

# Navipal

## Assistive Devices

**TILDA** Seminar Series  
1<sup>st</sup> of June 2021

**Katie** Software Development  
**Conall** Engineering  
**Richard** Engineering

## Richard Vaniukevich



### Engineering

Richard is a 3<sup>rd</sup> year Mechanical and Manufacturing Engineering student at Trinity College Dublin currently studying under Dr. Shuo Yin as an assistant researching laser cutting technology and direct ink 3D printing where he is developing machine learning algorithms to investigate the changes in the various parameters of the interacting materials.

## Katie Kilroy



### Software Development

Katie is a 3<sup>rd</sup> year Mechanical and Manufacturing Engineering student at Trinity College Dublin. Her interest in dementia stemmed from her late grandmother, who had severe dementia before her passing. Since then, Katie has worked on different app projects relating to people with dementia, such as an app for daily use and reminders as well as a research assistant on an app to research dementia through games called Neureka.

## Conall Daly



### Engineering

Conall is a 3<sup>rd</sup> year Mechanical and Manufacturing Engineering student at Trinity College Dublin with an interest in medical device design. He is currently working as a member of Formula Trinity's Aerodynamics team using computational fluid dynamics software packages to optimise flow around airfoil profiles.

# Introduction

# The Origin of NaviPal

Katie's grandmother Annie  
1929 - 2015

She had Dementia before her  
passing.

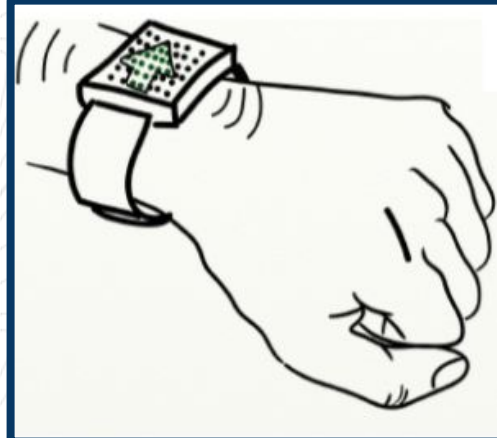
"Annie's Gift"

An app for everyday use  
made in her honour



# The Origin of NaviPal

We established a connection with the Irish Dementia Working Group to see if we could develop a product that could aide vulnerable members of our society in their daily lives.



# The Origin of NaviPal

Our Stakeholders:

- IDWG
- Dublin Bus
  - Chief inspector
  - Manager of the Control Center
  - The Travel Assistant Programme
- Iarnród Éireann
- Chime



# Feedback from IDWG



**Irish Dementia Working Group** @IrishDementiaWG · Nov 13, 2020

An interesting morning discussing transport with @tcddublin students Katie and Richard.

Thanks Sean, Kevin, Gerry and Jacinta by phone

#UnderstandTogether  
@alzheimersociarl

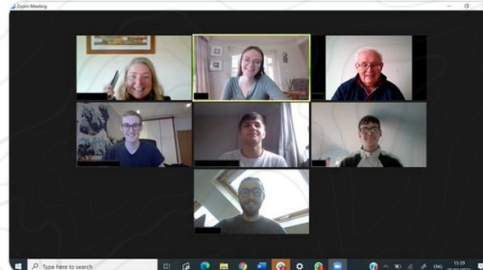


**Irish Dementia Working Group** @IrishDementiaWG · Feb 16

We are constantly reminded of the resilience of young people living through Covid19.

Our members are delighted to support Trinity students examining living with dementia & public transport

Students pictured with our Chair Sean Mackell & @alzheimersociarl  
Advocacy Officer @CloWhelan



**Irish Dementia Working Group** @IrishDementiaWG · Mar 29

Our Chair Sean Mackell was back to his advocacy today after appearing in the @VirginMedia\_One documentary #WeNeedToTalkAboutDementia yesterday

He joined colleagues Gerry & Jacinta to continue their collaboration with @tcddublin students on Transport & Dementia  
#UnderstandTogether



The Alzheimer Society of Ireland



# Our Mission Statement

*“To develop a discrete, accessible, non-intrusive device that allows people with disabilities to independently navigate the public transport system”*



