



MAPS ON SMARTWATCHES

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INTRODUCTION

There are several limitations when it comes to design of maps for smartwatches such as **limited screen size**, **limited battery supply** and **small hardware size** (Rawassizadeh, Price, & Petre, 2014).

Hardly any research has been done on the design, use and usability of map displays on smartwatches nor on the communication of spatio-temporal information through smartwatches in general.



The overall objective of this project is to provide **recommendations** for the design and use of maps on smartwatches.

The recommendations for the design could be further used by the smartwatch app developers to efficiently communicate the spatio-temporal information to the users to provide **effective, efficient and satisfactory location-based apps.**

RESEARCH OBJECTIVE

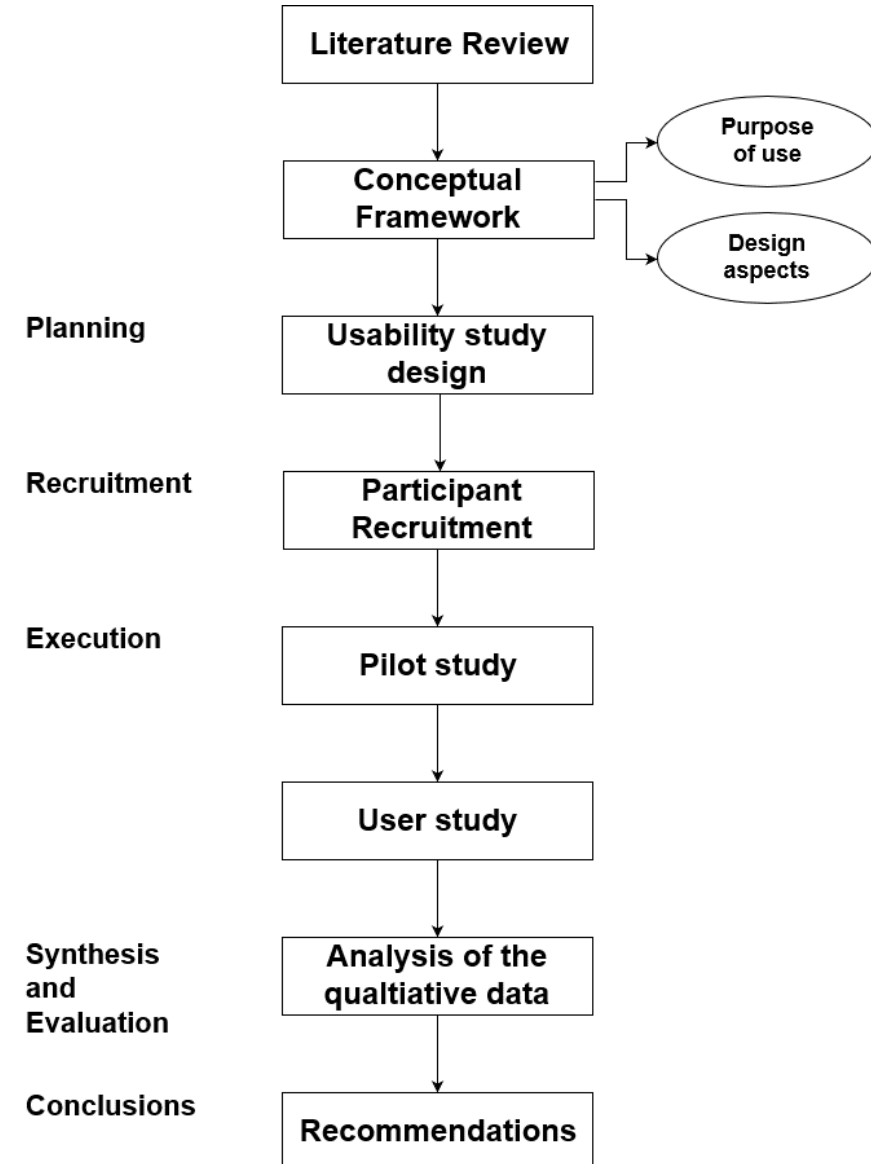


RESEARCH QUESTIONS



1. **What is the state-of-affairs with respect to the provision of spatio-temporal information through smartwatches?**
 - a) What spatio-temporal information is currently communicated through smartwatches and for which purposes?
 - b) How is spatio-temporal information currently communicated through smartwatches?
 - c) Which maps are being used for the communication of spatio-temporal information through smartwatches? What are their characteristics?
 - d) What are the purposes of maps on smartwatches?
 - e) Who is the target audience?
 - f) What are the potential strengths and weaknesses of maps on smartwatches.
2. **What is the usability of current maps on smartwatches?**
3. **Which recommendations can be provided for the communication of spatio-temporal information through smartwatches?**
 - a) In which cases and for which purposes are maps useful to convey spatio-temporal information?
 - b) In which cases and for which purposes is it better to use other ways of communication (eg. text, audio or haptics)?
 - c) How should a map be designed for an effective, efficient and satisfactory communication of spatio-temporal information?
 - d) How should an application be designed for an effective, efficient and satisfactory communication of spatio-temporal information?

