SmartBulb Desktop Application

Setup and Manage Home Lightning

Mislav Jurić
Department of Computer Science
University of Applied Science Konstanz
Konstanz, Germany
Mislav.Juric@htwg-konstanz.de

Maksym Gaiduk, Ralf Seepold
Department of Computer Science
University of Applied Science Konstanz
Konstanz, Germany
{Maksym.Gaiduk, Ralf.Seepold}@htwg-konstanz.de

***Abstract*—Nowadays smart lightbulbs have become a part of Internet of Things, which means it is possible to connect and operate them within existing Internet infrastructure. Application that operates lightbulbs must be user-friendly and should give user feedback about its behavior. Being a smart lightbulb should include such behavior that allows real-time adjustment. Therefore, it is just as important that adjustment is related to current state of user's surroundings, such as time of a day, and user's profile settings. Object-oriented programming is expected in development, so that maintenance and future development could be perform in well-structured code.**

Keywords—smart lightbulb; lighting management; real-time; IoT based system; object-oriented

I. INTRODUCTION

Becoming a part of Internet of Things, smart lightbulbs can be connected and operated within existing Internet infrastructure. Today's called "smart" technologies often do not offer features that corresponds to the customers' demands or the feature are too complicated to use [1].

Smart home technologies are getting more and more popular – so called smart LED lightbulbs are no exception [1]. Users have ability to control their lights from devices inside or outside their houses. Light bulbs are communicating over bridge which is connected to existing network. The system is detailly described in section III. A.

Internet of Things (IoT) stands for network of electronic devices, sensors, actuators and their applications and frameworks which are connected into one system. Implementation of IoT based systems into existing infrastructure is plain simple and straightforward.

This paper describes an object-oriented approach for developing and using application that adjusts color and brightness of the lightbulbs. The adjustment is applied based on user's preferences and rooms setup, which is detailly described in section III C. The project's main goal was development of desktop application in Java programming language.

II. STATE OF THE ART

On the market (or as projects) several other similar applications can be found. Although other applications share certain functionalities with the SmartBulb application, an effort was given to keep the app as user-friendly as possible. For that reason, all needed setups are simplified and once properly set up, application can start running immediately after loading. Having said that, this project can be used as a solid base for more complex application with additional features. Philips Hue technology that is used for the IoT based system, described in section III. A, is relatively new on the market. It was launched in 2012. and updated in both 2015. and 2016 and represents state-of-the-art product for home lightning control.

Desktop application Albedo [4] for Windows operating system is developed as third-party app as well. It is listed as first product on official website of Philips Hue [3]. From my point of view, it is not very user-friendly, and still has certain issues. For example, I have tested version 1.1.8 on Windows 10 and it was not working properly. Since it is still a program in development, it is expected to be updated. I have also tried WinHue 3 [5] application for Windows 10, version 3.0.1422.0, which I have not found very user-friendly either. It is listed on Philips Hue official website [3] as well. The best application I have tried from official website [3] is Huetro [6] version 5.2.5.0. It has brilliant design and offers great variety of features. Having said that, some functionalities, such as Disco mode, are locked in free version while others are still in beta state (automation).

My approach is based on object-oriented programming and is available for other developers. Therefore, it opens a possibility that someone continues my work as a base for his or her future project.

III. THE APPROACH

Approach for application development was separated into three parts. In the first part I have focused on backend – establishing and maintaining the connection to the bridge in IoT based system. After that, functional graphical user interface (GUI) had to be developed. The emphasis was on user-friendliness and simple design, so that user can easily get familiar with the application. In the last part focus was on development of intermediate structures, for example structure that represents a lightbulb and provides functionalities to set lightbulb's properties. Developed structures and functionalities of application are detailly described in section IV.

A. *Philips Hue*

Application uses Philips Hue products for the IoT based system. Philips has made various products that can be implemented within existing network. The central part of whole system is Philips Hue Bridge. The bridge uses RESTful interface over HTTP and the bridge is also the key figure for communication. The purpose of such web interface is to give each lightbulb an IP address in local network and to simplify communication.

