Increasing Usability in Variable Brightness Situations

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Abstract - As computing moves more the to mobile sphere, we are seeing more and more screen usage outside. As phone displays are not ideal for use in full brightness or even full darkness, we seek to find UI techniques that developers can utilize, such as specific colors and design techniques, that will maximize usability in all situations.

I. Introduction

As individuals are increasingly using mobile devices in their daily lives, we are slowly seeing the percentage of all computing done on mobile devices steadily increasing. With mobile device usage is increasing over time, we see users moving away from their homes and outside in the sunlight and darkness to use their devices. Although the increase of computing usage outside and in the world is beneficial, it poses issues to UI designers and those concerned about usability.

Many mobile device screens are not optimized for viewing in direct sunlight, thus decreasing usability of the device in such conditions. Many mobile devices change the user's brightness in direct sunlight, which works, but in many cases is not ideal for the user.

In comparison. when people use their phones late at night, many have complained about the brightness being too bright, regardless of their brightness level.

Looking into both of these issues, we can seek to find ways to increase usability in these situations.

II. Mobile Computing

In the past decade, the entire world has seen the explosion of the use of the smartphone. From the Palm Pilot all the way to the phones of today, we are continuing to see mobile devices take a greater share of the computing markets worldwide. As the share of all internet traffic slowly gravitates to that of mobile devices, we are seeing an increase in the situations in which the computing styles of the past are not necessarily applicable to those of today.

We have moved from simple devices with non-interactable LCD screens to the devices of today which often contain touch-enabled screens that consumers can interact with. With the new phones and devices, individuals can begin using their phones and tablets in places they haven't before, which add a level of complication that designers must consider.

While designing for mobile devices, a designer already has to consider many different things from when they design for a desktop application. Due to their smaller screens and lack of a pointer device, designers must create user interfaces that are designed for interaction with fingers in more casual contexts. The use of that design is called "responsive design", which are design principles that allow for a single application to be displayed correctly regardless.

With responsive design, we are seeing a significant increase in usability on smartphone devices. However usable an application may be, there are still shortfalls with current design practices. There is one factor that many people do not consider.

III. Proposed Concept

With mobile devices becoming more and more prevalent, designers have failed to account for an important factor of mobile device usage; non-normal device usage. With more and more people using their phones outside and late at night, designers are beginning to notice that it is not as easy to use an application in either full sunlight or complete darkness. Due to how the surroundings interact with the device, it is reasonable to believe that designers should compensate for these situations.

In daytime situations, due to the design of LCD screens on phones, they often have extremely poor visibility to the end user. Even if the brightness of the device is on maximum, individuals still may have a difficult time reading what's on the screen. Although device manufacturers attempt to compensate for that by increasing brightness, this is not always an effective solution, especially if one is trying to preserve battery life.

It is proposed in such a situation that designers and manufacturers work together to enact specific design principles in order to increase usability.

In darkness situations, the brightness of one's phone can be distracting and decrease from the overall user experience. As seen by attempting to look at a bright screen in a dark room, it can be found that usability can be decreased when one tries to switch between the screen and anything else in the darkness. It is also proposed that a similar solution is found to that of it during daylight usage.

Current design principles do not specify cases for the brightness of one's surrounding and by addressing those issues, we can increase usability of any application.

IV. Current Solutions

With the mobile devices of today, device manufacturers of today understand that screens are not always readable in all situations. In full sunlight, many LCD/LED displays have issues staying readable. Current solutions, specifically those in Apple devices, adjust brightness of the screen based on a light sensor embedded within the device. This works for some users, but for those who are concerned with battery life, messing with brightness is not ideal for all users.

Asides from changing the brightness of a device, there are also programs that change the temperature of the white light of the display. Although this does not necessarily increase usability, it is easier on the user's eyes. This increase of readability is something that has been found to be beneficial, which could directly relate to usability.

With individual applications, there are modes called “night modes”. These are often found on things such as GPS applications or other applications that are used in both daytime and nighttime situations. With a slight color change, the developers create applications that are easier on the eyes.