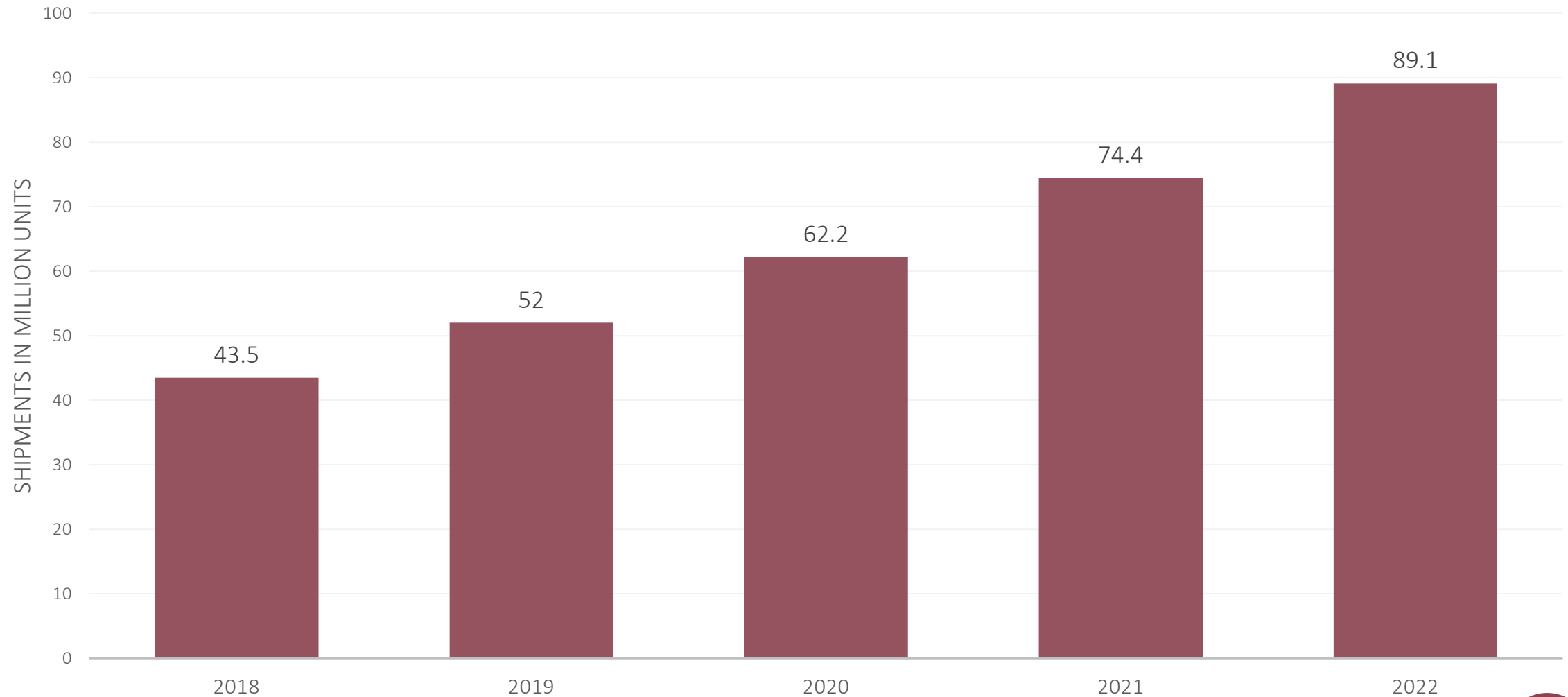
RESEARCH WORKFLOW



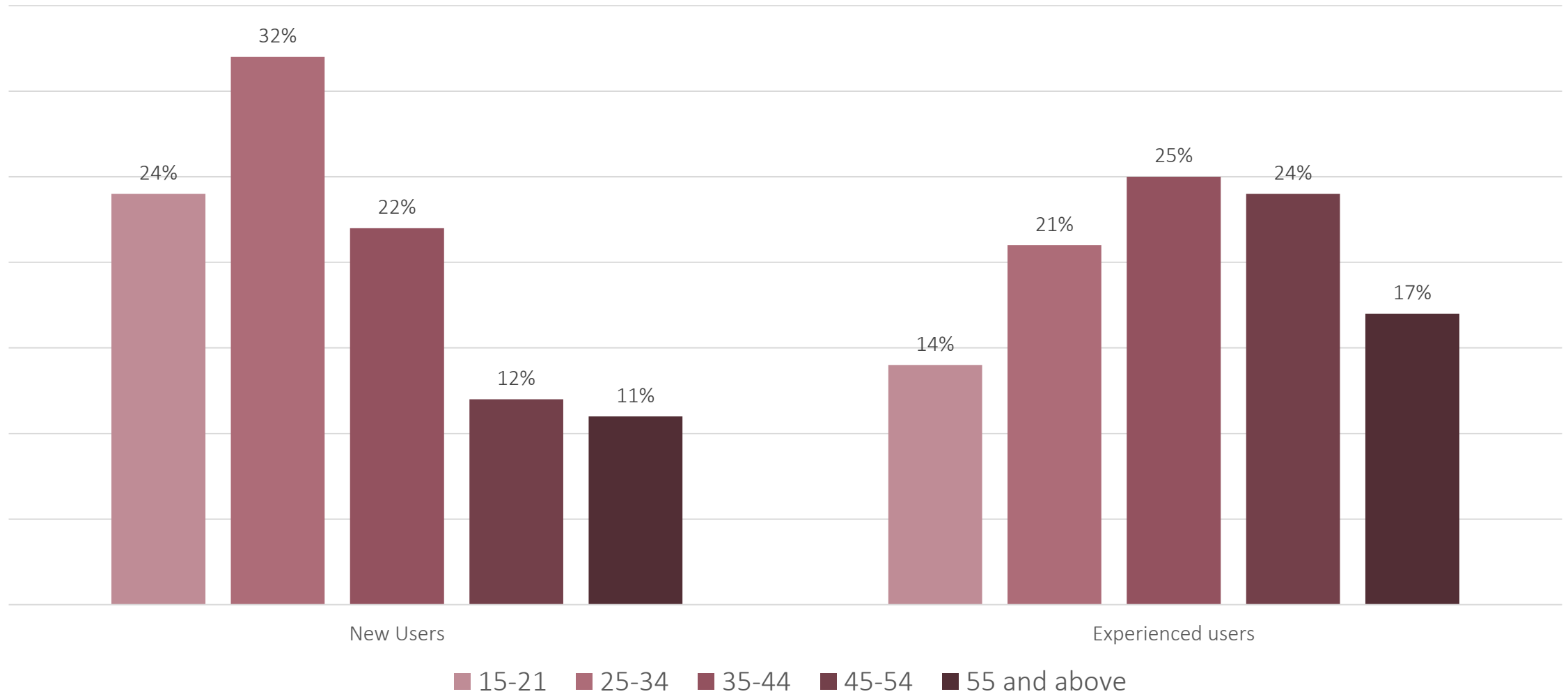
WHAT IS A SMARTWATCH?

A smartwatch is “a wrist-worn device with advanced computational power, that can connect to other devices via short range wireless connectivity; provides alert notifications; collects personal data through a range of sensors and stores them; and has an integrated clock”. (Cecchinato, Cox, & Bird, 2017).

Smartwatch shipments forecast worldwide from 2018 to 2022 (in millions)*



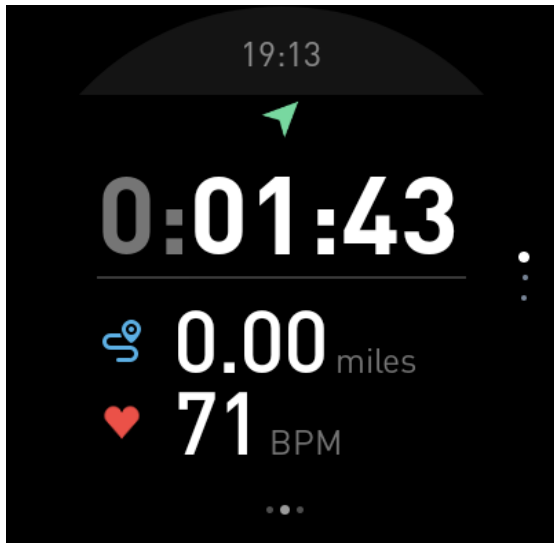
Experienced and new users of wearables by age group



INVENTORY

Category	WatchOS	WearOS	Tizen
Biking	Strava, Map My Ride By Under Armour, Cyclometer Cycling Running GPS	Strava, Bikemap – GPS Bike Route Tracker & Map for Cycling, Ghostracer – GPS Run & Cycle, Cycle Now:	Strava, Bike&Go
Running	Nike+ Run Club, Strava Running, Endomondo, RunGo, Runkeeper, Runtastic, MapMyRun	Runkeeper, Runstastic, Endomondo, Wear Run Pro, Ghostracer, Zombies, Run!, Endmondo	Map My Run, Endomondo, Strava, Personal Fitness Coach, Run4Gear, GearS3Running
Travel	TripAdvisor, Citymapper, Brtish Airways, Find Near Me, Yelp, Foursqare City Guide, Hotwire, App in the Air, Cleartrip, Triplt:	Foursquare City Guide, App in the Air, Citymapper	City Navigator, App in the Air for Samsung, Places
Hiking	AllTrails: Hike, Run & Cycle, Map My Hike by Under Armour, Elevation – Sea Level Map	Locus Map Watch, ViewRanger: Trail Maps for Hiking, Biking, Skiing	BackCountry Navigator, Locus Map Watch
Skiing	Slopes, Steamboat Ski and Resort, Jackson Hole, SNOCRU Skiing & Snow Tracking	Ski Tracks, Ski Pursuit	Samsung Health, Ski Pursuit
Golfing	Hole19, Tag Heuer Golf, UDisc Disc Golf	Hole19, Golf GPS Rangefinder: Golf Pad	Hole19, Golf Navi Pro, Golfwith: Smartcaddie
Taxi/ Driving	Uber, mytaxi, Easy, a Cabify app, PlugShare (EV charger locator app), iParkit Garage Parking	Uber, ParKing, Find My Parked Car - Automatically Locate Car	Uber, Find My Car
Weather	Carrot Weather, Dark Sky Weather, NOAA Radar PRO	Weather 14 Days – Meteored, Dark Sky, NOAA Weather International, Weather Maven for Wear OS, RadarScope	Storm Radar, Weather, GPS Weather Radar, Lightning Map
General Navigation	Maps, ETA – Arrie on time, Transit, New York Subway MTA Map, Tube Map	Google Maps, Offline Map Navigation - Live GPS, Transit Now MBTA, AC Transit, SFMTA Muni, La Metro	HERE WeGo, Navigatior PRO, Navigator – Voice Navigation, GMaps – Google Maps with Navigation, Navigator Standalone,
Social Navigation	Find My Family, Phone, Friends; Glympse		Glympse – Share GPS location

