Disruptive Technologies – UV Protect – Smart Watch Application

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ABSTRACT
Health care industry is one of the most interesting domains where we can bring innovative and smart technologies that can have a big positive impact on our health. These days people are starting to be more and more concerned about their health and they are interested in having small wearable devices that allow them to be able to get real time data through different sensors regarding the environment or different activities they are involved in.

In this paper we will show how new disruptive technologies can be used to monitored the level of the ultraviolet radiation and then how the user can be notified about that.

Author Keywords
Disruptive Technologies; Smart Watch; Samsung Gear S; Ultraviolet Radiation

ACM Classification Keywords
H5.2. Information interfaces and presentation; J3. Life and Medical Sciences – Medical Information Systems

INTRODUCTION
The first step in protecting against any factor that could have a negative impact on our health is prevention. This paper will focus on the impact of UV on our health and how we can prevent different health conditions caused by excessive UV exposure using the smart watch app UV Protect.

Exposure to the ultraviolet (UV) radiation is one of people's many concerns, especially for those from Nordic countries, because the UV radiation can still harm you even if it is not sunny or warm outside. There is no link between UV levels and the temperature, because many other factors could affect the amount of UV radiation that reaches the Earth such as ozone layer, latitude, altitude, time of day, cloud cover or air pollution. Excessive UV exposure can cause eye damage, premature skin aging, sunburn or skin cancer. It is important to understand the risk we expose ourselves and to take action in order to protect our body.

UV Protect is a standalone application that runs on Samsung Gear S smart watch and it helps user to protect against UV exposure by automatically detecting the ultraviolet levels variations and by informing him about the potentials risk that he is exposed.

STATE-OF-THE-ART
The idea is not new to smartphones. There are applications that can indicate the UV index level, predict how long we can stay in the sun before burning, etc. such as Wolfram Sun Exposure Reference App [1].

There are also some custom build in wearable devices such as band wrist (UveBand) [2] or Violet [3] gadget that are sync with a mobile phone application in order to monitor the user real-time UV exposure.

But the smart watches have not any complex application that could offer us a variety of features such as automatic detection of UV level changes that are harmfully to our body, offer detailed information about past records, offer help and custom advices based on the UV level detected.

For example, the integrated application S Health from Gear S has a small application that indicates the UV index and keeps the most recent records. But this application requires user interaction in order to find out if he is at risk of sun burn or not.

In what follows, we present an application created by us, UV Protect, which will have a considerable positive impact on our health by informing us about potential excessive UV exposure.

The main advantages of this app comparing with the existing ones are: a standalone app that does not require another device like a mobile phone, which is used in similar apps, to do more complex actions. All the data is collected and processed using the smart watch where the UV Protect is installed. Another important feature comparing with other existing apps is the automatic mode that can be enabled just with two taps. Using this feature the app can automatically reads UV data from time to time, having configured a recurrence in minutes and a threshold UV Index value that indicates the minimum exposure the user wants. The app will notify the user via short wrist vibrations if the maximum value was reached and will display proper advice. Moreover, this app also can run offline, because it does not require an explicit Internet connection to store the data. The app can store the data locally and when it has an Internet connection, all the data from the queue will be synchronized. More details about these features and more will be explained in the next section.

SYSTEM ARCHITECTURE

UV Protect is a standalone application compatible with the wearable devices that have Tizen Wearable profile of the Tizen OS [4] and have support for UV and light sensors, such as Gear S or above.

Tizen is an open-source operation system that could run on different devices area like mobile, TV, In-Vehicle-Infotainment and wearable.

The Tizen Wearable architecture, offers a web runtime engine that allows Web application to run outside the browser. The Web Runtime provides the following Tizen Web APIs to web application: W3C/ HTML5 APIs and Tizen Device API [5].

W3C/HTML5 offers various features that you can use in creating Tizen Web applications such as: DOM, HTML5, communication, storage, security, performance and optimization, location and UI. Tizen Device API based on JavaScript provides advanced access to the device's platform capabilities such as sensors data, human activity monitor and other system information.

