieved by the instructions given by an ‘informed’ passenger i.e. a person inside the vehicle with detailed route knowledge who provides clear, timely instructions. Despite the clear advantages of the auditory modality, there are some key advantages for the use of visual guidance information. For instance, with an in-vehicle display drivers can choose when to glance away from road scene and this modality is better suited for explaining what to do at complex maneuvers. Consensus appears to be that, given current technology, a combination of visual and voice information offers the best solution. Thus, drivers can potentially gain from the advantages of both modalities.

Practices in Navigation: Driving Behavior and Local Knowledge.

The route choice process is as frequent in everyday vehicle traveling, as it is complex to describe and understand. When planning a journey in detail a driver considers numerous parameters, such as road characteristics, traffic conditions, time of day, personal preferences, purpose of the trip, weather conditions etc. More the information, better the basis for a decision. Without supporting systems this is very much summing up to the driver’s level of local knowledge. Lotan (1997) compared the route choice behavior of familiar and unfamiliar drivers who use the same road network [15]. The investigation, based on a driver simulator without navigation aids, shows a larger homogeneity among unfamiliar drivers in terms of switching and diverting behavior. This phenomenon is also confirmed by Lindkvist et al. (1995), establishing that the majority of the unfamiliar drivers “are not inclined to divert from the planned route” [14]. In contrast, familiar drivers

show clear preferences among route alternatives. They tend to stick to their previous route, but at the same time they demonstrate a larger flexibility in their diversion behavior en-route [15]. Based on a survey Lindkvist et al (1995) confirm this by reporting “two thirds of the drivers on familiar journeys sometimes or often change their normal route during the trip.” [14] The most common reason for choosing an alternative route on a familiar journey is to avoid congestion that was anticipated in advance.”

Earlier research indicates the need for a wider range of navigation services tailored for different contexts, assisting users with different needs. Lindkvist (1995) shows that local knowledge is often reflected in driving behavior. [14] On the basis of a survey Bonsall & Parry (1990) suggest that supporting drivers in familiar areas is, typically, a matter of informing. [1] The user preferably makes the assessment.

The level of familiarity with the road network seems to have clear impact on the route choice behavior, but to what extent are journeys carried out in well known traveling environments? In a survey by Bonsall & Parry (1990) most respondents said “most of their journeys were along familiar roads to familiar destinations” [1]. It is reasonable to believe that this result is representative to all drivers.

COGNITIVE MAPS AND LANDMARKS

Cognitive Maps

The notion of the ‘cognitive map’ has long been central to studies of maps, way finding and navigation. As with other geographical technologies, maps are used in specific places to understand the orientation and get an idea of the distance between two points. Using fieldwork from how tourists use maps and guide books Brown & Laurier explore how technologies span ‘place’ and ‘space’. They mention “much of their power comes from their standardized, global nature, yet they are only ever used in specific sites.” [2]

An individual who possesses a well-formed cognitive map is able to accomplish navigation tasks based on their own internal knowledge with few cognitive demands. Indeed, in many situations (e.g., when traveling within a home town), the navigation task may involve automatic processing. [11] Informed individuals also have the flexibility to choose and then navigate numerous alternative routes to suit particular preferences (e.g., for a scenic versus efficient route), or in response to unanticipated situations, e.g. heavy traffic, poor weather. Hill (1987) noted that a well-formed cognitive map provides a wider transport efficiency and social function. [10] This empowers a person to navigate for others for example by providing verbal directions as a passenger, pedestrian, or over the phone, sketching maps to send in the post, and so on.

Ashish shared an observation about a friend who is good at finding directions by mentioning, “Anand is very good with the streets and their intersections. He has a good sense of orientation and long-term memory to remember the directions easily. He rarely needs a GPS device to navigate. However, GPS provides a lot of flexibility to the driver in terms to selecting his stopover and changing routes along the way, which cannot be done with the help of a physical map. A printed map only provides a pre-determined set of routes to take but once the person has deviated from the regular path it is sometimes difficult to get back.”