## John's Story



## Paula's Story



# Our Timeline



Concept

Concept Refinement



Stakeholder Feedback



Initial Prototype

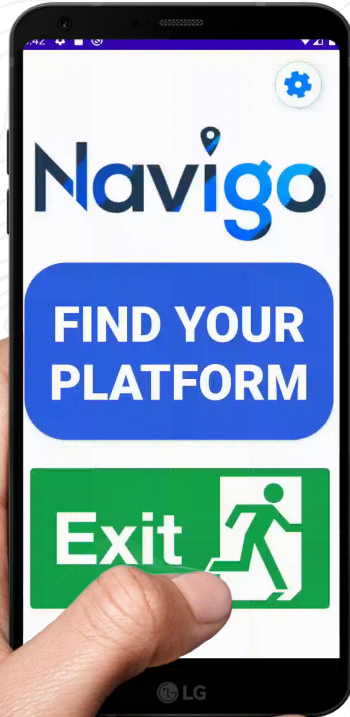
# NaviPal Device



Navipal

**Navigo**

# The Navigo App









The Navipal watch will be used in conjunction with the Navigo App.

The user or carer inputs a destination through the app settings or by voice.



3:42





Train/Bus Details:

Train/Bus Name:  

Sligo

Departure Time:  

12:30

Number of Platform/Gate:  

4

Emergency Contact Details:

Name:  




katie

Phone Number:  

+353861234567

Password for Settings ☐

SAVE



# User Input

All the necessary information entered through the app settings, which is accessible through the homescreen

This includes:

- Train/bus Name
- Platform Number
- Departure Time
- Emergency Contact

**To Access the Settings Please Enter Your Password:**

Password

CONFIRM



## Navigation

The user selects to be directed to either the platform or exit on the home screen.

# Navigation

**Follow the  
arrows on your  
watch to go to  
your platform  
to get the  
12:30 train to  
Sligo**

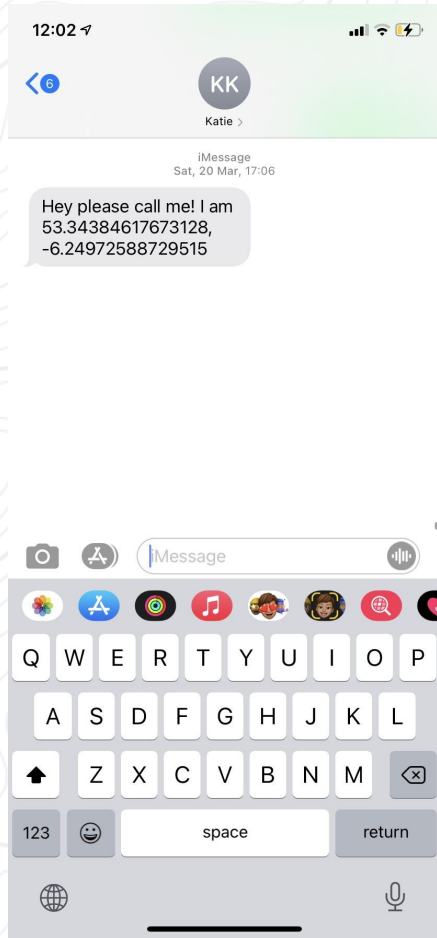


**Follow the  
arrows on your  
watch to go to  
the Exit**



The user selects to be directed to either the platform or exit on the home screen.

This brings up a screen telling the user to follow the arrows on their watch to their selected destination.



# The Emergency Feature

An automated message will be sent to a trusted contact when the user is in need of assistance.

The contact details will be inputted and stored in the app settings.

Activated once the user holds down the button on the side of the watch.

# Technical Aspects

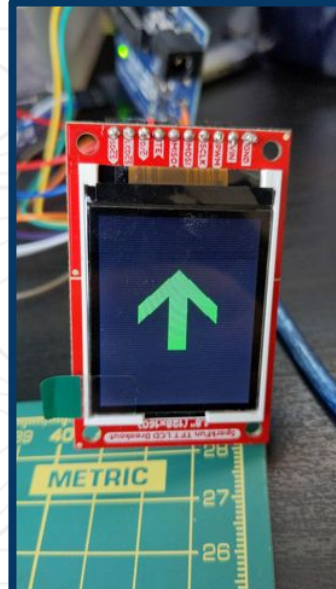
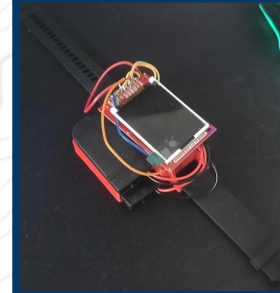
# NaviPal Watch

Runs on an Arduino Nano 33 BLE Sense.