At the application level, UV Protect application consists from 2 main modules: user interface (UI) module and services module.

The UI module is responsible for offering a rich user experience by displaying the ultraviolet information gathered from UV sensor with a simple tap or two, using vivid graphics, rich text and flexible content layouts. This module offers pages for displaying the current info about ultraviolet index, pages for displaying history data in charts with different filters and pages for user profile and different settings. Also it provides notification alerts that inform the user in case the sensors detect UV radiation levels that are higher than the threshold set by the user (see Figure 1).

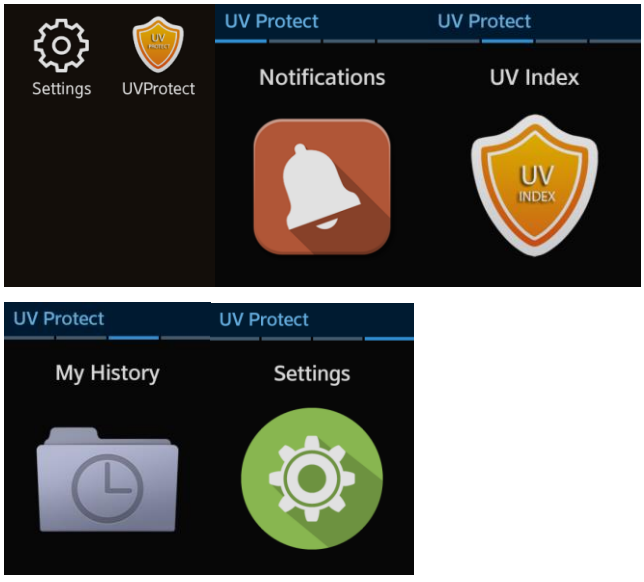

Figure 1. The Main UV Protect App features: Notifications, UV Index, My History and Settings.

The services module has 4 main other subservices: one for listening for UV sensors and retrieving the data, one for sending the data to a remote REST API for storing the details, one for synchronization, in case no Internet connection is available at the moment when the service reads data sensor and one for sending notification by wakening the app and showing the details.

The listener service reads data from the ultraviolet sensor that is integrated in the smart watch and it compares them with a well know index level. According to the United States Environmental Protection Agency [6] the UV index scale is from 1 to 11 (see Figure2).

Figure 2. The UV Index scale used in the United States conforms to international guidelines for UVI reporting established by the World Health Organization[1].

On this scale there are 5 levels and according to these, UV Protect automatically send notifications on the watch and in the same time the application informs the user how to protect him via custom recommendations based on which interval the UV index is.

The user can customize the notification settings as you can see in Figure 3, by setting a recurrence in minutes and a new sensor read will occur repetitive at that recurrence. Also the user has the ability to set a threshold UV Index value that indicates the minimum value witch will activate the alerts and the notifications. Moreover if the user activates the Vibration, the notification will be followed by a wrist vibration. In this way the app will have more success in getting the user attention.

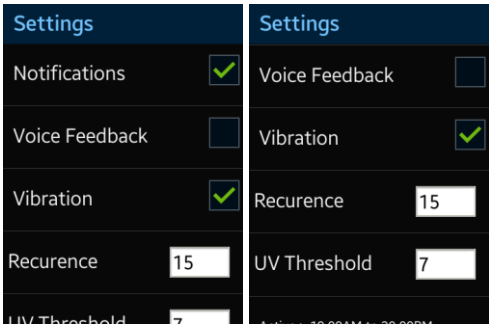

Figure 3. Settings panel.

After the notification service has been called and the user got notified, the data is stored locally if no Internet connection exists or it is uploaded to a remote Restful REST API [7] service that store all user records. The data stored locally is synchronized when an Internet connection is available via a transaction.

[1] World Health Organization: http://www.who.int/uv/en/

Also the app has integrated a history feature that allow the users to see the maximum UV Index values per days, starting with a day selected through a UI control. More details will be shown in Case Study 2.