The role of landmarks in navigation

Landmarks are key components in cognitive maps, which has been identified as one of the main strategy for navigation to an unfamiliar destination. Landmarks provide external reference points, which are easily remembered and recognized. They potentially reduce the need to refer to an information display. Research has been conducted to investigate, within a real driving environment, the impact on driving and navigating performance of providing landmark information of varying quality within drivers’ navigation instructions. [16] The navigation systems have been found to be more effective and safer by incorporating landmarks as key navigation cues [3].

The notion of the landmarks provided by Patel et al [17] is that it is user specific; however, there are universal landmarks that are easy to see, remember, and use while navigating. Since universal landmarks are often visible from long distances, we can exploit real world cues to provide additional context when orienting users (e.g., “turn left at the third traffic light”). Universal landmarks can also help users avoid driving off route by using landmarks to reassure (e.g., “you will pass by a grocery store”) and redirect lost users (e.g., “you have gone to far if you see the gas station”).

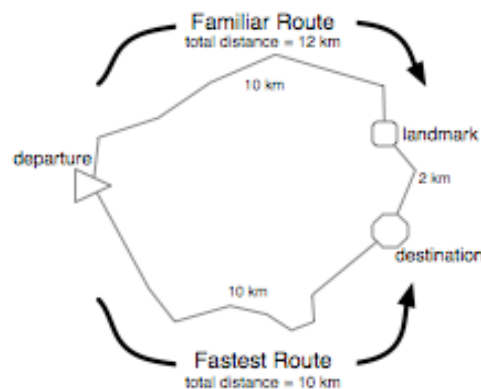


Figure 3: The example above contains a trade off between familiarity and distance. Driving directly from the departure point to the destination is shorter but involves more unfamiliar turns, while driving from the departure point to a landmark and then to the destination is longer but more

familiar [17]

Burnett, Smith, & May (2001) identified 5 attributes that were characteristic of 'good' landmarks for vehicular navigation: permanence, visibility, usefulness of location, uniqueness (incorporating distinctiveness) and ability to be described with brevity. [4]

A hybrid approach (distance to turn and landmarks) may be most beneficial, where distance to turn information is used to create initial driver confidence, and good landmarks used when they become clearly visible. Although landmarks are a natural component within human navigation strategies, they will only be beneficial if they are good landmarks, taking into account their visual characteristics, the perception of them by potential users, and traffic environment, such that drivers can see, recognize and use them as navigation cues.

METHOD

The study consisted observations of the GPS users while driving and conducting interviews that were primarily focused on gathering the personal experiences and emotional attachment with the GPS device. The nine participants were all graduate students between the ages of 24 and 30, eight males and one female. The selection was done keeping an equal number of experienced and infrequent/new users with the criteria of experience was six months of regular usage of GPS. The sample consisted of 4 regular users and 5 infrequent/ new users. The driving experiences of the users ranged from eight months to more than 10 years with most of the users having also driven in countries other than the United States.

The GPS units used by the participants were of different models and make. These units were either owned by the informants or provided to them for the study. Sessions typically included taking a ride in the car with the participant driving to locations randomly selected by from the options provided by the GPS. In five sessions we went for a cup coffee to a randomly selected cafe whose location was not know to the user. Two sessions were round trip to grocery stores and these trips were already planned by the participants and also accompanying other people in the car. Other two trips included returning to campus from restaurants in Tustin and Santa Ana respectively. All the trips were in and around Irvine within Orange County.

In the first two sessions I asked questions to the users while they were driving whereas, in the subsequent sessions interviewed them right after the trip. Each session was between 35 - 60 minutes. The analysis of the collected data was done by recording the sessions, transcribing and coding the interviews. Literature survey consisted of reading different research papers related to the study of GPS, the importance of maps and landmarks in navigation, etc.