Connects via Bluetooth to Navigo app receiving destination information from it.

Powered by simple watch batteries.

Components primarily chosen based on ease of prototyping.





# Bluetooth Beacons

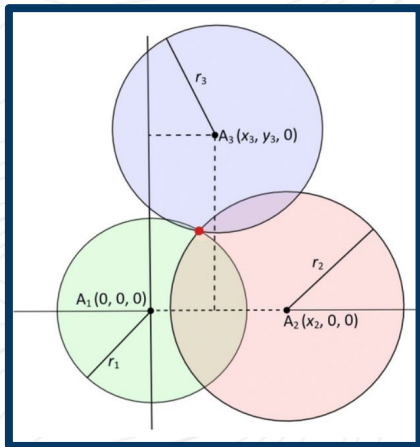
Navigation is ultra accurate ( $\pm 10\text{cm}$ ) with Bluetooth Low Energy Beacons (BLE).

Uses Received Signal Strength Indicator (RSSI) which is the same technology used by COVID contact tracing apps.

Act as the “rulers” so to speak (a big area of improvement).

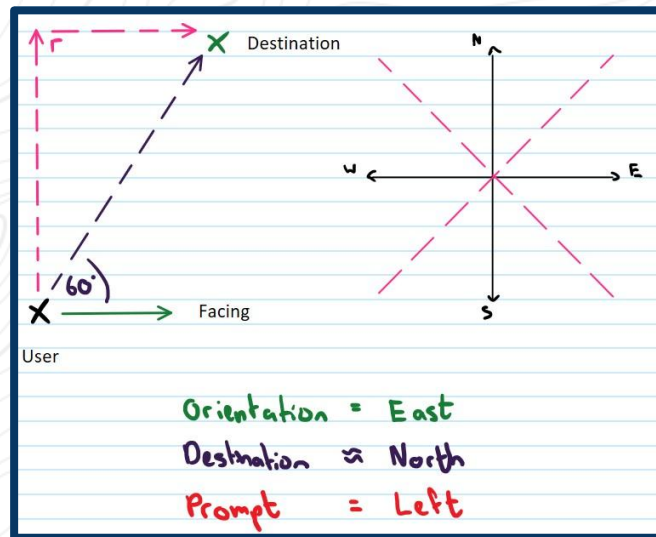


# Navigation Software



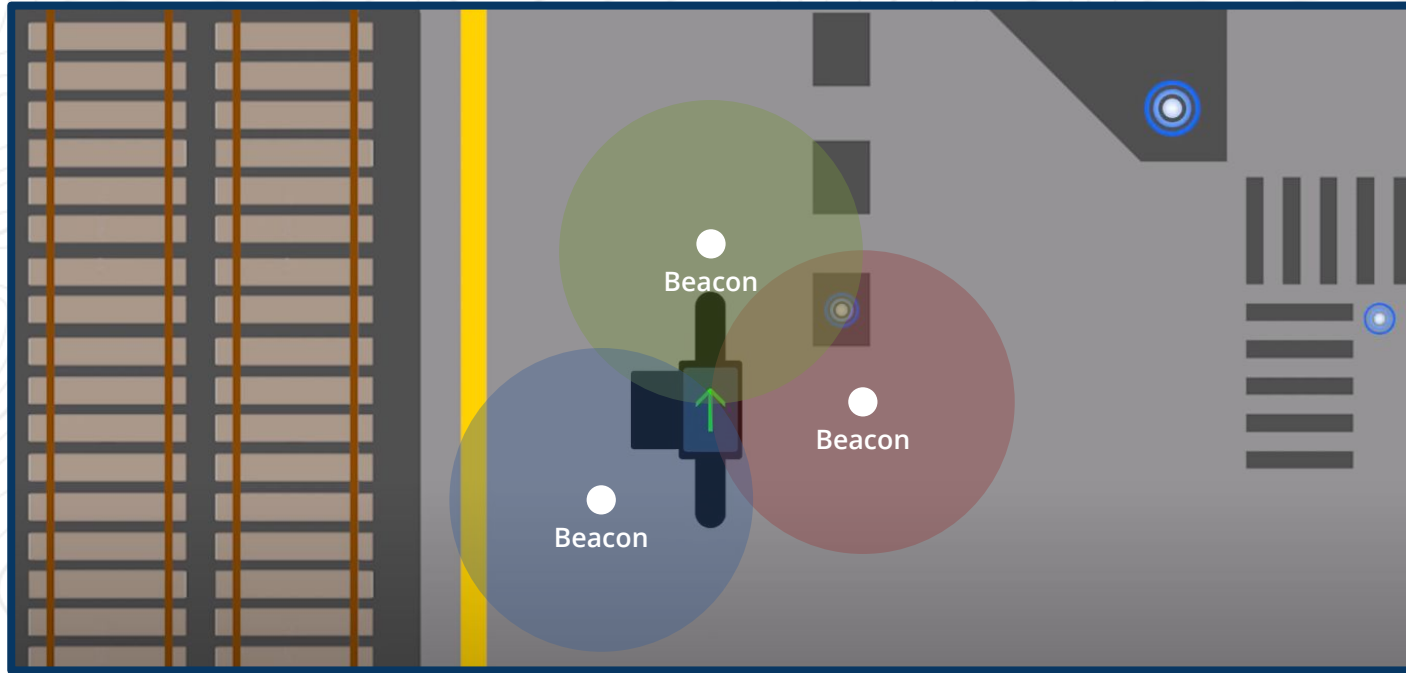
$A_1(0, 0, 0)$	$r_1^2 = x^2 + y^2 + z^2$	$x = \frac{r_1^2 - r_2^2 + x_2^2}{2x_2}$
$A_2(x_2, 0, 0)$	$r_2^2 = (x - x_2)^2 + y^2 + z^2$	$y = \frac{r_1^2 - r_2^2 + x_2^2 + y_2^2 - (2x_2x)}{2y_2}$
$A_3(x_3, y_3, 0)$	$r_3^2 = (x - x_3)^2 + (y - y_3)^2 + z^2$	$z = \sqrt{r_1^2 - x^2 - y^2}$

