Exploring Location Histories as a Design Material for Reflection with Memory Compass & Memory Tracer

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Abstract
There are a growing number of GPS-based smartphone applications that record a person's location over time. This accumulation of geolocation metadata offers a valuable resource for supporting reflection on past life experiences. Yet, little design research has explored how location histories can be applied as a material in designing such experiences. We propose *Memory Compass*, an application that offers a novel way to explore your past, and *Memory Tracer*, a device which periodically surfaces location-based past moments from your life. We reflect on key decisions in our process and early implications for future research.

Author Keywords
Location history; Metadata; Temporality; Design Research.

CCS Concepts
• Human-centered computing ~Interaction design
• Human-centered computing ~Human computer interaction (HCI)

Introduction and Background
From keeping an old passport to displaying knick-knacks from travels to showcasing a map with pins in it, tracking

the places that one goes is a common practice. Indeed, the capture and re-visitation of significant locations and places across one's life can play important roles in supporting self-reflection and social connecting [2],[10]. There now exist numerous smartphone apps that record a user's location. One category of apps records location for a specific amount of time (e.g., fitness apps like Strava [23]). Another category continually records a user's location at all times (e.g., Google Maps Timeline [20]). As a by-product of people using services such as Google Maps Timeline, a standardized, accessible form of metadata is now generated that captures exactly where someone is (and sometimes what they are doing) at any point of the day.

While previous work has shown location data can aid in recall of memories [11], this abundance of location history data presents new challenges for the HCI community. This data is largely invisible, often buried in large software applications. This makes it hard for people to get a "grasp" on what is in their location history data. Its lack of material presence also restricts people's ability to casually engage with it as a resource for reflecting on past life experiences [15]. There is an opportunity to engage with these challenges through the creation of new design artifacts that explore how rich engagements with location metadata can be better supported.

What opportunities are there to use this metadata as a way to reflect on one's past? How might curious interactions be supported as people's location history archive grows over time? To explore these questions, we propose *Memory Compass*, an application that allows a user to explore moments from their past based on their current location and *Memory Tracer* a device that occasionally surfaces a moment from this date in a user's location history. Several related approaches including ludic design [5], reflective design [21], and slow technology [8],[16] shaped our design-led inquiry. Methodologically, our work builds on research that emphasize the development of new knowledge through design proposals and practice (e.g., [1],[4],[9],[18],[19],[22]).


```
{
    "timestampMs" : "1492552922083",
    "latitudeE7" : 372242977,
    "longitudeE7" : -804198727,
    "accuracy" : 19,
    "activity" : [ {
      "timestampMs" : "1492552924862",
      "activity" : [ {
        "type" : "STILL",
        "confidence" : 100
        } ]
    } ]
}
```


Figure 1. Moment in dataset

Design Process and Implementation

Memory Compass and Memory Tracer work by leveraging the metadata from Google Maps Timeline. Timeline is a feature of Google Maps that, when enabled on their smartphone, allows Google Maps to continually record a person's location at all times. This data is securely kept in the person's Google account, though the entire history can be exported and downloaded in JSON format. In existence since 2015 [20], with a similar feature called Location History limitedly available since 2013 [24], Timeline gives us the most expansive form of location history metadata.

The first author had recorded their location via Timeline for the past 4 years, which we directly draw on to support our design research inquiry. The entire archive consists of a single array of objects that we dubbed "***moments"*** (see **Figure 1**). For each *moment* there is a timestamp, latitude, longitude, and accuracy value. Some *moments* also have an estimation of the activity that was occurring, velocity, altitude, and vertical accuracy. The first author had 31 months of recorded data, with the dataset containing 70,293 *moments*. After downloading the dataset, we developed numerous Python scripts to get a handle on the data as a material in our design process.

With a relatively simple script we were able to determine all big vacations and travel activities across the years by calculating which days had the greatest distance in miles between *moments*. Another script plotted a randomly chosen *moment* on a map, from the current date in a previous year. When testing this script, it surprisingly sparked a meaningful reflection experience for the first author. This finding made us realize that a singular *moment* from the dataset can prompt reflection. Building on these and other scripts, we then ideated many concepts for interactive systems that make use of location history metadata. Through various cycles of concept generation and critique among our design team, we eventually arrived at *Memory Compass* and *Memory Tracer*. We are in the process of fully implementing both designs and further resolving the form.

Memory Compass

Memory Compass enables a person to explore their location history based on where they are currently located on the globe. First, the user points their wrist towards the direction they want to explore, then sets the distance they want to "cast out." Upon "casting," Memory Compass finds all *moments* within a 10% radius of the casted point (see **Figure 2**). For example, if a person "casts" while facing 94ºE with a distance of 300miles, it will find the exact location 300mi away, then retrieve all *moments* within a 30-mile radius. The farther the cast in any direction, the higher the chance there won't be any *moments* returned, forcing the user to try multiple times before a successful cast. If there are multiple *moments*, it will randomly choose one to return. Once a *moment* is retrieved, the user is able to scroll through a series of information about the *moment*: time, city, location name, activity, and a map.