POINT OF VIEW: 'POSITIVE' AND 'NEGATIVE'

GPS in positive light

GPS provides the orientation and navigation delivered real-time (as a commodity) frees drivers and car passengers from a task that can be cumbersome and consuming, thereby offering added degrees of freedom and new opportunities for engagement with the outside world.

As Dourish in his paper 'Re-space-ing place: "place" and "space"' ten years in CSCW'06, argues the fact that in-car GPS navigation systems provide a virtual representation of a physical space (the grid of streets and coordinates) does not imply the emergence of a separate, detached world with a distinct sphere of practice. Maps, for instance, are technologies that aid in navigating and way finding, and their use reveals complex practices of engaging with the surroundings rather than disengaging with it. The technologically mediated space in this way of thinking essentially provides "new opportunities for appropriating the physical world as part of everyday practice." [7]

Debasis on his GPS: *"I like it very much. This is the best thing I ever had; this is the best gadget I have invested in."* He further adds, *"If I miss something it will re-calculate the map automatically. The best thing is if I plan to go for a movie and I didn't plan for a dinner or some food then it helps me searching a place like an Indian restaurant nearby. Taking a note/print of a google map, won't help to get the direction to the restaurant nearby, Here GPS saves the day."*

GPS in negative light

Existing studies of GPS navigation are typically interested in usability issues, and their methodologies fall into experimental formats. Few research have been conducted in this field which brings out the fact that navigating with GPS devices supports only a reduced, virtual (technology mediated) understanding of landscape. It hinders the development of cognitive maps, and results in poor reconstruction and memory of the environment through which one is driving. Usage of GPS navigation demand less skill and attention by providing orientation and navigation, with instant availability, ubiquity, safety, and ease of use. This results in loss of engagement with the environment and others. This is also brought to light by one of the users. Sri: *"It makes you more dumb."*

While driving Sri expressed his displeasure: *"I have a lot against the GPS device. When you know the place its not a good idea to use the device as it will tell you as it usually asks you to take round about routes. Currently it's asking me to take left on to the 405 N/ 5N freeway but I won't take that, as I know the shorter way home. Usually I try to ignore it. I really can't say whether its distracting or not as I have very less experience of driving with a GPS. However, I can see why it can frustrate the driver as it is repeatedly asking me to take 5N which I will not take and its telling me*

to take a U-turn.”



Figure 4: GPS displaying the next exit to I-5 freeway.

Regular usage of GPS makes one lose focus of the directions. Using the GPS one loses track of actual location with respect to his overall journey. The user blindly follows the instructions provided by the GPS which in turn keeps track of the location by default.

This could be seen in the specific occasions that took place during the study. One of the participants Vivek while coming back to the Campus from Wal-Mart remarked, “I roughly know the way but I would like to use the GPS to just be sure.” So the destination was set to Campus ‘Palo Verde Housing’. We had to stop at Mervyn’s for some purchases on our way to campus but he didn’t enter its location on the GPS saying that that he is too lazy to enter Mervyn’s location in GPS. After following the GPS direction for sometime he realized that we had already crossed it via another route. This incident explains the fact that the user becomes so accustomed and dependent on the GPS that he doesn’t realize the physical landmarks.

Sri’s views the use of GPS: “It is useful to have a GPS when you are not confident, when you are a new driver and finding a route is an extra burden over keeping control over the car than it may be a good idea to have a GPS. But, like I said it makes you dumb, you really don’t know where you are going, you may be taking a more circuitous road everyday wasting more fuel than you could have taken much simpler way. You always rely on the GPS.”

An interesting incident happened in one of the study sessions while going to a café with Debasis. On going round and round entering and exiting the freeway following the GPS directions. This frustrates Debasis so, he remarks, “I don’t know what is happening with the GPS, sometime it doesn’t work properly, I am so accustomed to following this GPS that I didn’t realize it was showing an inaccurate direction. You can say it’s a blind addiction to technology.”

After having driven for 25 minutes still heading no where Debasis says, “We are still lost, have driven 15 miles (25 minutes now) and still it shows the destination as 5 miles away. GPS is not working correctly now, let me pull over my car and see what can we do.”