Fig. 1. Philips Hue System

In case lightbulb's state has to be changed, a new value is sent to local URL that belongs to certain lightbulb. System that was used for project was consisted of a router, Philips Hue Bridge and three Philips Hue lightbulbs. The bridge is connected with router by ethernet cable, whereas communication between lightbulbs, desktop device (for example laptop) and router is done wirelessly, which is shown in Figure 1.

Even though for the matter of presentation a single lightbulb is sufficient to demonstrate correctness of application behavior, user can and is expected to add more lightbulb(s) to the system. Nevertheless, system will perform without any issue even without a single lightbulb. In that case, user will not be able to monitor changes on lightbulbs, but only on the screen of computer that runs the application shown in Figure 4.

B. *Influence of Color*

Color of room lightning has great impact on human being psychology, thoroughly described in papers [13], [14], [15], [16], [17], [18], [19] and [20]. Different wavelengths of light have distinctive effects on persons' feelings, emotions and mood.

The green color is found as restful color that helps relaxing and calming. It is very peaceful and speaks for balance. For that reason, it can be used in all rooms where such mood and temper need to be achieved.

The red color stands for the one which raises room's energy. It has the longest wavelength in the spectrum of colors that are visible by human eye. Since it is found very lively and energizing, it is suitable for warming the room and bringing its energy to higher level.

The blue color stands for intellectual and trustworthy. It calms the mind and helps in keeping the concentration. Because of that, it can be used in most of the rooms when it is necessary to stimulate and calm the thought. On the other hand, someone could find the blue color a bit too cold and unfriendly.

The yellow color is found essentially and emotionally stimulating because of its relatively long wavelength. It speaks for confidence, happiness, creativity and friendliness.

C. *Room and Profile Types*

In the application four different types of profile are predefined: Leisure, Gamer, Romantic and Party. The name of every profile should already suggest what type of lighting can be expected. For example, if the user is feeling relaxed and calm, most likely the user will choose Leisure type of profile. On the other hand, every room has its type as well. Six different room types are predefined: Livingroom, Bedroom, Kitchen, Toilet, Hallway and Other. As described before, names should simplify the selection of type when adding a room. The user can select Other if the room's type is not covered with predefined types. Depending on selection of room and profile type, certain auto adjustment can be applied. Not only that, but the application will refer to time of the day as well. When set to auto adjustment mode, the brightness of lightbulb will increase incrementally from 7:00 AM until 2:00 PM every half an hour. After 2:00 PM until 9:00 PM the brightness will be incrementally decreased every half an hour. During the night, the brightness of the lightbulbs is set to minimum. When it comes to choosing the color of a lightbulb for given profile and room type, influence of color on human, described in previous section III. B, was fallowed.

When Leisure profile type is selected, application sets up calm and joyful colors, such as yellow, green and red, depending on the type of a room. For example, yellow color is used for living room and bedroom, whereas red color is used for kitchen. For Gamer profile type colder color is used, between blue and violet. As expected, for romantic type of profile, variations of red color are used for all rooms. For the Party type of profile vivid colors are used, such as pink and orange. They are stimulating and powerful colors that increase energy and warmth in rooms.

Although not every type of room and profile was covered in this project, it gives a decent and proper insight into possibilities for developing completely automated system. Nevertheless, it could be also used as a base for future development of software. For example, for a software that is used for more thorough research of colors' influence on human being.

IV. Application

This section will describe the implemented application to get an impression about how it was done. All the color and brightness processing are made at the client side. The CPU-utilization is not overloaded by bridge's calls and is working in real-time (Windows 10, Intel i7-4510 CPU, 8 GB RAM, Samsung 850 EVO SSD). Application will run in the background without any issue as well. User is able to switchback to application or to turn it off, in which case application automatically disconnects from the bridge when closing.