The application is written using the Tizen IDE for Wearable and the technologies used are: JavaScript, HTML5 and CSS and Tizen Advanced UI (TAU) Framework that provides tools, such as UI components, events, effects and animations for wearable app development.

The Restful API is writing in C# using the ASP.NET Web API 2 [8] and the resources follows the HAL (Hypertext Application Language) [9] format that helps keeping an easy way to hyperlink between resources.

CASE STUDIES

In the next section we will present 2 case studies regarding the usage of the application.

Case Study 1

Let's say that a family with kids decided to take a small walk in the park, but it's almost 11:15 AM. One of the parents wants to check the UV radiation level and he uses his smart watch and the UV Protect App to detect if there is any possibility that his kids are under UV exposure risk.

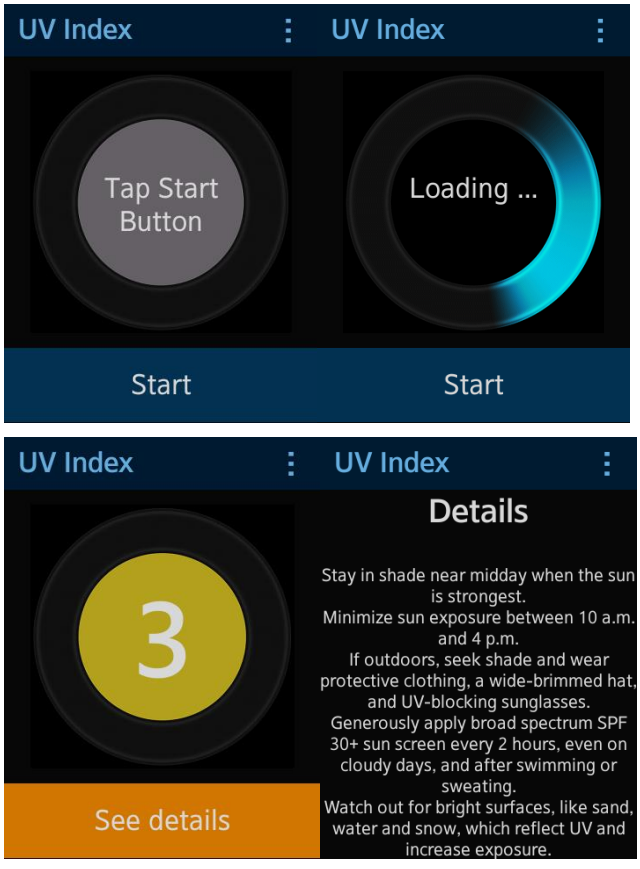

Figure 4. An example on using the application manually (the user has to do all the process).

How we can see in Figure 4, the user receives a list of recommendations.

Case Study 2

Let's say a person decides to take a walk on the beach at 1:00 PM, because it was in and he configures his UV Protect App to read the UV sensor data at every 1 minute, with a threshold of 4. After he finishes the configuration, he could enjoy the beach and the warm day, knowing that he does not need to worry about getting a sun burn, without knowing it.

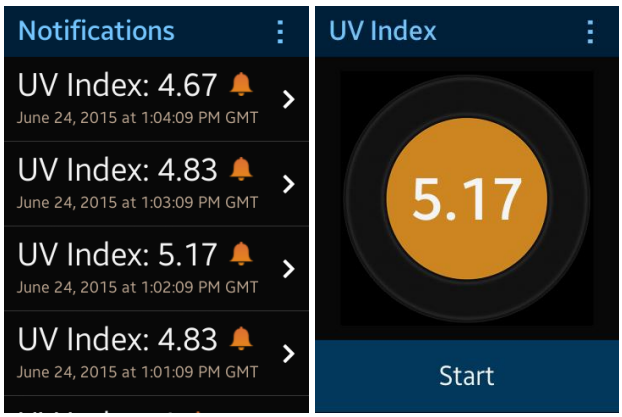

Figure 5. An example of using the application notifications.