Leshed et al. in her recent paper (CHI 2008) states that GPS users engage with the physical environment in the car and outside of it, but they also engage with the virtual-technological environment offered by the GPS. [13] They further state that GPS users become immersed more in the virtual-technological environment and less in the physical environment. That is, their primary interpretation process of objects in the world is guided through information provided by the GPS, e.g., when setting their speed based on the route represented by the GPS.

Paul Dourish [7] says that “As such, the blurred boundaries between the physical and the virtual worlds offer new practices “not by creating a distinct sphere of practice but by opening up new forms of practices within the everyday world, reflecting and conditioning the emergence of new forms of environmental knowing.”

Alternatives for people not using GPS

Sri says, “I look at the map-book previously to get a good feel of the road and I always have a print out with me. It has happened I couldn’t find a particular place because sometimes the map you have is outdated. It’s definitely not a natural interaction for me I feel it’s easier to know how to get there if you have a sense a direction. Some kind of mapping device is necessary.”

Pat: “I always go to google maps and note down the route list but sometimes keep the real/ physical map with me.”

DISCUSSION

‘Place’ and ‘Space’

The physical environment plays a large role in the design and use of technology. These systems offer the possibility of technology, which responds better to the environments it is in [5], and also technologies, which interact with the physical world in new ways [8]. Through these developments technology is increasingly taking on a geographical aspect, as it both disappears into the environment, and in turn make increasing use of that environment. The concepts of “space” and “place” would be a good idea to elaborate to understand the usage of GPS as navigation device.

The concepts of space and place have been used widely in interactive system design, although mainly with regard to media spaces and virtual reality, rather than context-aware systems. Harrison and Dourish argued that place and space can be categorized as different aspects of the physical and social world. Space, as they put it, is the physical world. The objects, artifacts, air, and so on that make up the world are space – the three dimensional extended world of reality as it is presented to us: Space is the structure of the world; it is the three-dimensional environment, in which objects and events occur, and in which they have relative position and

direction. The dictionary definition of space is fairly straightforward as “the infinite extension of the three-dimensional field in which all matter exists”. Moving beyond the dictionary definitions, however, Harrison and Dourish differentiate space from place. Place is space which has meaning.

Place is therefore a particular geographic location which has meaningful attachments to the people who pass through it. In a particularly effective example, Harrison and Dourish talk about the smoker’s corner outside Xerox PARC. This is a physical space where the smokers gather in numbers (and perhaps even gossip about what goes on inside the building) this space is a place – a space with value and meanings. In this case, it operates as an interval from the activities inside the building.

More specifically, Brown and Perry [2a] propose that the ways in which the mediation between space and place is “pulled off” by users as these technologies are put to use is an important issue in understanding the nature of the work that people do to make sense of landscape and road information. These artifacts bridge different geographic places through their design and use. They explained with the help of examples like the guidebook and the map that the technologies present the user with spatial information that needs to be put together with local placial information to guide activity. This “embedding” of representations within an activity is an important aspect of the performance of that activity.

The study of GPS shifts our focus in the direction of thinking about the space of technology – how it connects and links together disparate places. Use of the word “space” in particular allows us to think about the abstractions that technology makes use of. Yet we must not lost lose sight of the fact that technology is used in specific places. Indeed, technology often involves the job of applying abstractions to specific situations – bringing together space and place.

Experiences of Space and Place

One interesting differentiation is between space and place in relation to each other: “Space” is more abstract than “place.” Harrison and Dourish say “A place is generally a space with something added –social meaning, convention, cultural understandings about role, function and nature and so on.” Active participation and engagement, such as building a house or interacting with people, increase awareness of objects in the physical environment and generate valued attachment to them. [9]

However, active participation in the physical modern world is much reduced. For example, most people no longer build their own houses and many less interact with their neighbors. Furthermore, modern society is increasingly literate, depending less on physical and material objects in the environment and more on virtual symbols (books, the Web) to embody the value and meaning of our culture. GPS

technology, with its coordinate system, navigation directions, map displays, and array of settings, provides an abstract representation of the physical environment. This suggests that depending on GPS for navigation may replace embodied experiences of the physical world with conceptual abstractions of it.