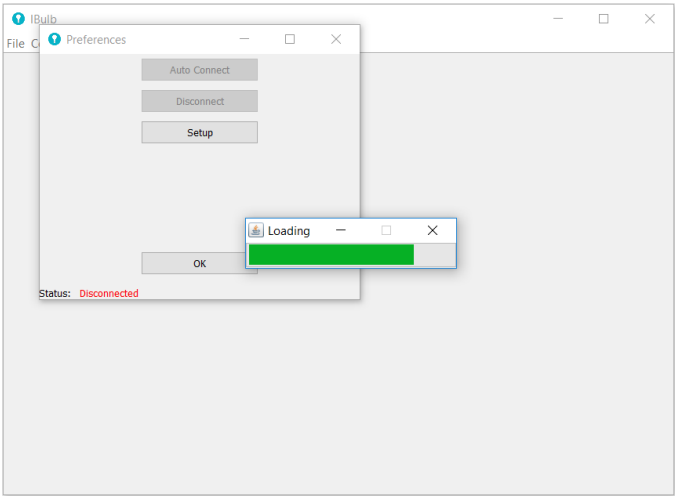

Fig. 2. Loading Screen

A. *Setup connection*

The application design was chosen light and clear. When the application is started for the first time, Preferences menu pops up. It is an indicator for the user that there is no connection to the bridge yet. Therefore, user is expected to enter Setup menu and search for the bridge(s). Described is shown in Figure 2. After the search is complete, all found bridges will be displayed in a list. The user is able to choose which bridge to connect to. For the matter of authentication, an additional frame is displayed when the user has to press the hardware button on the bridge. After this setup, all connection properties are saved and the user will not be asked to do it again. The application will connect automatically to the bridge when it starts running, as long as the same bridge is in use.

At the bottom of Preferences frame the status bar can be found. It is used for displaying current connection status. If the connection is established, the user is able to observe it in the status bar with provided bridge's ID and connection IP address.

B. *Setup profile*

When the connection is set up, the user will be asked to enter profile properties shown in Figure 3: name and type. Both can be changed later in the Profile menu bar. Based on profile and room type, certain auto adjustments will be applied as described in section III. C. After the profile is set up, the user can start adding the rooms and lights within it. Later in Profile menu, user can select checkbox Auto Adjustment which will run a new thread.

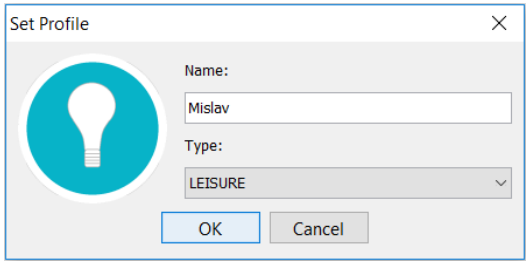

Fig. 3. Profile Setup

This thread will be continuously executed every 10 seconds until the checkbox is again unchecked. When the thread is executed, it will check every lightbulb in every room whether lightbulb's Auto Adjustment flag is selected. In case certain lightbulb has it set, the color and the brightness will be auto adjusted as described in section III. C.