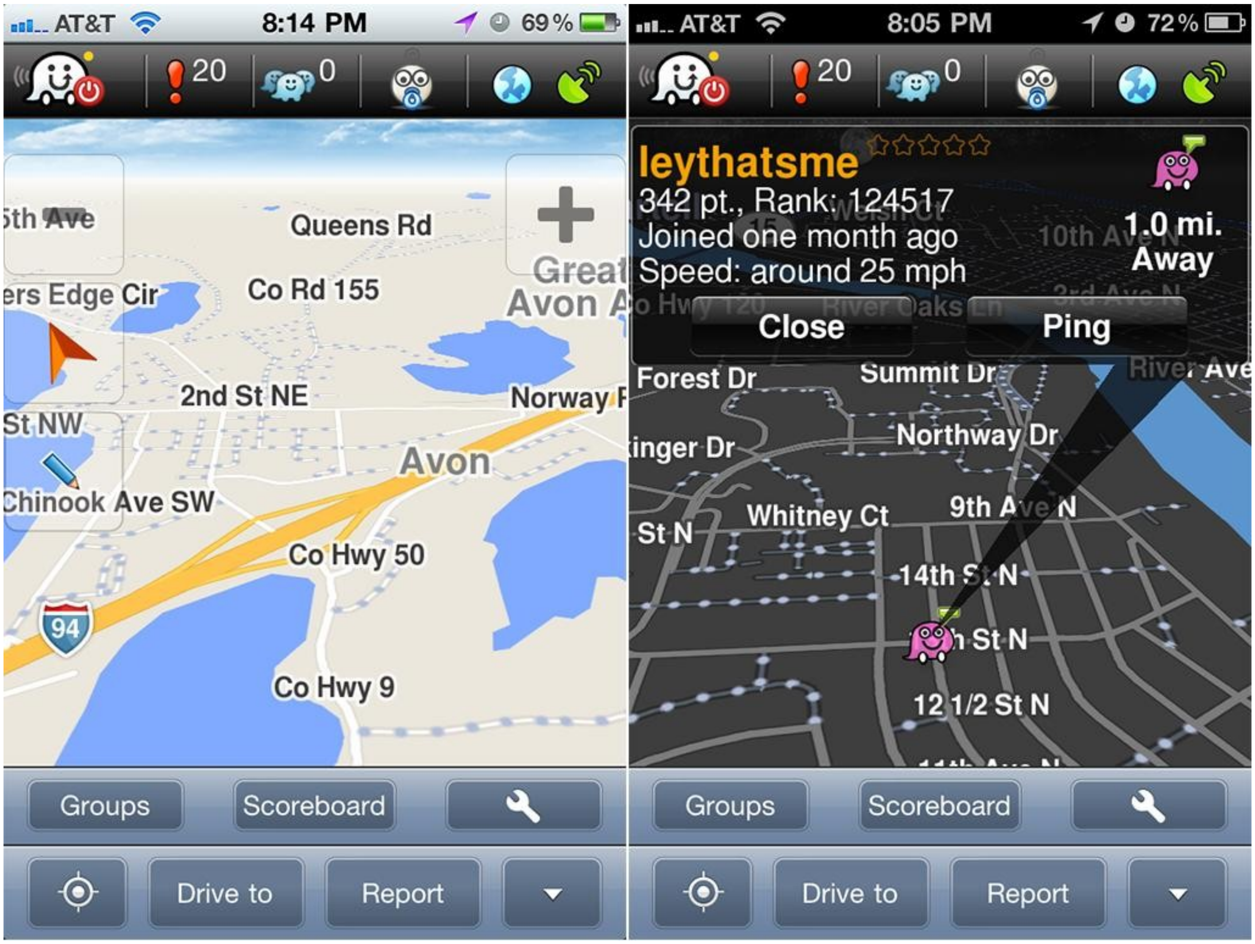

Figure 1. Example of a night mode for a mobile application

Although some applications utilize similar modes, it is not universal and do not turn on automatically in a dark situation, which leaves much to be desired from a usability standpoint.

V. Hardware Proposal

As we have found that different devices may already have sensors that allow it to compensate to large variations in brightness, we can propose a technique that hardware developers can utilize to provide application developers with a system in which they can enact the later proposals in order to further increase the usability of their applications.

Since many devices have brightness sensors, it is proposed that hardware developers create software APIs that will allow hardware developers to access the data that light sensors within the phones already have. With many APIs available for developers to access, such as cameras, microphones, and tactile feedback to name a few, creating an API for light sensors would not require a significant amount of effort.

Providing a light sensor to a developer would allow them to correctly develop different views of their application based upon the outside surroundings. With many “night modes” for applications, they are purely based on time of day. Although in a perfect situation the timing may work, but as one can observe from traveling a long distance within the same time zone (such as from Maine to Houghton, MI) we can see the sun sets at very different times, based on location.

By giving developers of applications an additional sensor to use in their applications, problems of timing with “night modes” would be eliminated in addition to the increase of usability.

If a light sensor in a device is not available, it would be reasonable to use a front camera of a device as a light sensor. With front cameras increasingly becoming available on phones, it would not be unreasonable to ask developers to use them as a sensor. By taking an image from the front camera and analyzing it, a developer can thus make a guess about the ambient brightness around the device. Utilizing this method, if a light sensor is not available, UI designers will be able to correctly display an interface to a user that would be best for their situation.