Using GPS alters the process of turning our surrounding environment from space into place. Rather, place becomes those objects within the GPS technology, while physical objects in the environment remain indistinct from each other.

Device-Centered interpretations of technology change.

When setting out to critically examine how a new technology changes our experiences of and is adopted in daily activities, there are two main point of views prevalent among users. First, that of technological determinism i.e., perceiving technology as an autonomous, external force imposing societal change. This would suggest that GPS technologies have a concrete and deterministic effect on users’ engagement with the world that arises from their functional structure without regard to the face that user appropriation and social forces involved in shaping technologies. Second, is romanticizing the traditional, which would suggest that if GPS technologies alter human behavior, this must necessarily be for the worse.

A similar case can be made for the use of in-car GPS navigation systems in urban or suburban environments. GPS relieves the car driver and passengers of the need to closely observe the environment, to look out for road signs or landmarks, to orient with respect to where they are located, and to memorize a chosen route for future reference. Instead it offers orientation and navigation as a commodity: anywhere and anytime. Thanks to GPS, “engaging with the environment becomes a matter of choice”.

Dourish instead encourages us not to look at space as pre-given, but to recognize both space and place as “products of embodied social practice” [7]. As the introduction of new technologies generates new practices, new forms of spatiality arise, with new opportunities for engagement with the environment. Hence, looking at the use of GPS devices is only one aspect of understanding the changes they bring about. For a more complete picture one would want to look at the social processes that are influencing and are influenced by these devices, and how they feed into their design and production. But it is our responsibility to take an active role and make informed choices instead of being judgmental to an independent technological development.

ANALYSIS

The analyzed ethnographic study is dedicated to in-car navigation usage – as practiced. Many observations are made, but some issues call for special attention. First, the

study provides a clear answer to the question whether driving context has impact on system usage. When driving in an unknown environment the participants frequently use the GPS navigation system. However, the GPS directions are only moderately followed when driving in a well-known regularly used environment. Therefore, driving context, in sense of where the journey is carried out, has a clear impact on the level of usage.

Second, the study illustrates how user behavior is related to driving context. In a foreign traffic environment the users basically always employ the system in an active manner. By the expression active, I refer to a use case where a destination is set, route calculated and guidance provided. However, when employing the system in well-known environment users seem to prefer a passive usage, without configuring a route, and thereby focusing on orientation and situation awareness.

Further, in the interview a number of participants touched upon the topic that users with good computer skills would have somewhat more active behavior, when operating the navigation system, than the average user. So a GPS should be designed keeping in mind the level of expertise and skill of the intended user.

Pre-navigation/Route Choice: In the study I was interested in how the participant, using a GPS device, chooses which path to take in order to get to his or her destination. Given that the GPS “knows” the current location and assumes that it is the origin of the path, the user only needs to state the destination of his or her travel. This is typically done by keying in the address, sometimes using suggestive menus, including the name of the place (e.g. restaurant name), street address, city, and state, or a combination of these.

Many new users faced the problem to find the Starbucks cafe from the existing options of the GPS. Sri said *“This is the second time I am using a GPS, I am totally stuck not sure how to enter it.”* He tried for a couple of minutes then gave up.

Once the destination is found, the GPS calculates an “optimal” route, typically given speed limits and distances.

GPS helps to go out to seek new places (e.g.: - go to different restaurants, tourist destinations) without the fear of getting lost. It makes the user adventurous to some extent. But the sense of adventure has a different meaning to different people. Some people like the “feeling of serendipity”; the sense of accidentally finding a place that is just perfect for the moment. They like to pave their own path. This sense of adventure can be explained with the help of the analogy of rock climbing, here the person who climbs first, leading the trail has no safety net and he reaches the top then ties the rope for others to follow. The other climbers are also seeking adventure by climbing the steep rock but with the help of the rope, which helps

keeping them safe as well as guiding them. This explains the difference between living on the edge and within calculated risk. Here the two aspects of rock climbers can be compared with the people who don’t use and use GPS respectively.