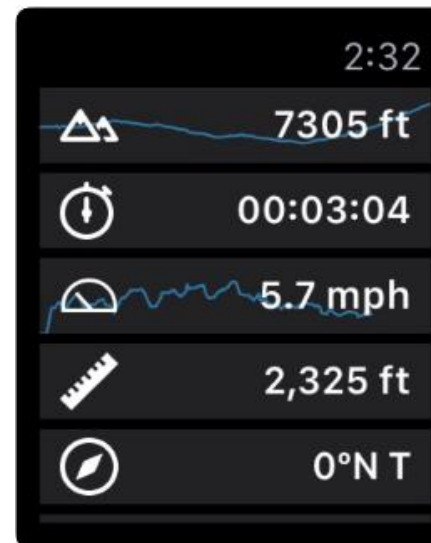
INVENTORY



Outdoor Run



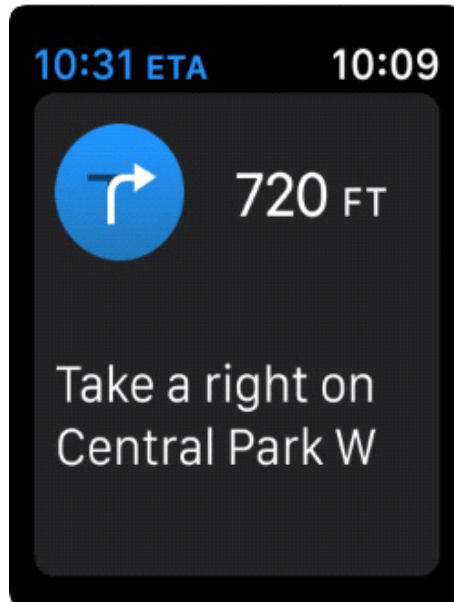
Zombies, Run!



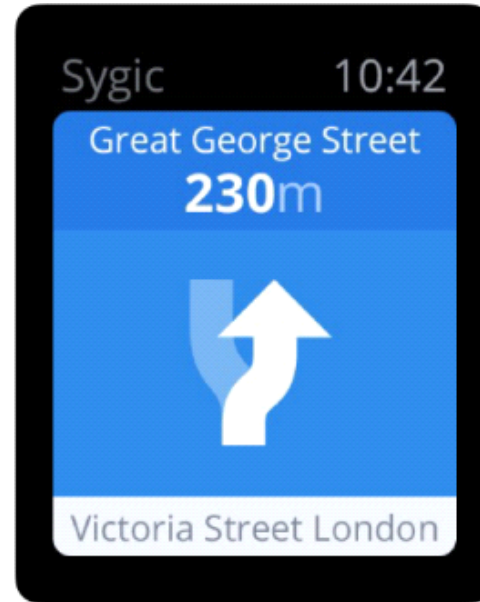
Gaia GPS

Applications using
text for
communicating
spatio-temporal
information

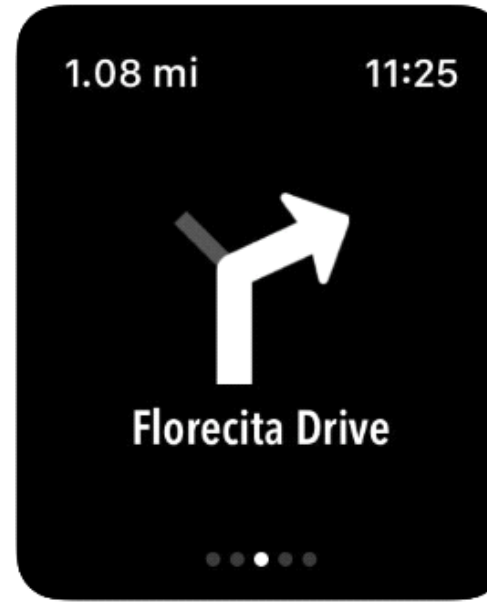
INVENTORY



Maps (WatchOS)



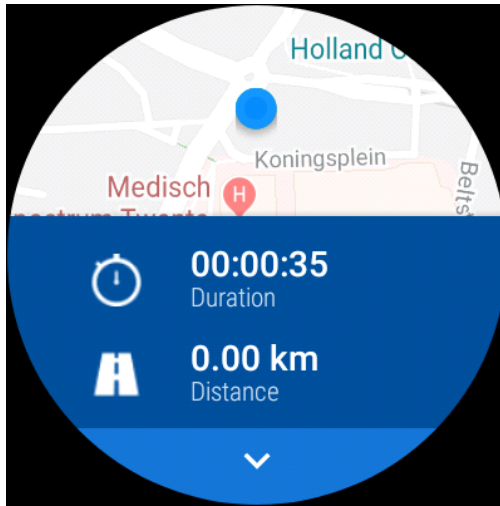
Sygic GPS Navigation
and Maps



Footpath Route
Planner

Applications using
text and symbols
for communicating
spatio-temporal
information

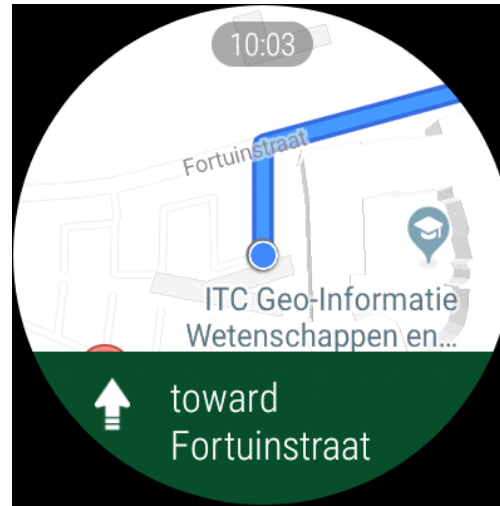
INVENTORY



Runtastic



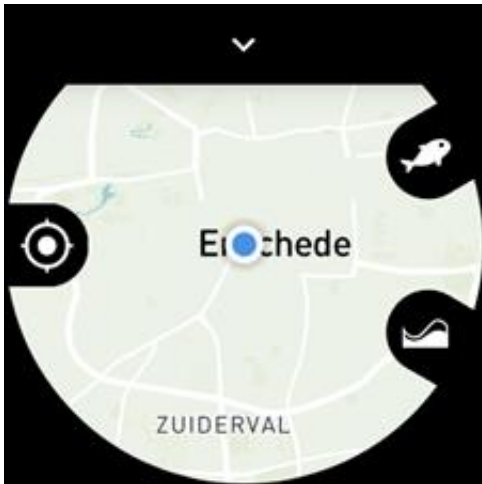
Watch Routes



Google Maps

Applications using both text and maps for communicating spatio-temporal information

