

# Designing for a Generation: Accessible Navigation Tools for Older Adults

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## Introduction

As the average age of the American population increases (Ortman), designs for applications must consider the effects of old age, such as decreased motor skills, worsening eyesight and cognitive processing skills (Fisk). Navigation applications such as Google Maps tend to be less helpful for older adults (Goodman), especially on mobile devices, despite 42% of adults aged 65+ owning a smartphone in the US in 2017 (Smith). In a recent conference, CHI 2017, an assisted navigation technique called BIGnav (Bayesian Information Gain for Guiding Multiscale Navigation) was introduced (Liu). By combining BIGnav's Bayesian probability function for interest points with design elements targeted at older adults, a navigation application more suitable for older adults' general needs and capabilities should arise.

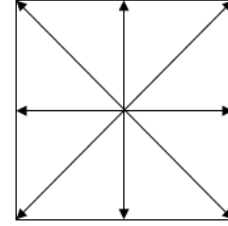
The probability function will be implemented so that the points of interest with the greatest probability of being the target location will be displayed in a dynamic list. While the map application will take input from the user as direct command, the screen view will "jump" across the map, leaving a previous edge visible for reference after a sliding animation of movement. Each command given by the user will change the relative probabilities of each point of interest simultaneously, while accounting for human error to a greater extent than the original ratio proposed. Thus targets should be more easily located and orientation time in new views will be minimized while removing most necessity for fine motor control.

This navigation technique relies on three variables to determine the most probable target; views shown to the user, the original probability per point of interest, and the command given by the user after being shown a view. While the original function (Liu) used information gain (or loss of entropy) to determine the next view shown to a user, we will not use this utility in order to minimize loss of orientation from changing views. While BIGnav was designed to "run experiments" on the user by changing views in order to maximize information gain, our application must be user directed, and cannot supply the user with what would appear to be random views.

## Background - Bayesian Formula for Point of Interest Probability

Notation and probability formulas in this section will be identical to that in BIGnav (Liu).

Element	Singular	Set
Point of Interest (POI)	$\theta$	$\Theta$
Command given by the user	$y$	$Y$
View shown to the user	$x$	$X$



The set  $Y$  of all commands possible by the user are the eight directions shown in the figure above (right), as well as a finite zoom in, and a selection command, or “click”. The reasoning behind this highly restrictive set of operations is twofold; first, the goal is to simplify the application for older adult usage, and second, the Bayesian formula requires a finite set of possible options.

The formula used is as follows;

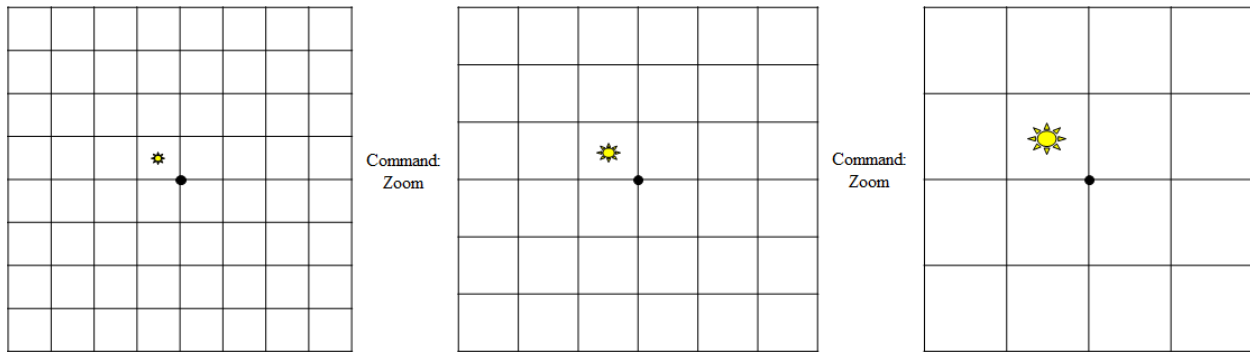
$$P(\Theta = \theta | X = x, Y = y) = \frac{P(Y = y | \Theta = \theta, X = x)P(\Theta = \theta)}{P(Y = y | X = x)}$$

Where

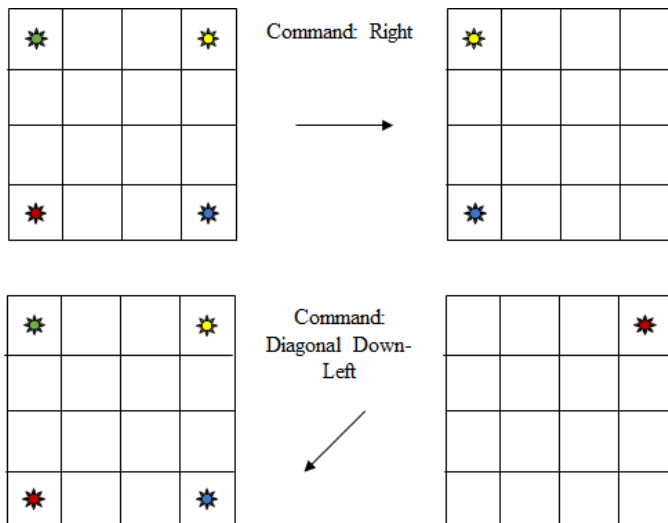
$$P(Y = y | X = x) = \sum_{\theta'} P(Y = y | \Theta = \theta', X = x)P(\Theta = \theta')$$

The probability for all  $\theta$  is uniform by default at the start of a POI search; for  $n$  targets, each target begins with a probability of  $\frac{1}{n}$ .

## Preliminary Design Ideas



Due to the nature of the equation, zoom will be implemented as finite sections of uniformly shaped tiles, where each tile can have a maximum of one POI, as shown above. When panning, the view moves depending on the direction, straight or diagonal, as shown below.



Every command is assumed to be a movement in the correct direction 85% of the time, and in the incorrect direction 15% of the time. For BIGnav, this ratio was increased to 95:5, but due to the factor of decreased motor control in older adults, we have assumed human error to be more frequent. The probability associated with all POI in the direction of the command from the center of the view will be increased after the command. For zoom, all POI inside the original view will be given

an increase in probability, and on the selection command, the chosen POI will be given an automatic probability of 1, or 100% chance.

This function would, essentially, provide a top suggestions list for points of interest based upon past movement commands, such as panning and zooming. In theory, this would allow older adults to quickly see what POIs they are moving toward, and should help them choose the point of interest they want by displaying it in a large list style instead of a small dropped pin style.

## Final Design and Implementation

Recall that in BIGnav, the computer runs an ‘experiment’ on the user by changing the view of the map; the user ‘reacts’ by issuing a direction command; the command changes the probabilities associated with each data point and yields information gain. Because running ‘experiments’ on a user is not likely to have good results, the probability function has been modified so that it doesn’t guess where the user wants to go and jump to that view, but rather suggests likely points of interest given the user’s past commands. Care has also been taken in order to make this less sensitive to user error.

All points of interest begin with uniform probability, and once the user issues a command, the probability function will alter the likelihood of points of interest depending on their location relative to the center of the view.

This probability setup has been implemented as a running background function in another navigation project, also targeted at older adults, that is in the prototype stage. This other project, entitled WhereTo?, is a user study based accessibility design that strips down Google Maps based on suggested changes from literature and older adult users.

## Citations

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Goodman, Joy, Stephen Brewster, and Philip Gray. "Older people, mobile devices and navigation." HCI and the Older Population (2004): 13-14.

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