Localization and driving environment influencing GPS usage in a different country.

Maps and signage help people identify new places with the help of landmarks and distance information to find their way in a new place. Maps and elaborate signage are one of the prevalent features in the western countries.

One of the users, from India shares his outlook about the difference in driving practices in the US.

Debasis says *“In the US its necessary to have a navigation system when you are traveling as there is no one here to tell you to go this way or that way.”*

Pat originally from Thailand states: *“One feature I think a GPS should have, which it currently doesn’t in US is that it should remember the route that is taken especially helpful in case when driving to a place when we don’t have the street map of that particular place specially driving to a village or remote area. This feature would help track and record the route followed and would help provide the rough directions on the way back. This feature is available in the GPS my brother had in Thailand where we once went to a village which had no existing maps but the device would help map the points to create a path on white space which gave us a rough sense of direction and route to follow on our way back.”*

Pat further adds the importance of GPS in the United states by referring to the gas station. He says: *“GPS is very helpful to find the nearest Gas station when you are running out of it. Its very different from the Gas stations in Thailand which have tall indicators that one could see them from a long distance away, so in US you require a GPS for emergency.”*

Sharing general experiences specifying the requirement of GPS.

Pat said *“I am a bird-watcher and nature photographer by hobby and I like to explore a lot and go to new places. On the way to these places I normally don’t follow a specific route and try to reach places where I could get the best view to take photos. The problem faced by me on few occasions is that I don’t remember the direction to get back so have a hard time wandering on my way back. If the place I am going to visit is not known to me then I normally take note or print the directions from Google maps.”*

He shared an incident that took place while returning home from Los Angeles by describing the scenario *“When I visited my friends place in LA downtown 2 months back. I copied the directions to her place in a piece of paper from Google maps and referred it to reach there. While returning I forgot the note at her house and as a result faced a lot of*

problems returning back. LA has many one-way and carpool freeways so it took me more than 15 minutes to figure out the entrance to the freeway. It would have been a lot easier if I had a GPS then, would have saved a lot of time and effort.”

GPS at Fault

Debasis says “I am completely dependent on it, always take it whenever I plan to go out recently I went to Yosemite, I took my GPS. It saved my life on the trip; there was a detour on the way due to roadblock. Highway no. 120 was blocked due to some ongoing roadwork and the traffic was slow (speed limit was 25). GPS was asking to take 120; in that case I had to use the map. GPS is not always accurate; always you have to use your mind since it is a machine after all and they cannot beat human mind. I had a good idea regarding these conditions and we had some roads in our mind so it turned out ok.”

Ramarcha says, “You cannot completely depend on it and have to use your brain. You have to have some idea of the route and maps as backup.” The same thought has been shared by Abraham as he said “The GPS is an electronic gadget, so it helps you to navigate in driving and going to different places. It cannot make decisions on your behalf as I feel the GPS has still not evolved to that extent. If you are following your GPS and something breaks down then you should have other alternatives to fall back in these situation.”

The study also found that while a few users never use other navigation aids, most are reluctant to only rely upon the GPS and they take with them road maps, printed instructions from online services such as Map Quest and Google Maps. However, having the GPS at hand turns the other navigation aids into backup services, “just in case” the GPS fails.

Debasis said “I once went to a club in Costa Mesa and the GPS suddenly stopped working. I always keep the AAA map as a back up in case I require it. Obviously, every electronic device has some probability that it may fail (not very high one). I cannot bet my life on this.”