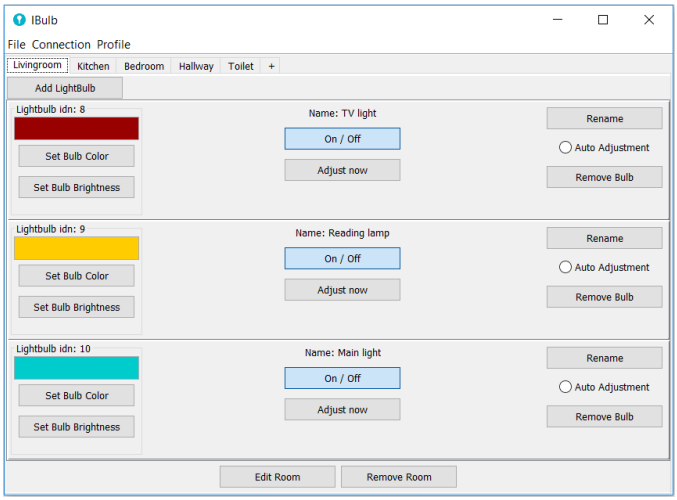

Fig. 4. Main Screen

C. *Main Screen*

The main screen, when everything is set up, is consisted of rooms separated in tabs. When the user selects a certain room, lights that are added to the room are displayed on the main screen in a scrollable list. Every room and light can be either edited later or removed. Lights are added in each room separately, by choosing Add Lightbulb option. In case certain lightbulb is already added in other room, it will not be displayed in list of available lights. If the user wants to add lightbulb in other room, firstly it has to be removed from previous room. To create a new room, special tab is provided which is always the one most to the right, marked with plus symbol. Described can be found in Figure 4.

When the application is starting, unless the app has not been set up yet, the main screen is always loaded automatically and displayed to the user. All the changes that were made in previous session are automatically saved, so that the user would not have to concern about saving the settings.

At any moment the user is able to enter Connection menu bar to observe current status of the connection or to disconnect from current bridge and connect to new one. Since the bridge might not see all the lightbulbs, there is an option to find them manually. The option Add Lightbulb can be also found under Connection menu bar. If the lightbulb is found after entering its serial number, the user will be notified by popup message and the lightbulb will turn off and on.

D. *Adjustments*

The user has the ability to edit lightbulbs and rooms at any time. For a single lightbulb several properties can be manually adjusted: name, color, brightness and an auto adjustment checkbox. It can be turn off and on, removed from a room and added to another one, or instantly auto adjusted. If auto

adjustment flag is marked, it will be auto adjusted when another thread is executed as previously described in section IV. B.

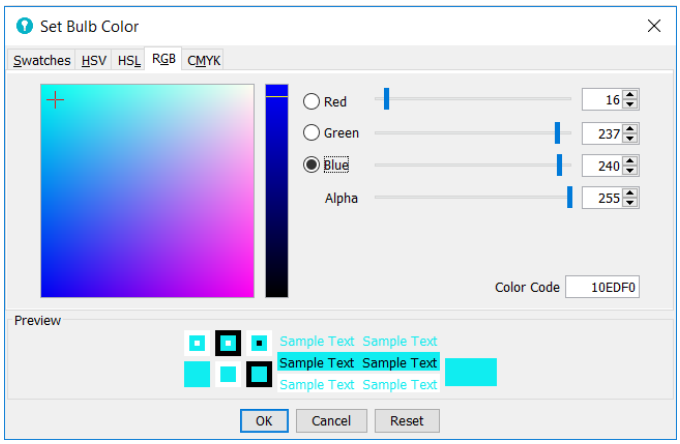

Fig. 5. Color Setup

Color can be manually adjusted in several ways as shown in Figure 5. If the color is being set with RGB values, it will be converted into HSV values, because of the Philips Hue technology. Therefore, the user might notify slight difference in the color presented on the main screen and the color of a lightbulb.

V. Conclusion and Future Work

The main goal of project was development of a desktop application for smart management of Philips Hue system. The application is written in Java programming language. Therefore, the app can be executed on any machine that has Java Virtual Machine. It was tested on Windows 10 operating system.

The application is written in object-oriented manner so that it could be easily upgraded and the code reused. Along with managing the lightning, smart auto adjustment is implemented as well. The user has ability to leave the application to completely operate the lightbulbs automatically.

This project successfully shows, what is possible with smart technologies in combination of application development. The user is immediately able to adjust the lightbulbs without a complex configuration. Nevertheless, this is just one approach of adjusting lightbulbs and there is potential for improvement.