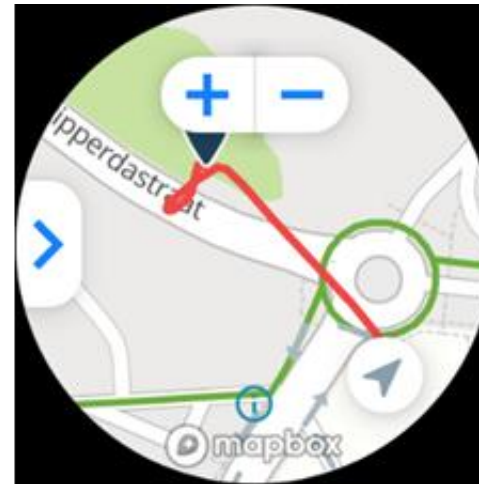
INVENTORY



Fishbrain



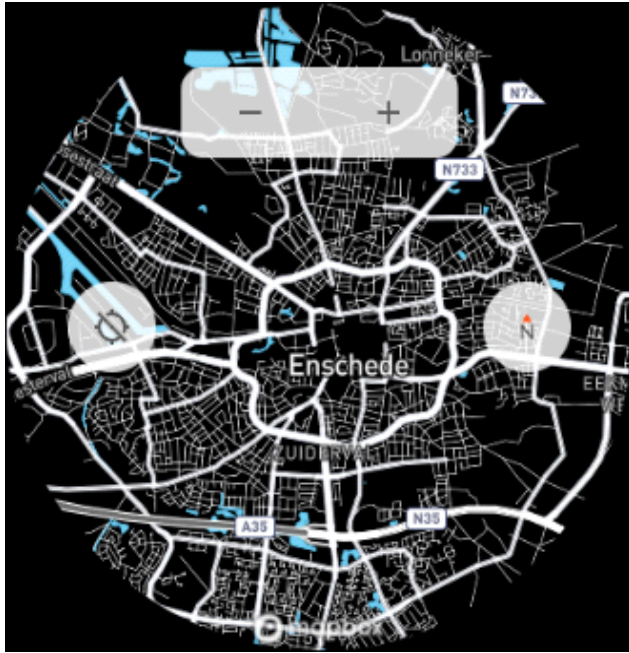
Maps (WearOS)



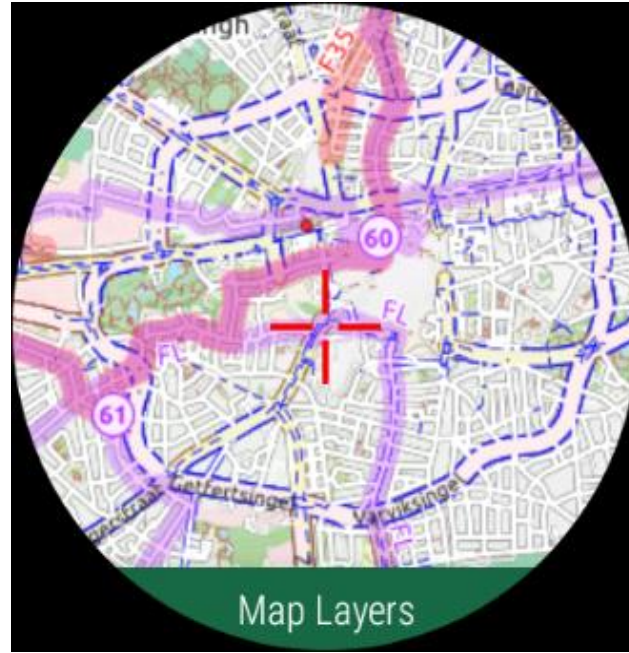
Bikemap

Applications using primarily maps for communicating spatio-temporal information

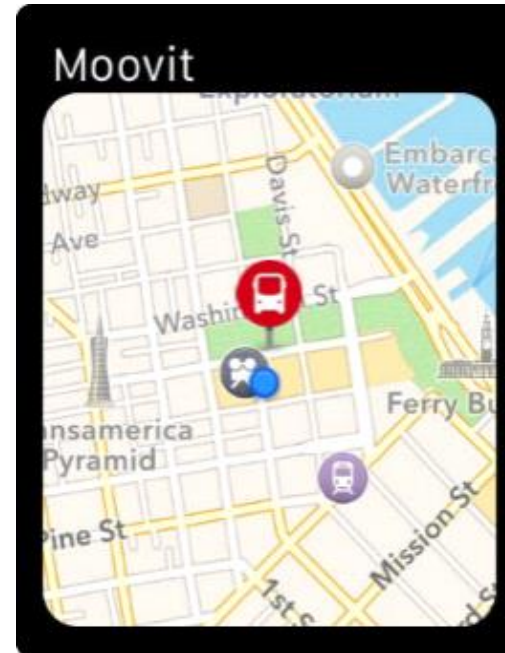
INVENTORY



Maps



View Ranger (WearOS)



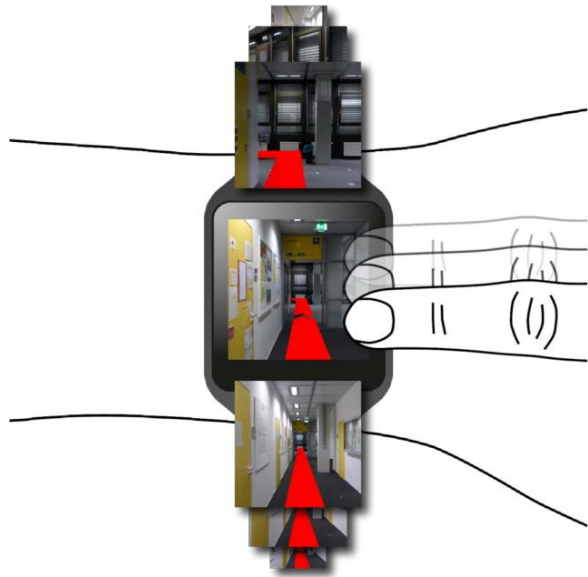
Moovit



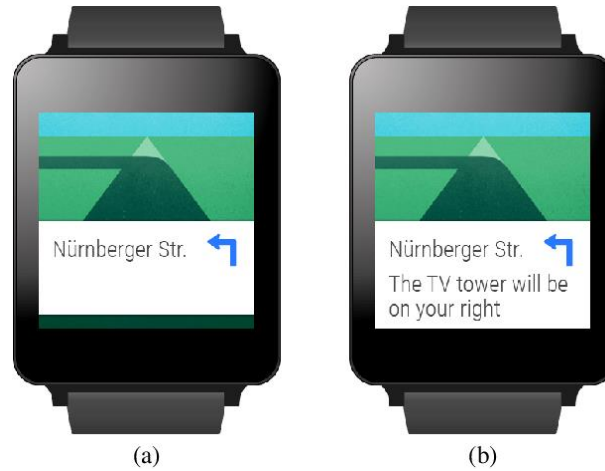
TopoMaps+

Basemap styles

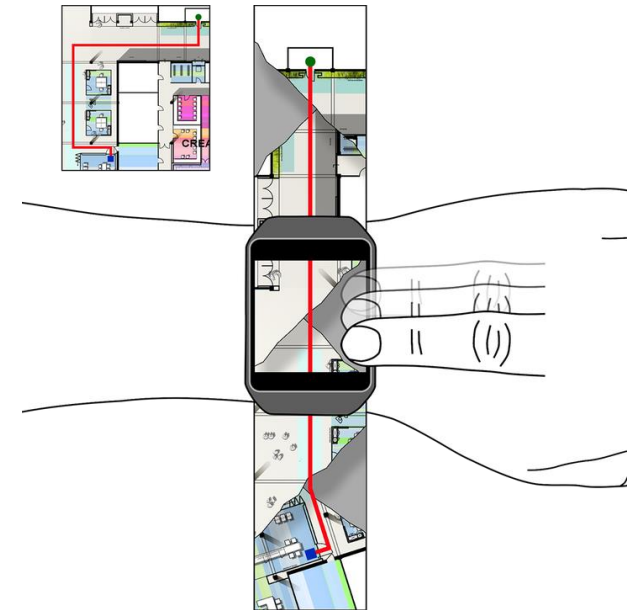
RELATED USER STUDIES



Scrolling Home



Pharos



Stripe Maps

METHODOLOGY

- Online survey
- Observation and think aloud
- Eye tracking
- Semi-structured interview



