Color Targets: A Wayfinding System for the Visually Impaired

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Abstract

A wayfinding system is an audible or visual method to provide information such as names of location, directions, etc. in order for a person to find his way to a specific destination, which is a challenge to those who are visually impaired. Cellphones are an ideal platform for developing these types of system, especially since they are inexpensive, portable, and ubiquitous. Another problem found within other wayfinding systems is also solved by cellphones; that is, with cellphones, the user does not have to worry about any cosmetic concerns (e.g., wearing some outer device that will draw stares). Using a color target as a landmark symbol, the camera of a cellphone is able to read and recognize these targets as well as speak aloud the name of the target found within fractions of a second. Using a four-color scheme, we are able to specify 24 different permutations with each one representing a unique location. The system can be implemented within a building where each color target can specify an office or other location such as the restroom. We have implemented this system on a Nokia N95 cellphone for now.

1 Introduction

A wayfinding system is an audible or visual method that provides information such as areas of interest, names of streets or locations, directions, etc. These systems are especially useful in aiding those who are visually impaired. What we wanted to accomplish was to create a wayfinding system that is affordable, portable, and ubiquitous while avoiding any cosmetic concerns that may be brought upon the user. Cellphones satisfy these requirements: a cellphone with a basic camera can be inexpensive, easily portable, can be used by anyone, and will not raise any cosmetic concerns that may occur with other wayfinding systems that require a user to wear some sort of device on his person. For our system, we also wanted to take advantage of the camera attachment found in cellphones. We wished to utilize a sort of landmark symbol that will be scanned and recognized by the camera. We implemented a color target that consists of four different colors that represent a unique or rare pattern not usually found within a building. The color target can be quickly detected by a cellphone's CPU within fractions of a second (Coughlan and Manduchi, 2007). In their previous work, James Coughlan and Roberto Manduchi have previously implemented this system on a Nokia cellphone and carried out experiments using visually impaired subjects to test the efficiency of their method.

2 Methods

2.1 Equipment

For now, we have programmed our system in order to work with a Nokia cellphone (specifically, an N95 in our case). We programmed using the Symbian OS (the open operating system for mobile devices) and used the Nokia PC suite to transfer and install the program into our cellphone. We also used Carbide development tools to program the software in C++.

2.2 First Phase

In developing the color target used for this system, Coughlan and Manduchi designed a pattern that is distinctive from the background, which will produce the smallest amount of false positives as possible. The color target should also be invariant, meaning that changes within the environment should not have much of an influence (e.g., lighting). The color scheme that they constructed consists of four printable, simple colors (white, blue, black, and red).

The camera would scan this color target and then the software would transform the image into its RGB counterpart. The algorithm employed by Coughlan and Manduchi checks for pixels at each of the four color patches and compares the differences within the different color channels (red, green, and blue) to check whether it meets certain thresholds or requirements. If it does, then a potential target has been detected.

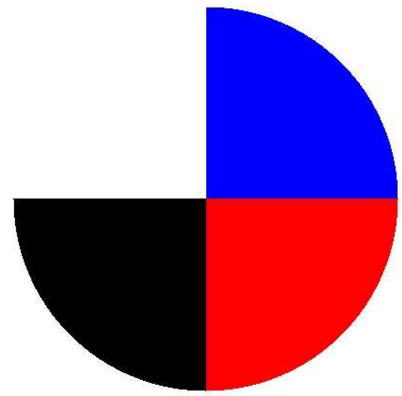

Figure 1: The four-color target used

How it worked was that the algorithm calculated the differences within the green channels between the white patch and the red patch, the red channels between the red patch and white patch, the red patch and black patch, and between the red patch and blue patch. If the differences were greater than 58, less than 90, greater than 33, and greater than 22, then a potential target has been detected.

What we wished to expand on this system is to increase the number of potential locations as the previous algorithm only worked with only one target. Since we worked with four different colors, we wish to obtain 24 possible permutations with each one representing a unique target.