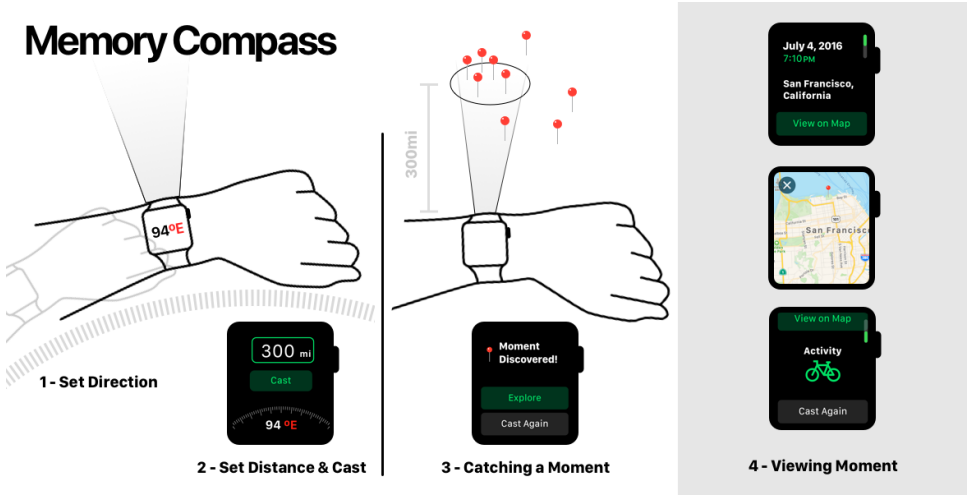

Figure 2. Memory Compass interaction design

Memory Compass' design balances precision in the underlying software with a degree of unpredictability through the interaction. Our intention is that through using Memory Compass one will gain greater situational awareness and understanding of their location history and reflect on moments from their past that they may have not otherwise re-encountered. Future versions could integrate photos taken at the location or songs listened to by cross referencing the timestamp of the *moment* with a listening history archive [13].

Memory Tracer

Memory Tracer is an in-home device that combines and connects two people's location history to surface shared *moments* from today's date in history (i.e., the calendar day of today's date). The device uses a diffused 16x16 LED grid as a display. When Memory Tracer finds a shared *moment* on this day in history, it begins a slow animation while that *moment* is being surfaced. For each year in the past, it takes 1hr to surface; e.g., a *moment*

from 2016 would take 4hrs to surface. Once the animation stops and the display is filled, it lightly pulsates. The same length of time it took for the *moment* to surface, the user has to engage with it. By rotating the device, the user can see information about the *moment*. A touch sensor allows tapping through details: year, distance away, city, activity (if available), and location name. When all details have been viewed, the grid goes empty and the device waits to surface another memory. Memory Tracer's design aims to spark reflection on a shared moment between two people. Through providing a slow expression of information that signals a memory is emerging, time is provided for the user to contemplate what happened on this day in the past, prior to interacting with it. Time also moves through Memory Tracer as it surfaces new *moments* as its owner's location history data grows over time.

Discussion and Conclusion

Through grounding our design led research in the proposal of Memory Compass and Memory Tracer, our work takes a modest step toward responding to growing calls in DIS and HCI communities to design technologies capable of: (a) supporting reflective, interpretive, and meaningful experiences over time [3],[4],[5],[8], [16],[21] and (b) opening new possibilities for forming relations to our personal data in everyday life on individual and social levels [6],[7],[12],[13],[17]. Our research offers early insights into alternative strategies for leveraging location history data as a material to support reflection on personal and shared life experiences. Memory Compass offers the user direct control over surfacing and exploring moments in their location history, but in a way that is unpredictable and can be learned and understood over time. Memory Tracer subverts direct user control to emphasize a slow, yet perpetual pacing that reveals moments from one's shared past with a loved one. Collectively, these design proposals show promise to support reflective, interpretive, and potentially serendipitous experiences with location history data that can scale over time. We envision field studies of Memory Compass and Memory Tracer could provide insights into how their respective interaction qualities might support people's experiences of revisiting, sharing, and living-with their digital location histories. We plan to continue our ongoing work to fully resolve the form, UI, and backend implementation of each design proposal; then produce a small batch of research product [[14]] versions to investigate people's experiences with them over time.

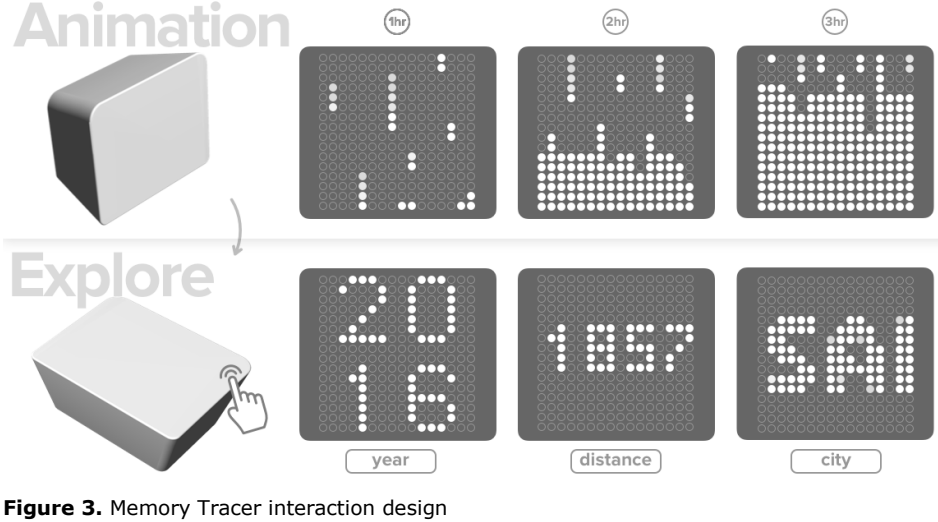

Figure 3. Memory Tracer interaction design

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