Following the Route

The experience GPS users undergo while navigating toward their destination. GPS eliminates much of the need to pay attention on the physical signs. Users can blindly follow the visual and vocal instructions provided by the GPS and reach their destination. Couple of instances showed such patterns of interaction. Some participants listened to the vocal instructions and followed them, without knowing where they are or questioning whether the instructions are correct.

Vivek said that as long as he has the GPS he doesn’t need to be familiar with the roads and he rarely even look at the road signs. Instead of learning the route or using other

navigation aids, drivers using GPS need to learn to follow the instructions correctly.

Social Interactions around the GPS.

GPS units are designed for a one-on-one interaction between the driver and the technology. As a result, we know that interaction with other passengers in the car has altered given in-car GPS units. With vocal directions from the GPS unit, a passenger who serves as a navigator in the car is no longer in need, and so the driver/navigator roles are modified. Alternatively, from our experience we have seen that the passenger riding next to the driver sometimes received the role of interacting with the GPS, in terms of switching settings and displays and pulling up information.

Treating the GPS as a real person. An interesting finding was treating the GPS unit socially, almost as another passenger to give company in the car. Two participants have named their GPS systems and responded to their voice directions.

Vivek said on switching on the GPS: “Saty meet Lydia”. He had named his GPS “Lydia” and referred the device as “she”, also had “conversations” with the GPS unit although it did not incorporate voice recognition. When in parking lot the GPS directed to get to the nearest road a couple of times, he jovially commented “Lydia is getting angry.”

Pat addressed to a similar scenario in the interview “ Sometimes people use GPS to kill time to keep their attention when driving alone. I have a friend who uses the GPS when he drives to his office precisely for this reason, as he knows the route to his office. It’s an interesting practice as he travels via the same route day in and day-out but still uses the GPS to divert his attention so here the GPS acts more like a buddy than a device used to show directions.” This point also illustrates how the social dynamics in the car during the ride has been altered given the existence of GPS.

FUTURE WORK AND DESIGN IMPLICATION

GPS: Efficiency, Enjoyment and Safety in driving.

Efficiency: When discussing navigation in terms of efficiency it is clearly a matter of optimizing journeys, which is a rather complex task. In the end this is about individual preferences of the specific driver, continuously changing with the purpose of the journey. However, when adopting an end-user perspective it is easy to identify a set of key factors of efficient in-car navigation. First and foremost, the system shall be capable of saving time compared to alternative methods. Skilled routing, considering both static map data and dynamic traffic information, is essential to identify fast route alternatives, avoiding congestions.

However, a fast journey is not necessarily effective if the

targeted arrival time is not met. Therefore, precise time of arrival estimation is an important feature of an efficient navigation service. Other time consuming activities addressed by an efficient navigation service are pre-trip planning and on-demand identification of travel enablers, such as petrol stations. The second factor is the capability of reducing mileage. Basically, this is about offering short routes alternatives to the user, but ability to identify temporary restrictions, such as road works, via dynamic traffic information is also relevant.

A third factor when discussing efficiency is the potential to save money for the user. In addition to mileage, it is relevant for a skilled routing to be able to consider toll roads, ferries, charged congestion zones etc, which have a considerable impact on the total travel cost.

Enjoyment: Whether or not a trip has a clear objective traveling can be exciting, interesting and instructive. In-car navigation has a clear potential to improve the subjective quality of the journey, creating a richer travel experience. For an open journey this might be about providing entertaining route alternatives, such as scenic routes. For fixed routes a navigation system can, for example, identify relevant intermediate destinations, such as restaurants, shopping centers, tourist attractions etc. Moreover, a navigation system is, to many end-users, entertaining in itself, providing numerous of challenging features like Mp3 music player options, interactive /stimulating games, etc.

Safety: Traveling always bring a wide range of safety related questions. On one hand worries about getting lost en-route, on the other hand the risk of getting seriously injured, or killed, in an accident. In-car navigation has a role to play over the entire spectrum of safety issues.