Recruiting test persons for evaluating maps on smartwatches

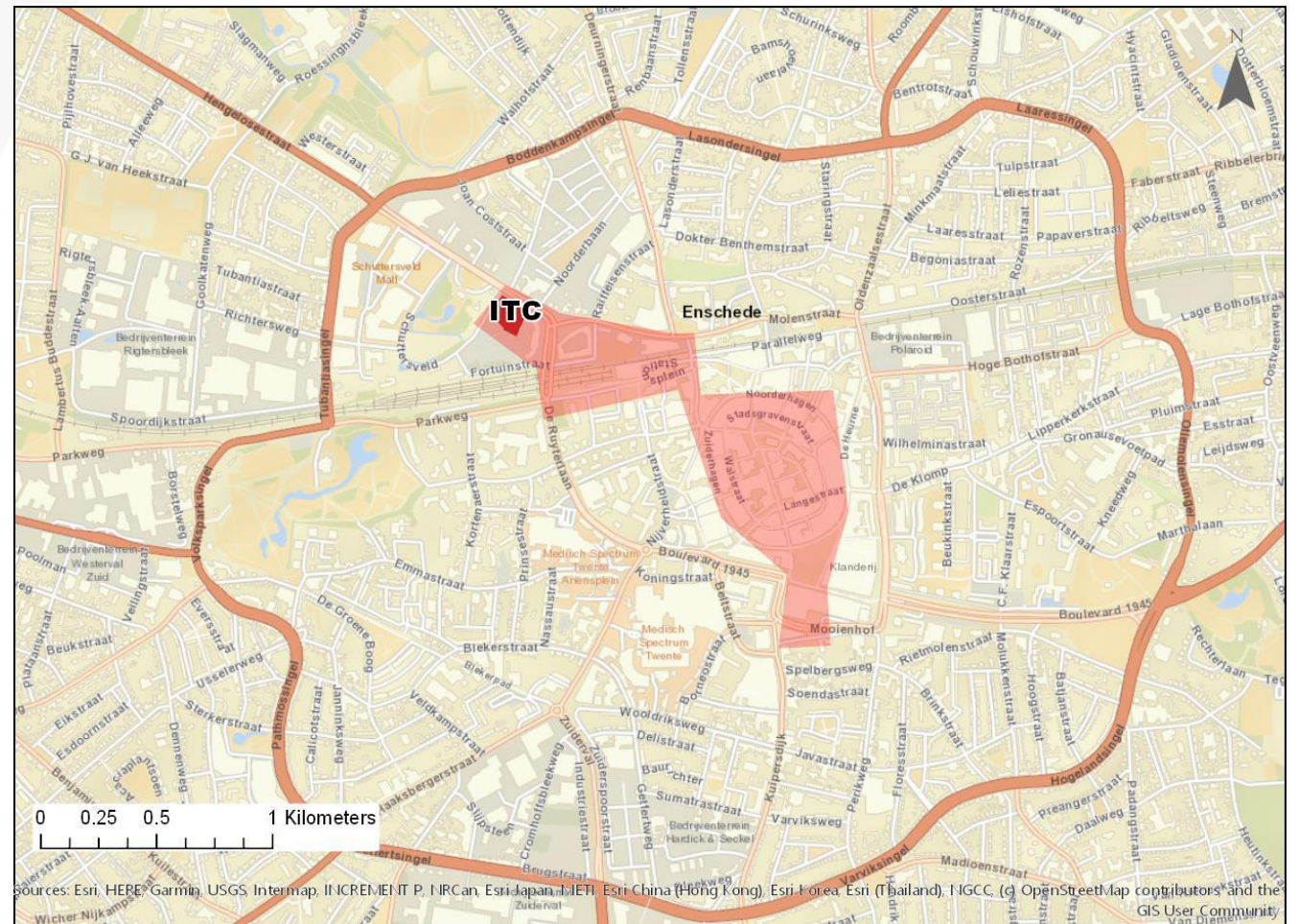
Dear Sir / Madam,

I am Maira Utebaliyeva, an Erasmus Mundus Master of Science Programme student, currently studying in the Faculty ITC of the University of Twente. In my Master research, I am researching the usability of maps on smartwatches. As part of my research, I would like to conduct a user study for understanding the usability of maps on smartwatches.

I would very much appreciate it if you would be willing to participate in my test. Besides

