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Developing a website to visualize image data based on the working principles of Dark Sky Meter

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Summary

In 2009, Australia's "universe" magazine reported that a survey showed that 70% of the world's population lived in the light pollution. 20% of the world's population (67% of the US and 50% of Europe) could not see the beauty of the galaxy with the naked eye at night. The author of the report said: "human beings are losing the beautiful night sky, and it is artificial lighting that causes the stars to disappear." In a clear night sky without light pollution, 7000 stars can be seen by the naked eye, but under the influence of the city glow, only less than 30 can be seen.

Nowadays, more and more organizations begin to pay a lot of attention and researching on light pollution, while this paper focuses on a famous and popular mobile phone application - Dark Sky Meter, to discuss how to use an economic and efficient way of technology to obtain a relatively accurate data of light pollution, so as to enhance the quality of astronomy needs to research in various fields. In this article, we will examine in depth on how this software collects data, generates light pollution maps, and other related applications. The purpose here is to combine the technology of artificial intelligence to extend the similar benefits of Dark Sky Meter on combining other operating system and devices, not only iOS, to the maximum with this application. And at the same time, we will explore more possibilities for spreading the influences and effects of this web version so that it can be utilized and developed in more different fields of users.

In this article, in addition to the exploration and analysis of the original functions of the Dark Sky Meter software, the emphasis is to provide a similar platform for other devices outside the iOS device to achieve similar results. What is more, in addition to the basic working principles and processes with the Dark Sky Meter, we will add some new details to make the measurement of the sky luminosity higher accuracy and the reference value. For example, providing more professional information collection to professional equipment users; providing an open environment for all users to see all the relevant details; the possibility of extending more types of devices to upload resources is also a major feature of the software, and so on.

This series of research combines many aspects of knowledge, such as web development, front-end design, API design, image processing and so on, so it is hoped that this design can provide some degree of reference for other research projects in similar fields.

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1. Introduction

Dark Sky Meter is an mobile application only for iOS system, its purpose is to measure the level of brightness of the night sky with the usage of camera of iPhone. This application and its whole project were planed, designed and implemented by an independent netherlandish software company that named as DDQ. It was co-operated by Zetmedia, amateur astronomers, scientists and staff from the International Dark-Sky Association (IDA).

This software through the collection and collation of light pollution data from all over the world who downloads this application, the International Development Association(IDA) will be more powerful and reasonable to ask for those governments, local authorities and companies to manage the light output level, so as to effectively control the light pollution results. In an efficient and comprehensive way, scientific data is obtained from a large number of public scientific data provided by a large number of nonprofessionals.

This article here mainly contains two important contents, they include the followings:

- Analyze how the light pollution maps of Dark Sky Meter are generated and make a simple comparison with other similar ones.

- Designing and developing a web page, including frontend and backend, that receives images and information from mobiles (Android) and reflex cameras.

In the first part, after a detailed understanding of the details of the Dark Sky Meter application and the Global at Night project, I have read a lot of papers on the field of light pollution, in addition to the application of computer science, which involves a large number of geographic information technology, biological science, natural science, and so on. The knowledge of many related fields has further cognizance of the generation of light pollution and light pollution map. These articles effectively help me to clearly and quickly separate the pattern of Dark Sky Meter software from light pollution map generation and let me have a general understanding of the various types of generation patterns.

In the second plates, after a detailed analysis of the working principles of the Dark Sky Meter software based on the iOS system, I mainly use the PHP language to build the basic framework and form of the web page with HTML, CSS, and Javascript. The main principle is based on the Developing Architecture which is designed by Esteban González Guardia. After that, the API is designed so that the external functional scripts can be properly and efficiently connected to the backstage database of the website, and then the sky images taken from the devices outside the iOS system are analyzed.

2. Analysis of Light Pollution Map

Nowadays, with the increasing demand for light pollution research, many researchers have chosen different technologies and measurement models to analyze the map of light pollution, such as remote sensing observation, GIS model and so on.

The analysis in this paper is based on a more detailed analysis of the technology adopted by the Dark Sky Meter in order to provide more reference value for the direction of the collection of light pollution. The software focuses on the application of SQM and NELM technology to analyze the data collected by users independently, combine the Google Earth, and use the geographic information to publish the effective data to the world map for the researchers to use.