The application has done its job and after a while his watch recorded the UV radiation levels and started vibrating, letting him know that UV exposure is too high and it is recommend seeking shade and wearing protective clothing, a wide-brimmed hat, and UV-blocking sunglasses. Also it suggested him to generously apply broad spectrum SPF 30+ sunscreen every 2 hours, even on cloudy days, and after swimming or sweating.

Moreover, the user has access to his history logs, as you can see in Figure 5.

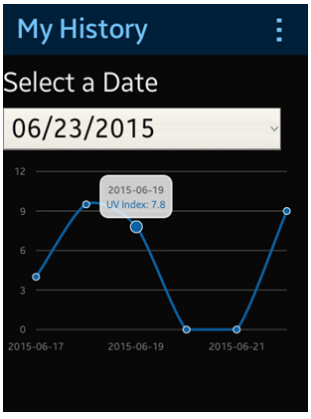

Figure 6. My History chart

The chart shows the maximum values per day, in the last 7 days from the day selected. The line chart is first computed with local data, if exists, otherwise the data is fetched from the REST API. This graph is usefully because it can show

the user relevant information about how the UV levels changed during a specific period of time and what were the maximum UV Index values on the period selected.

EVALUATION

The amount of UV radiation can be affected by different factors. According to the Australian Government – Bureau of Meteorology [10], one of the main important factor still remain the ozone layer, because lower ozone values in the atmosphere can increase the UV levels. For example Australia is more exposed to UV radiation because it is located closer to the ozone hole over the Antarctic and this means much higher and harmful radiation get through the ground level. In addition, Australian people have the highest rates of skin cancer in the world. Every year, around 1.200 Australians die because of different types of skin diseases even if this can be prevented with the proper actions. Another factors that have a considerably impact on the UV radiation levels are: latitude, time of the day, time of the year (season), altitude, cloud cover, air pollution and land cover. In the following line there is some brief info about the factors that we mentioned.

Up to 50% of the UV radiation is received around midday when the sun is at the highest point, between 11:00AM and 2:00PM. The angle of the sun influence the amount of UV radiation because solar energy must travel a greater distance through atmosphere when the sun is low in the sky and the UV may be absorbed by water vapors or other atmospheric components. Also the air is thinner and cleaner on higher altitudes; therefore more UV radiation reaches on top of the mountains. For example on altitudes near 2000m, the areas will receive up to 25% more than locations situated at the sea level.

Moreover the clouds cover and air polluting such as urban smog can influence the UV radiation levels by absorbing or reflecting back towards space. Also different surfaces can reflect the UV and have a big impact on our health. For example the snow reflects up to 88%, sea surf: 25 to 30% or sand: 7 to 18%.

In the following lines we will present some statistics regarding different scenarios where we tested the UV Protect App.

On a day between 11:00AM and 12:00AM, having the temperature 17°C and with high cloud coverage and small precipitation, being exposes to direct natural light the values recorded were very small, between 0 and 1.22 out of 15 (this is the maximum value that the UV sensor can read). In this interval we measured the UV levels in a public transport, but the index was 0, because the glass from the public transport reflected any UV radiation that existed at that moment on a direct light contact.

On the next day, between 1:32PM and 2:00PM, with a temperature of 24°C, with a clear sky with some clouds, on direct sun light the UV levels where between 5 and 5.84. Under an umbrella or a tree, the UV index decreased down to 0.61. Also the same test we conducted under a bridge and at a train station and the registered values were between 0.22 and 0.44. Inside the building, no matter the day time, if no direct sun light was preset the values always were 0.

Between two reads, at the same moment of the day and same conditions, the values could different with a maximum of 0.5. This is due to the position of the hand; on witch hand (right or left) do you wear the watch etc.

CONCLUSION

UV Protect is an application for everyone that wants to be informed and avoid harmful exposure to UV radiation. It is an application that is easy to use by any person, due to its user orientated interface. It offers different features such as: UV Index with general recommendations to protect against excessive UV exposure, notifications and history logs.

This application could help you to avoid unnecessary sun burn and to prevent different skin conditions by keeping you away from too much UV radiation.

ACKNOWLEDGMENTS

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