Trilateration



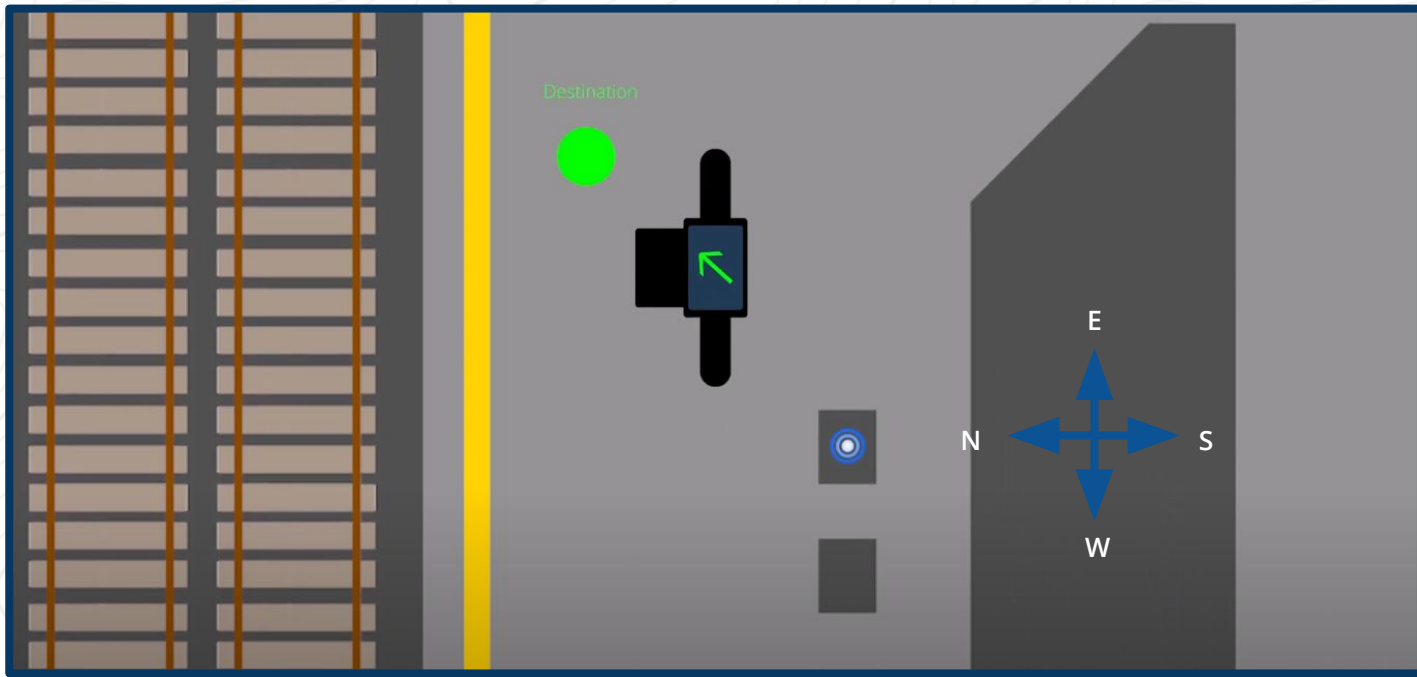
Vector Operations and  
Path Finding

# Navigation Software



Trilaterate coordinates of user.

# Navigation Software



Use watch frame of reference (magnetic field) to figure out which way user is facing and display arrow correctly.

## John's Story



## Paula's Story



**Looking to the Future**



# Our Plans for the Future

Continue testing our prototype.

- More secure software.
- Further develop the prototype.
- Different environments.
  - Train stations
  - Outside
  - Hospitals
  - Schools
  - etc.

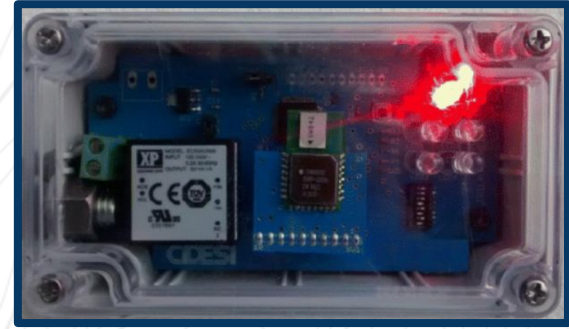


# Technical Improvements

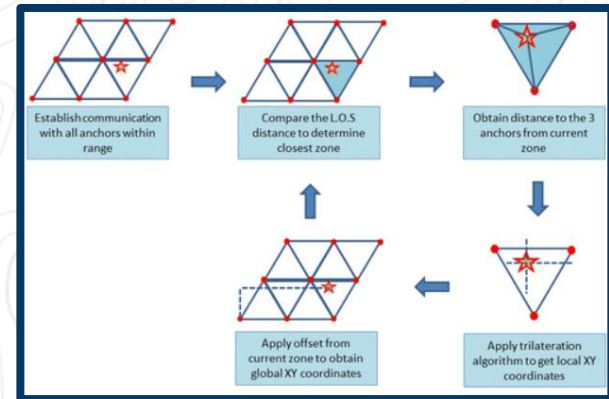
We've identified a number of key technical improvements to enhance the functioning and value of device for users.

Large improvements could be made to the beacons (currently outsourced).

Creation of custom Smart Beacons would speed up system setup for transport providers (in this case Iarnrod Eireann).



**Smart Beacon (Raspberry Pi B+)**



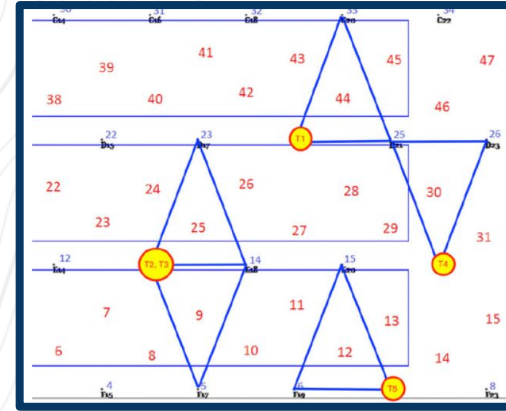
**Zone Detection and Global Positioning**

# Technical Improvements

Knitting together a mesh of beacons is also another big step we want to take to develop a fully featured capable navigation system.

Set up a robust test bed for development of the device and general troubleshooting.

Improve device look and feel along with app UI based on medical evidence.