First, in-car navigation services provide increased confidence, especially when traveling in foreign environments. Continuous navigation support guarantee that the destination will be found, guidance will be given when action is needed and, maybe most important, the driver will never get lost. This stands true even when the driver takes a detour from his expected route. Second, in a stressful traveling environment in-car navigation can be a valuable tool decreasing frustration, simply by informing. The main goal is, of course, to notify on traffic problems and redirect route, but even when stuck in queue traffic information is highly relevant. Information on congestion extension or estimated duration provides options, whether it is about turning around, taking a break, canceling meetings or simply remaining in the queue.

Third, using in-car navigation adds a secondary task on the driver, which always has to be considered during system design. The trade-off between user value and distraction from the primary task, driving, is difficult. However, a navigation system clearly has to decrease driver workload compared to traditional methods, such as map reading and

notes. Finally, the extensive map databases used by the navigation services opens up for additional services. From a safety perspective it is very interesting to monitor and put attention on inappropriate driving behavior. This might be violation of traffic regulations such as speed limits or other regulations.

Messaging through GPS

With messaging, be it through the telephone, email or messaging, there is also the potential for introducing interactive assistance about places, so that a user could communicate with those who provide services in locations such as transport organizations, tourist information providers, or hoteliers. This feature could be integrated in the GPS. Multi-media messaging could augment these interactions, with information sent when requested. The use of location services also verifies where an event occurred.

Currently GPS technology is based on Lat/Long having variable for location to represent on the map. The representation of time would greatly enhance the experience, as it would help map the events that occurred in recent past at a specific location. This feature could be enhanced to provide the current events with the functionality of personalization depending on the end-users choice. The GPS device would then present the user with the option of “your local current *points of interests*” The context and interaction with surrounding would come into play and thus pave way for better understanding and interacting with the environment.

Moving beyond straightforward way finding, the GPS systems should also more explicitly support the linking of the ‘placial’ features of sites with spatial information. Through providing local information, such as pictures and sounds, it could communicate the specific aspects of places that make them interesting and distinct, rather than simply presenting them as a set of co-ordinates and streets through a standardized spatial view. This is not to say that standardized views are not of use; although it is important to understand how different views are useful at different times.

Communication and information exchange between GPS devices.

Automobile GPS should also integrate radio broadcasting feature that would provide the driver with traffic/ weather forecasts and map that on the map interface. I could also provide real-time accident conditions based on the route and destination. Lets have a scenario that a person is driving from Irvine to San Diego, 60 miles away, it would be of immense help if he knows in advance the weather condition possibility of low pressure, heavy showers, extent of forest fires in the region. A communication standard should be evolved to share information and communicate between two GPS similar to Bluetooth technology, to keep track of other vehicles and to know the speed of the traffic

by detecting the speed of the vehicle ahead of you. This would enhance the ability to know beforehand the traffic conditions ahead and would help take a different route to save time. This could be used to detect the accidents, recent disturbance and road conditions that have occurred on the route that would be covered to reach the destination.

CONCLUSION

The results of the study show how drivers using GPS interpret, learn, navigate, and experience spaces and places in which they interact. Today's GPS navigation systems are aware of position, vehicle motion, destination and numerous of other parameters. However, they are completely unaware of fundamental issues as the driver's local knowledge, experience of driving in a specific area or simply personal preferences of driving or system interaction. Therefore, extended context-awareness seems to be a key to a broader design rationale, considering a wider range of driving contexts. Leshed et al. (CHI 2008) suggests including environmental engagement in the design goals for GPS navigation devices, and suggest design principles that encourage user interactions with the environment to lead to a richer, more engaged driving experience. [13]

Discovering landmarks otherwise invisible from the road, exploring previously unknown areas and the new sense of security, and interacting with the GPS units as if they are fellow passengers are examples of new practices that arise around this technology. Furthermore, GPS units support making sense of the physical world through examples such as locating Starbucks Cafe and Wal-Mart and indicating familiar places such as 'home' and 'work' on the GPS map, thereby increases the comfort level in both familiar and less familiar areas.

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