2.3 Second Phase

For the second phase, we wished to expand the number of potential targets. Since we worked with four different colors, we were able to obtain up to 24 unique locations. We extended the algorithm to check for all 24 possible permutations and carry out the same procedure as

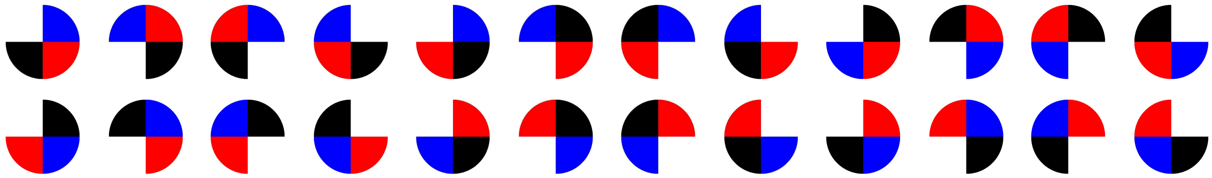

Figure 2: The 24 possible permutations

in phase one. However, we added one more difference to check, since it was having troubles distinguishing between two permutations that were too similar to one another (e.g., one permutation had white in position A, red in position D, blue in position B, and black is in position C while the another permutation had white and red in the same positions while blue and black were switched). The problem was that there was no check for differences within the blue channels that were causing the problem in detecting locations that were similar except and the blue and black channels were switched.

We added a new threshold to check when trying to detect a potential target. In addition to the other differences, we calculated the difference within the blue channels between the blue and black patches. The algorithm checked whether the difference was positive or negative and depending on that result was how the algorithm determined it was one permutation or the other.

Another change we made to the program was that instead of having the cellphone read aloud how far away the distance was, we implemented a beeping sound that repeats itself and whose repeating speed depends on the distance (i.e., the closer the target is, the faster the sound repeats itself). The software also comes preloaded with 24 recorded sounds, with each one representing one of the 24 permutations (e.g., "One" would be read aloud if permutation 1 has been detected).

3 Conclusion and Future Work

Even with checking 24 possible targets, our wayfinding system was still able to detect a target within fractions of a second. Every target was also properly recognized. However we did encounter some other problems that we need to address.

For our future work, we want to fix some bugs that we encountered during the second phase. There seems to be an orientation problem that was not present in the first phase. If a target has been detected and the phone is tilted by just a few degrees, the target has been lost. This was not a problem within the first phase in which the phone can be tilted up to 45 or -45 degrees and the target would still be recognized. Another problem we need to address is reducing the number of false positives, which can be solved by changing the thresholds that need to be met or optimizing our code.

We also wish to implement our wayfinding system in order to test it. This can be done by assigning an office or other place of interest such as a restroom with one of the 24 permutations. Then we can have subjects walking and testing the efficiency of our updated system. From this, we also wish to increase the number of locations, since 24 possible targets is not sufficient for a large building. Something else we wish to implement is the text-to-speech function within the cellphone so we do not have to preload the cellphone with all these sounds, which makes the software take a while to fully load and properly work.

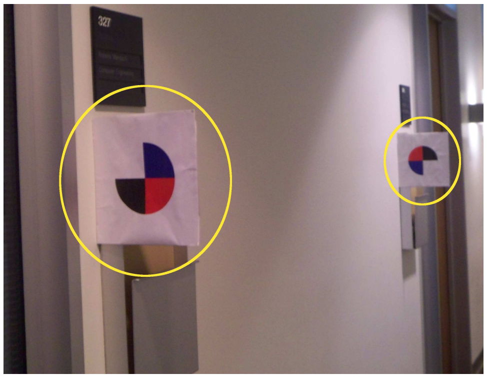

Figure 3: Two permutations representing two different locations

4 Acknowledgements

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References

J. Coughlan and R. Manduchi. Color targets: fiducials to help visually impaired people find their way by camera phone. *EURASIP Journal on Image and Video Processing*, Dayton, OH, 2007.