**Zone Identification**

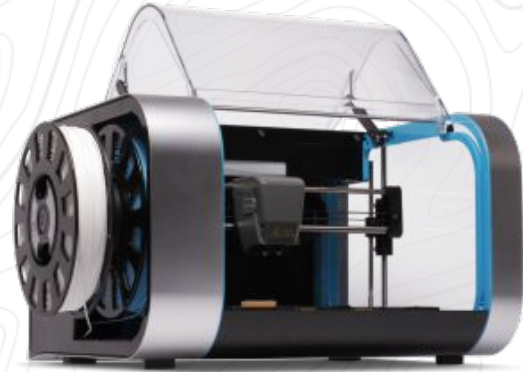


**Possible Test Bed Setup**

# Manufacturing Considerations

3D printing will primarily be used for production allowing for open source development and easy prototyping.

Similar to the way it democratised development prosthetics.





# Finance Estimates

Cost of €105 for prototype device.

We naturally expect that the price of components to fall with bulk purchasing.

Further enquiry into whether this will proceed as a solely software project will be informed by feedback from stakeholders.

Bill of Materials for NaviPal							
Item Number	Part Name	Supplier	Part Number	Cost (€)	Quantity	Total Cost (€)	URL
1	Arduino Nano 33 BLE Sense	SparkFun	DEV-15580	33.21	1	33.21	<a href="https://www.sparkfun.com/products/15580">https://www.sparkfun.com/products/15580</a>
2	TFT LCD Breakout - 1.8" (128x160)	SparkFun	LCD-15143	26.19	1	26.19	<a href="https://www.sparkfun.com/products/15143">https://www.sparkfun.com/products/15143</a>
3	Bluetooth Beacon	Amazon	BEC09-2	18.62	1	18.62	<a href="https://www.amazon.co.uk/INOUE-Bluetooth-Programmable-Eddystone-nRF52810/dp/B07FM8VKZ9/ref=sr_1_4?dchild=1&amp;keywords=bluetooth+beacon&amp;qid=1616182748&amp;sr=8-4">https://www.amazon.co.uk/INOUE-Bluetooth-Programmable-Eddystone-nRF52810/dp/B07FM8VKZ9/ref=sr_1_4?dchild=1&amp;keywords=bluetooth+beacon&amp;qid=1616182748&amp;sr=8-4</a>
4	Mini Pushbutton Switch	SparkFun	COM-00097	0.29	1	0.29	<a href="https://www.sparkfun.com/products/97">https://www.sparkfun.com/products/97</a>
5	Haptic Motor	Group Members	N/A	0	1	0	N/A
6	Panasonic CR2032 Battery (2 Pack)	Amazon	CR-2032EL/6BP	1.85	2	3.7	<a href="https://www.amazon.co.uk/Panasonic-CR2032-Battery-pack-Lithium-Silver/dp/B002U002NK">https://www.amazon.co.uk/Panasonic-CR2032-Battery-pack-Lithium-Silver/dp/B002U002NK</a>
7	Miscellaneous Electronic Components	Group Members	N/A	0	N/A	0	N/A
8	Battery Holder (10 Pack)	Amazon	B07MJG6XZR	6.98	1	6.98	<a href="https://www.amazon.co.uk/HALLIA-Portable-General-Battery-Co">https://www.amazon.co.uk/HALLIA-Portable-General-Battery-Co</a>
9	Watch Strap	Amazon	ARC-QRS-BLK16	16.29	1	16.29	<a href="https://www.amazon.co.uk/Archer-Watch-Straps-Replacement-Smartwatches/dp/B01NA05i0D/ref=sr_1_5?dchild=1&amp;keywords=watch%2Bstrap&amp;qid=1616182495&amp;sr=8-5&amp;th=1">https://www.amazon.co.uk/Archer-Watch-Straps-Replacement-Smartwatches/dp/B01NA05i0D/ref=sr_1_5?dchild=1&amp;keywords=watch%2Bstrap&amp;qid=1616182495&amp;sr=8-5&amp;th=1</a>
10	3D Printed Housing	Trinity College Dublin	N/A	0	1	0	N/A
Grand Total						105.28	

# Applications

While in make or break development stage we want to focus on our initial niche of navigating a train station.

However the technology's scope can be widened to further fields.

Perhaps on hospital wards and in nursing homes.

People with other disabilities.





# GDPR and Safeguarding Measures

## Current

- No name input.
- No external storage of data other than transferring the code to the watch.

## Future Improvements

- More secure connection between app and watch.
- More secure connection between watch and ble beacons.

# NaviPal

Assistive Devices