With a method for developers to sense ambient brightness, we are allowing them to provide different views of a page within their application that allows for the greatest level of usability. Without the sensor data detailing the ambient light, a developer would have a difficult time implementing the views.

VI. Sunlight Proposal

In sunlight situations, it has been observed that LCD readability decreased with the increase in lumens in the surrounding areas. We can observe in Figure 2 how a phone screen in direct sunlight is not as ‘vibrant’ as it would be in a normal situation. This decrease in readability is what we would like to address with changes that utilize the full capability of the device. With UI design, there are a few overlooked things that can allow for increased usability.

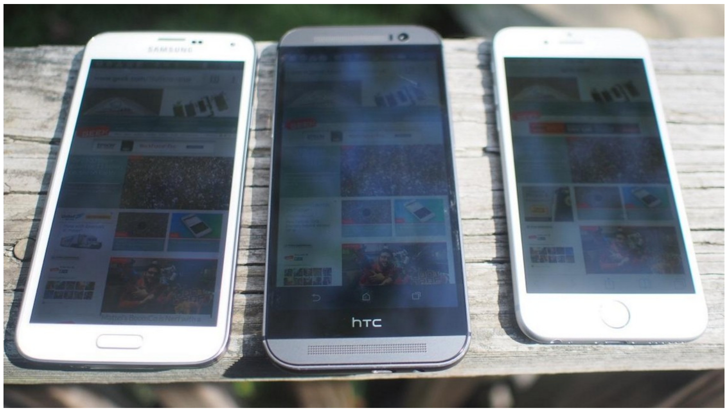

Figure 2. Example of mobile phone in sunlight

In direct sunlight, we can see that the screens are hard to read and at quick glance, the only things we can see are the borders between the whitespace and pictures on the page. By noticing this difference, we see the major problem that a designer must face while designing for devices that may be used outside. Due to the design of the LCD display, humans are only able to observe high contrast differences with relative ease in the sun.

In addition, we can see that the shapes are easiest to see are larger and well defined. These larger, less detailed icons may not necessarily be as visually appealing as those that are small and intricately detailed, but in terms in increasing usability, the sacrifice is well deserved. Large, well defined shapes are significantly easier to comprehend in scenarios where the sun causes the individual to be visually impaired. Knowing this, designers can use specific UI themes in order to increase usability.

In order to combat the reduction of usability in sunlight situations, it can be proposed to developers that they implement a few changes in their applications. By using the previous proposal of a hardware sensor, developers can implement a view during sunlight situations in order to increase usability.

As we have found through the studying of a LCD screen in a sunlight situation, contrast is key being able to view any content on a screen. Although the amount of viewable material on a screen is highly dependent on the brightness of the surroundings and screen, increasing the contrast of the components of a user interface is one of the best ways of increasing usability.

Increasing contrast in an interface is a fantastic way of increasing usability and by doing so in a sunlight situation provides an elegant way for the user to view material on their screens easier. Due to the fact that sunlight decreases a user's perception of the contents of the screen, by increasing contrast one will be able to perceive screen contents better.

The other way to increase usability in a sunlight situation is to better define the elements on a screen. Small, hard to view elements on the screen are difficult to comprehend while an interface is obstructed. Increasing whitespace between elements and better defining them provides a way of increasing usability. Although this may prevent designers from packing more in an interface, we do see an increase of usability.

VII. Darkness Proposal

In a dark room or area, the brightness from an LCD screen on a phone or tablet can be detrimental to one's nighttime vision. The light emitted from the displays, even at the lowest level, can be almost painful to the end user's eyes. Many individuals who use their phone prior to bed have all had situations in which their phone has "burned" their eyes when they unlock it. Minimizing or preventing this drastic change in perceived brightness can increase the usability of the application.

As discussed previously, many applications have night modes for users who may have to use their applications at night. Although some apps may have this feature built in, such as a GPS application, it is not always well implemented. As stated before, it is mostly based on the time that the device is observing and not the realistic world conditions. Darkening the screen of a device is known to help with one's night vision, so the "night modes" of the applications are useful, but due to the lack of sensor data, their usefulness could be greatly improved.

With a bright screen on a phone as compared to a dark background, individuals have a very tough time either interacting with their phone or their surroundings, decreasing the usability of one device or the other item one is interacting with. Due to this, it is sought to have a solution on the phone in order to increase the overall usability of whatever the individual is interacting with. Finding such a solution is imperative for improving the usability of not only the phone, but also any additional devices a user may be using. The following proposal is a suggestion for designers and UI experts to implement in order to increase usability.