0 of 19 answered

STUDY AREA



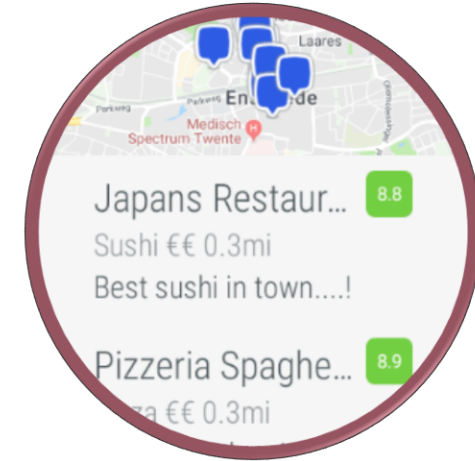
SELETED APPLICATIONS



My Location



CityMapper



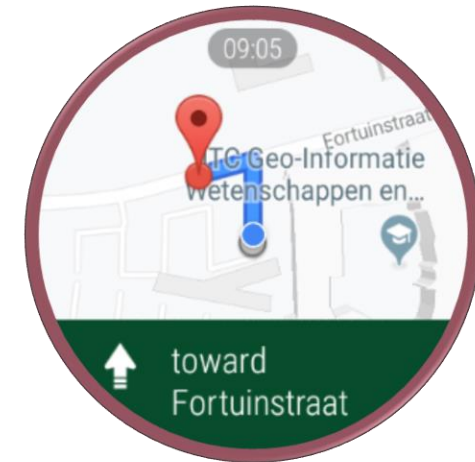
Foursquare



Parking



Locus Maps



Google Maps

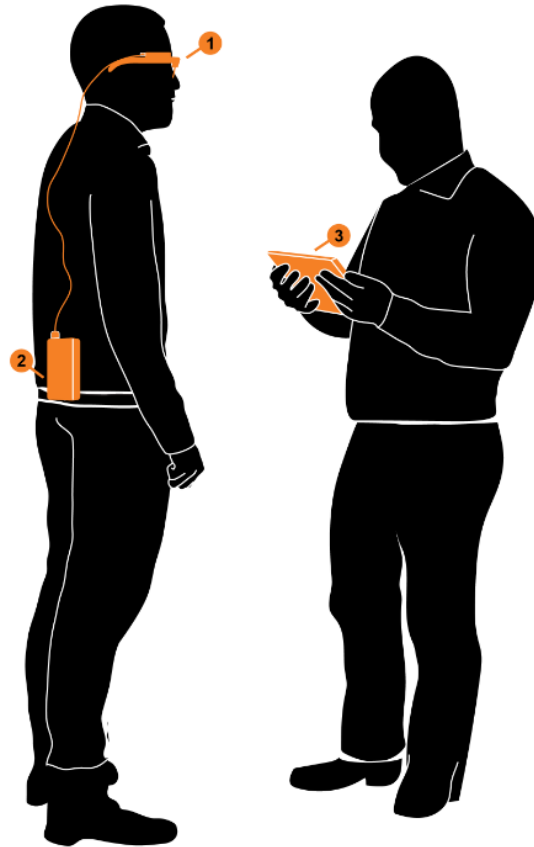
PARTICIPANT DEMOGRAPHICS

ID	Age	Gender	Country of Origin	Highest completed education level	Geo-related major	Smartwatch Ownership	How long have you lived in Enschede?	How well do you know the area?
TP1	36-40	Female	Indonesia	MSc	Yes	Yes	3-12 months	I am somewhat familiar with the area
TP2	26-30	Female	Mexico	MSc	Yes	No	I do not live in Enschede	I do not know the area
TP3	21-25	Male	Netherlands	MSc	No	Yes	More than 4 years	I know area very well
TP4	21-25	Male	India	B.Tech	Yes	Yes	3-12 months	I am familiar with the area
TP5	31-35	Male	México	MSc	No	No	3-12 months	I am somewhat familiar with the area
TP6	36-40	Male	Guatemala	MSc	Yes	No	More than 4 years	I know area very well
TP7	26-30	Male	Pakistan	BSc	Yes	No	3-12 months	I know area very well
TP8	41-45	Female	Romania	BSc	No	No	More than 4 years	I am familiar with the area
TP9	31-35	Female	Greece	PhD	Yes	No	1-2 years	I am familiar with the area

EQUIPMENT



Mobvoi
Ticwatch E2



Tobii Pro Glasses 2
eye-tracking system



Samsung Galaxy J2



Olympia Memo 99 II
voice recorder

PILOT STUDY





TASKS

Application	No	Task description
My Location	Task 1	Identify the name of the place of your current location on the map
	Task 3	Find Grote Kerk at Oude Markt on the map
Foursquare	Task 1	Find the closest place where you can have dessert
	Task 2	Find the place where you can have breakfast next to the railway station
	Task 3	Find where lunch places are concentrated
	Task 4	Choose lunch place next to the Grote Kerk (Oude Markt) with the highest rating
Citymapper	Task 1	What is the name of the street where the bus stop is located?
	Task 2	How many stops do you have to ride?

Application	No	Task description
Google Maps	Task 1	Find Blue Sakura
	Task 2	Check how long will it take you to arrive at the destination
	Task 3	Follow the route
Locus Maps	Task 1	Find the closest parking on the map on the smartwatch
	Task 2	Follow the route
ParKing	Task 1	"Park" your car by placing the car icon on the map
	Task 2	Navigate to your car
Google Maps	Task 1	Navigate to Mexican restaurant using smartwatch (with audio commands on)

SAMPLE USER PROTOCOL

Application	Task	Type	TP6
My Location	Task 1 Identify the name of the place of your current location on the map	Time of the completion	1:30 - 3:00
		Completed task	Yes
		User actions	User takes a watch and opens the application. He immediately recognizes his current location by seeing a blue dot. User zooms in using two fingers. User reads the name of the place from the base map. Then he taps on the map and the popup with the name of the place appears.
		Where the user is looking	User is looking at the map
		User Comments	I go to My Location... I'm tapping on it and accessing the map. Ok, now I see a blue dot with my location. Identify the name of the current location. Well, the name is the ITC Information Faculty... not all the name appears. Okay, long tap on the map. Ah, okay. Now I see, there is a pop-up, the name of the faculty. ITC Faculty Geoinformation Sciences.

CODING CATEGORIES

Category	Sample quote
Map use	Maybe I look at the map because I want to be next to the church.
Map description	This is a very detailed map which in small places like the city center is very useful.
Map layout	I want to move the map because I want to... I need to locate the points, like for example the north point. In this case, I'm lost. Yes, I can't move this. That's a problem.
Map generalization	I think they could do some simplification depending on the level of detail or which level of zoom you are, they can have some simplification of the data because if you zoom out, the icons are very small, so you have to zoom in to look at them in real size.
Map labels	So when they have the navigation line it's always better not to obscure the name of the street, maybe you know more transparent color.
Map symbols	The symbols are so small. They are super small.
Map orientation	Actually, this is the first time I'm wondering is the north always pointing ahead of me? Can I rotate?
Visual hierarchy	So because basically one of the reasons may be that icons and the background were flat in terms of visual aspects.
Color	It took me so much time to find out, it was a very light blue color.
Direction	It would be very good if this shows which direction I'm seeing.
Self-location	Ok, now I see a blue dot with my location.
Audio commands	I'm not actually not used to listening to audio commands and moving.
Vibration	When we approaching the turning point it vibrates.
Zooming	Can I zoom in the map?
Positional accuracy	The G.P.S. precision is more, much better here now.
Fat finger	Well, but I can see already that my fingers are too big.

ANALYSIS OF THE EYE-TRACKING DATA



ANALYSIS OF THE EYE-TRACKING DATA



USABILITY ISSUES (Map use)

- Zooming functionality



USABILITY ISSUES (Map use)

- Map rotation



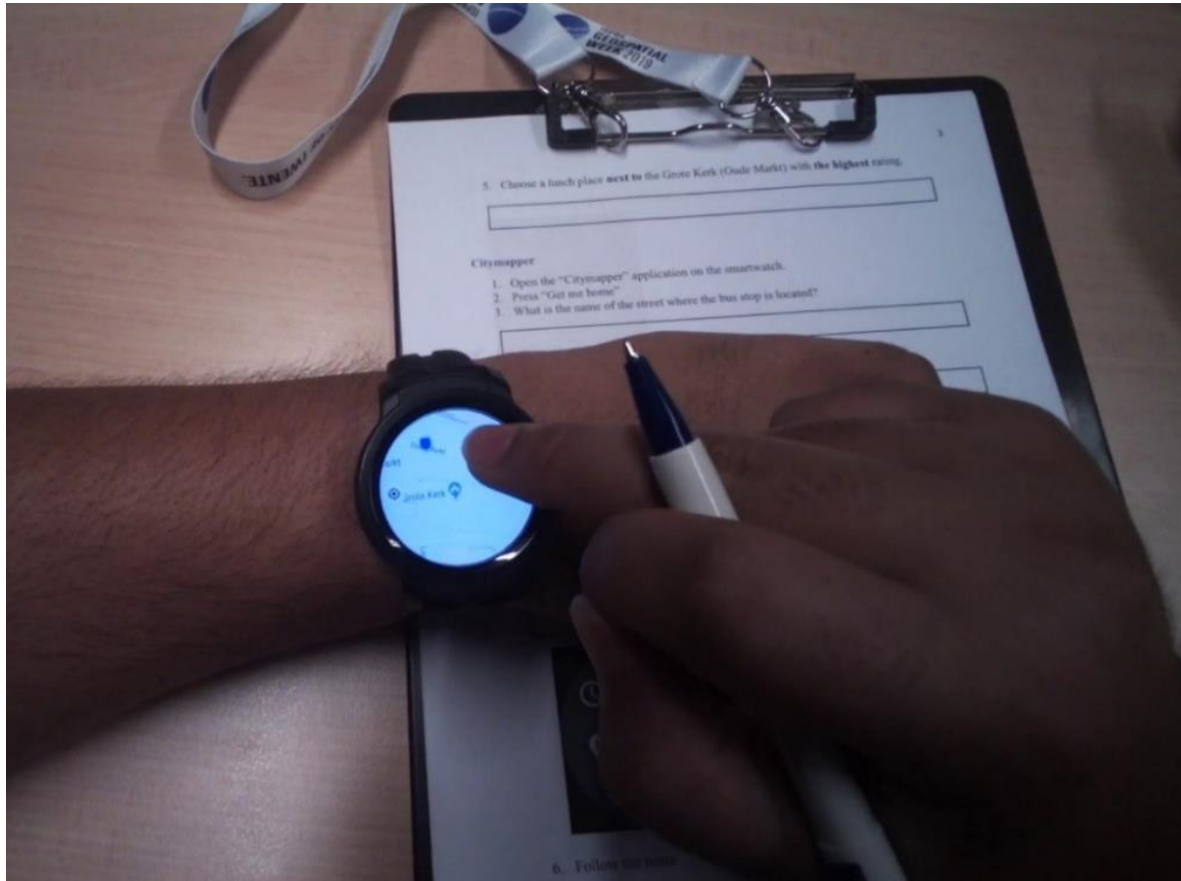
USABILITY ISSUES (Map use)