References

[1] Süddeutsche.de GmbH; Munich; Germany (2016), "Wie Fernseher-Hersteller ihre Kunden überfordern". Available online at http://www.sueddeutsche.de/digital/fernsehen-einfach-kompliziert-1.3226436, accessed on 12/25/2017.

[2] Rheinische Anzeigenblätter (2017): Smart Home, "Smarte Technik im Haus". Available online at https://www.rheinische-anzeigenblaetter.de/sonderthemen/ratgeber/haus-garten/smart-home-smarte-technik-im-haus-29332334, accessed on 12/25/2017.

[3] Philips Hue third-pary Applications for Windows: https://developers.meethue.com/documentation/windows-apps accessed on 1/10/2018.

[4] Albedo Application: http://loginer.net/albedo/ accessed on 1/21/2018.

[5] WinHue 3 Application: https://hyrules.github.io/WinHue3/ accessed on 1/21/2018.

[6] Huetro Application: https://www.microsoft.com/de-de/store/p/huetro-for-hue/9wzdncrfjj3t?rtc=1 accessed on 1/21/2018.

[7] Philips (2016): Things you need to know | Philips Hue API. Available online at https://developers.meethue.com/things-you-need-know, accessed on 1/19/2018.

[8] Barbara Liskov with John Guttag (2000), "Program Development in Java", Avaible online at https://books.google.de/books?id=I0xnnSTMyjwC&printsec=frontcover&dq=java+programming+development+book&hl=en&sa=X&ved=0ahUKEwist5qTje_YAhUGWBQKHSH2D1oQ6AEIJzAA#v=onepage&q=java%20programming%20development%20book&f=false, accessed on 1/21/2018.

[9] Philips Hue Java SDK and Documentation https://developers.meethue.com/documentation/hue-sdk, accessed on 1/21/2018

[10] Wireless Router Image Reference: https://openclipart.org/detail/167055/wireless-router, accessed on 1/21/2018.

[11] Philips Lightbulb Image Reference: https://www.wink.com/products/philips-hue-lighting/, accessed on 1/21/2018.

[12] Philips Bridge Image Reference: https://www.johnlewis.com/philips-hue-personal-wireless-lighting-bridge-apple-homekit-enabled/p2229454, accessed on 1/21/2018.

[13] T. K. Rana, A. Chakraborty, T. Banerjee, T. Samadder, B. Rana (2016), "Season and Time Influenced Room Lighting for Optimal Human Need", Available online at http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7746336.

[14] A. Wright (2008), "Psychological Properties Of Colours". Available online at http://www.colour-affects.co.uk/psychological-properties-of-colours.

[15] M. R. Luo, F. Zhao, Q. Zhai, X. Liu, B. Wang (2013), "The Impact of LED on Human Visual Experience". Available online at http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7177370.

[16] J. F. Duffy, "Effect of Light on Human Circadian Physiology" (2009). Available online at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2717723/.

[17] U. M. Pal, "Effect of Artificial and Natural light on the Human body" (2014). Available online at https://www.ledinside.com/knowledge/2014/4/effect_of_artificual_and_natural_light_on_the_human_body.

[18] T. Morita, H. Tokura, "The Influence of Different Wavelengths of Light on Human Biological Rhythms" (1998). Available online at https://www.jstage.jst.go.jp/article/ahs/17/3/17_3_91/_pdf/-char/en.

[19] P. R. Boyce, "The Impact of Light in Buildings on Human Health" (2009). Available online at http://journals.sagepub.com/doi/pdf/10.1177/1420326X09358028.

[20] V. Pilorz, S. K. E. Tam, S. Hughes, C. A. Pothecary, A. Jagannath, M. W. Hankins, D. M. Bannerman, S. L. Lightman, V. V. Vyazovskiy, P. M. Nolan, R. G. Foster, S. N. Peirson, "Melanopsin Regulates Both Sleep-Promoting and Arousal-Promoting Responses to Light" (2016). Available online at http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002482