In nighttime situations, screens can often cause a significant strain on a user's eyes based on the contrast in brightness levels between the screen and the surroundings. Although an ideal solution would be found if a brightness level was used that is not harsh on the eyes, it is not always the case. Devices often have minimum brightness levels that are not as low as individuals would like. This causes discomfort which leads to decreases in usability in the process. There is one main technique that user interface designers can implement in certain situations in order to increase the usability of any system the technique is used in.

The white light from phones are often harmful to the user's eyes late at night. The temperature of light that is emitted from a device can have a drastic impact on the usability of the device at night. We've seen many times while driving that different headlights often ruin your night vision more than others. The same concept applies to your cell phone or tablet. Using this concept, we can begin to look at what makes some light "better" than others for use in a dark situation.

Yellow or warm light has many health benefits, especially late at night. Relating specifically to an individual's natural sleep rhythm, white light can cause disruptions to an individual's sleep patterns if exposed late at night or in darkness. This disruption can cause discomfort to the user and their well being. Switching a device to a yellowish hue in a dark situation can prevent this disruption and lessen the effect on the individual.

Besides the sleep disruption prevention, switching to yellow light in one's device can reduce general strain on the eyes, as one can perceive details easier when there is a yellowish hue to the color scheme as compared to a normal display. One is better at determining contrast at a brightness level with a yellow tint as compared to a display without one.

By changing the temperature of a phone's user interface, you are allowing individuals to use your interface with less levels of discomfort. Although it may not directly affect usability, the ability to use an application with ease adds to the overall usability of the application.

VIII. Implementation

As we have discussed the three proposals that can all work separately to improve the usability of a device in a specific light situation, it is not yet known how a developer would use these techniques with their applications in order to improve usability of their apps. It can be seen that regardless of what an individual wishes to implement, a sensor, be it a light sensor or a camera repurposed for light detection, is extremely important in determining what view or technique one would implement in order to improve the user experience.

With one or both light situations, the use of a sensor can allow for the developer to give a range of different views relating to the different levels of implementation of the proposals. A developer of a GPS application may want to gradually change the colors of their application based on the levels of light that the driver is experiencing at the time of use. Meanwhile, a developer of a social network application may want to increase white space once in their application or modify the colors on launch and not gradually with the surroundings in order to keep a consistent experience. The benefits of the usage of a sensor cannot be stressed enough.

In terms of how to implement the daytime situation proposals, a user experience expert would need to determine what parts of their application would be particularly difficult to view or comprehend in the sunlight. Not all applications would necessarily need to fully implement both items in the proposal, but most applications could benefit from using one or more of the sub-proposals.

For example, an application who aides individuals that are working in a given field may want to implement both of the concepts to ensure the users of the application can view the content and interact with the application in full sunlight. Although this may be an instance where a designer can consistently shift an interface with an application, apps such as games cannot necessarily modify their user experiences as significantly. In such a case where consistency is required and one cannot increase elemental contrast, a designer can easily increase the contrast on the page as a whole to better define elements.

User experience experts must carefully determine if a proposal can be effectively be used for their applications in order to improve usability.

In dark situations, implementation of the proposal is significantly easier, as there is only one main way of implementation. There are two main way that this proposal is implemented; system wide or through specific applications.

Through a system-wide application, the device manufacturer would either install or allow the installation of a system that passively measures ambient light and adjusts screen temperature accordingly. With such an implementation, it would allow for the effects to be present but with minimal disruption to the end user.

If an application implements this proposal on it's own, it could utilize the sensor data to identify what temperature would be ideal for the user to view. As it would be harsh for a developer to drastically change the temperature of the light emanating from a user's device, it would be suggested that the temperature of the display be gradually changed until it reaches the correct level for viewing. By using a gradual change, you avoid the user noticing the change as much and causing a level of discomfort for the user, which may affect usability.

IX. Conclusion

Light, or the lack of it, can be highly detrimental for the usability of a mobile device. Be it a lack of visibility due to the sun or a distraction device in the dark, usability is affected in non-ideal conditions. By using the proposed methods to increase it, designers can begin to prevent some of the issues that plague mobile phone users currently, regardless of the applications they use. Solutions, which start at the device maker and trickle down to the developer and consumer are not difficult to implement, but can have a profound impact on the consumer.

Millions of individuals face the usage problems as outlined in this paper, meaning developers owe it to these individuals to implement these simple changes. It may not take much to significantly change the user experience, but without these proposals, users will continue to be plagued with the issues that prevent them from using their phones as well in all situations.

X. Works Cited

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XI. Additional Information

Commercial night vision goggles are available for low light environments.