- Direction



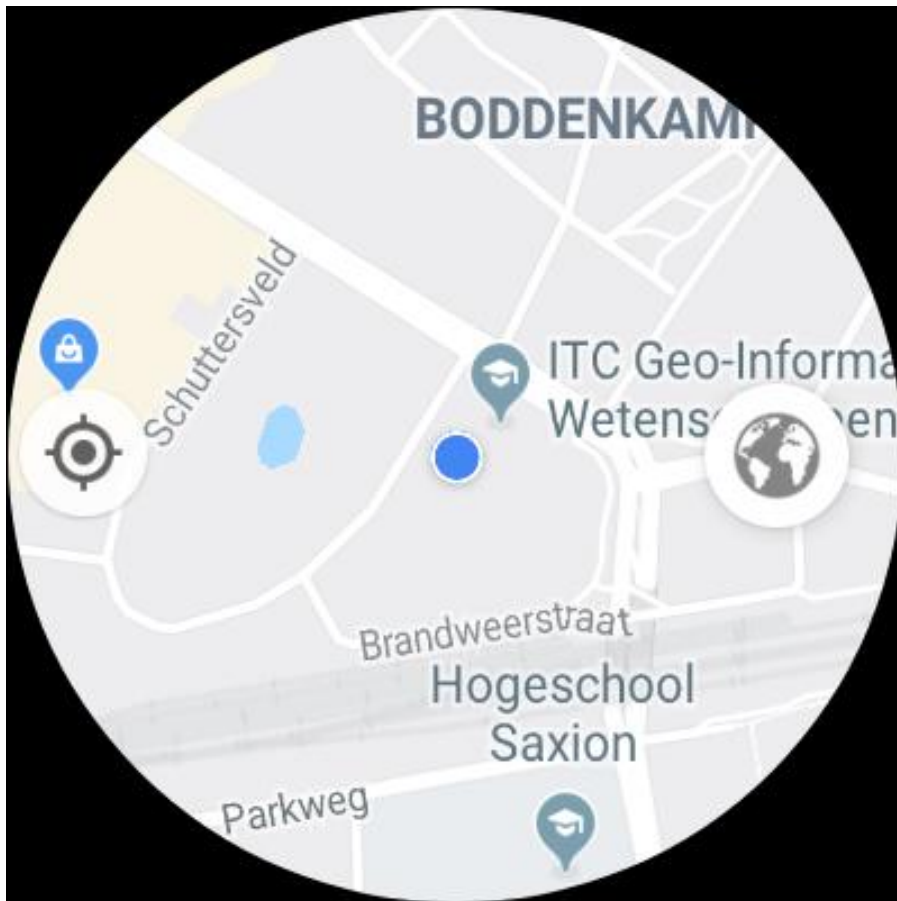
USABILITY ISSUES (Map use)

- Positional accuracy
- Fat finger problem



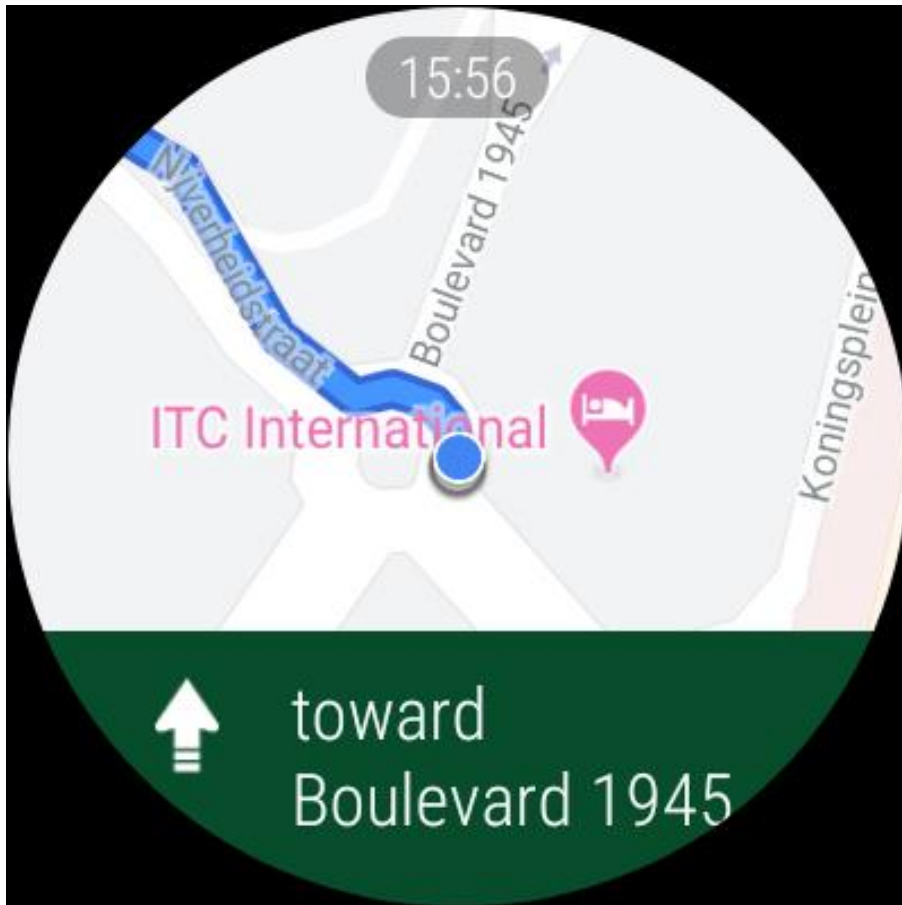
USABILITY ISSUES (Map design)

- Map generalization



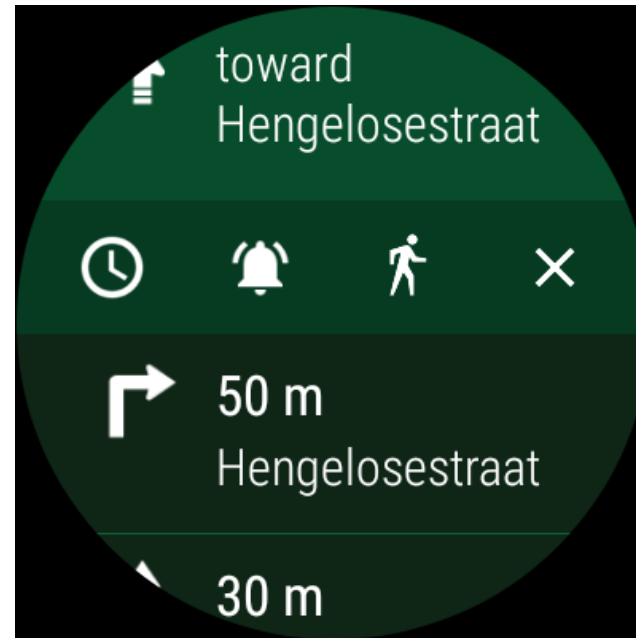
USABILITY ISSUES (Map design)

- Map labels



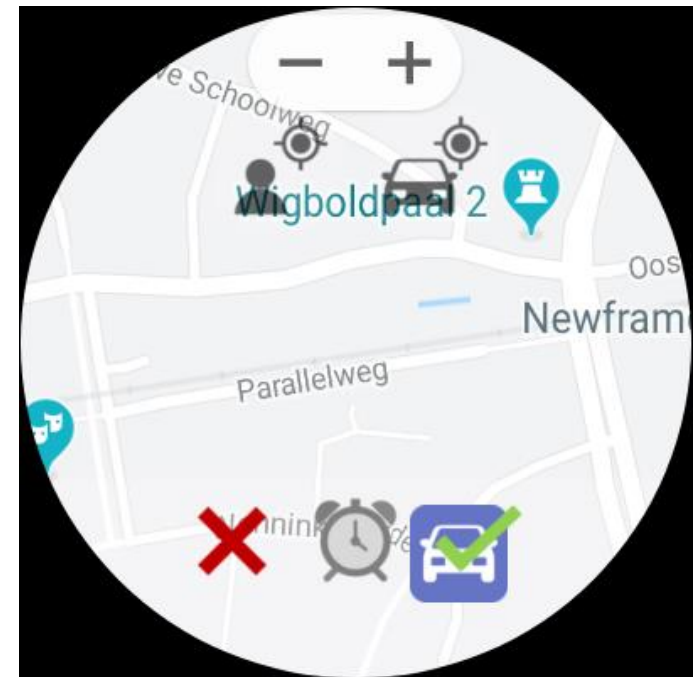
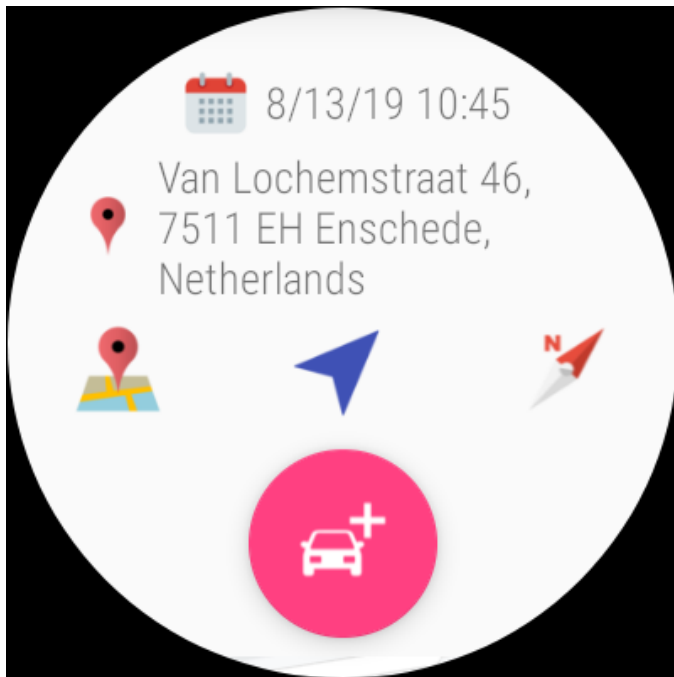
USABILITY ISSUES (Map design)

- Map layout



USABILITY ISSUES (Map design)

- Map symbols



RECOMMENDATIONS



General recommendations for the use of maps on smartwatches are related to the geographic questions the map should answer.

- For gathering spatio-temporal information regarding **geographic objects in the user's proximity**, a map is not necessary, and information could be provided in textual form.
- For gathering spatio-temporal information regarding the **spatial distribution** of geographic objects, the **spatial relation between different objects**, and **overview of the region**, maps are needed.
- For **wayfinding** and **navigation**, the map is needed for route confirmation.

RECOMMENDATIONS for MAP DESIGN

Map Composition & Layout

Maximize the screen real-estate used for the map view for the purpose of overview and use a compartmentalized layout for navigation.

Scale & Generalization

Use a more generalized basemap in the navigation mode and provide more information when the user is browsing the map.

Projection

Make rotations of the map smooth and allow the user to disable it, if possible.

Typography

Keep text upright as a user rotates the map.

Symbolization

Make map icons more simplified and bigger.

Use self-explanatory icons for POIs.

Keep visual hierarchy in the map layout.

Use simple colors on the basemap with sufficient contrast.

Do not cover up the street names with the route symbolization.

Include vector and imagery basemap options.

Map Elements

Include a compass-type graphic, so that users know which direction they are facing.

Include a search bar on the map with text and audio input.

RECOMMENDATIONS for APPLICATION INTERACTION

Interaction
Allow the user to manipulate the map when in navigation mode.
Make icons “clickable” – use shading to emphasize that the icons could be clicked – provide visual affordance.
Create visual affordances to recognize the availability of additional information.
Use the same swiping motion for opening and closing the page.
Use both zooming buttons and a pinch to zoom tool.
Use sound and vibration.

RECOMMENDATIONS FOR FURTHER RESEARCH



- During the realization of this research due to the exploratory nature of the research questions, this research was largely based on qualitative research methods. Hence, one of the suggestions for future research is to have **a larger number of test participants** to yield statistically significant results and perform research using quantitative methods.
- Another limitation of this study is the “**selection bias.**” The test participants used in this study had mostly a **geographic background** and moreover not all the test participants owned a smartwatch. Therefore another suggestion is to involve smartwatch owners with diverse backgrounds.
- Moreover, all test participants, except for one, were **familiar with the research area**. Thus, selecting participants who are new to the area might retrieve more reliable results.
- For this research, only one smartwatch with a **WearOS operating system** was used. A suggestion for further research is to test multiple smartwatches with different operating systems.
- Due to the time limitation, only **six applications** were tested in this user study. Furthermore, more smartwatch applications could be tested on different operating systems.



THANK
YOU

REFERENCES



- Cecchinato, M. E., Cox, A. L., & Bird, J. (2017). Always On(line)? *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, 3557–3568.
<https://doi.org/10.1145/3025453.3025538>
- Ericsson ConsumerLab. (n.d.). ConsumerLab report on Wearable Technology and IoT – Ericsson - Ericsson. Retrieved from <https://www.ericsson.com/en/trends-and-insights/consumerlab/consumer-insights/reports/wearable-technology-and-the-internet-of-things>
- IDC, & Statista. (2018). Smartwatch shipments worldwide from 2018 to 2023 (in millions) [Graph]. In Statista. Retrieved September 13, 2019, from <https://www.statista.com/statistics/878144/worldwide-smart-wristwear-shipments-forecast/>
- Rawassizadeh, R., Price, B. A., & Petre, M. (2015). Wearables. *Communications of the ACM*, 58(1), 45–47.
<https://doi.org/10.1145/2629633>