2.1 What is light pollution map

The light pollution map is a reference map based on the influence of visible light on the spatial structure of observation nebula. It can be based on many technical forms. According to the accuracy and quality, maps of different quality will be provided for researchers. In this paper, the technology used in this application, Dark Sky Meter, is analyzed based on the light pollution map formed in the software.

2.2 The technology used in Dark Sky Meter

The core of Dark Sky Meter is a friendlier and globalized collection of effective data, so the technology used within the program is very convenient for user receipt data. Its main technology is based on the data comparison and calculation effect of SQM and NELM, and then with the data received by the user's camera and the built-in GPS sensor, and at the same time parsing The user's raw data and the light pollution value with reference value is generated to create a format that can be used by users for various needs. The main page and the resulting page with the SQM value are as shown in Figure 1.
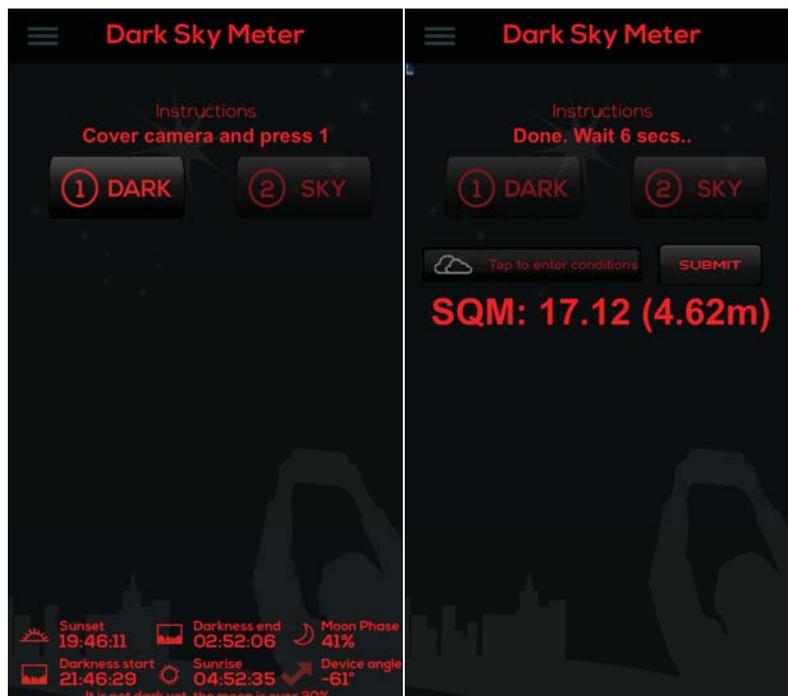
Figure 1. The main and final result interface of the application

2.2.1 The operation of users

Almost all valid data are derived from users, so the first step to generate light pollution maps are to collect data from users, as shown in Figure 2. This step has been displayed in the main page of Dark Sky Meter. When users start to use it, the system will tell users what should they do and the operation orders as well.
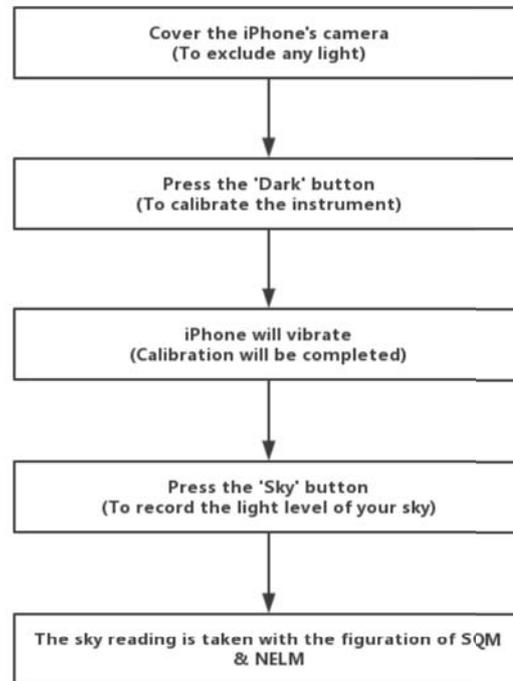
Figure 2. First step of collection data from users

2.2.2 Data collection and analysis of Dark Sky Meter

The project has taken a convenient and very friendly way to analyze the data in order to quickly collect data with a certain reference value so as to achieve long-term monitoring of light pollution in different parts of the world.

- First step: The internal SQM data are compared and analyzed with some of the original data of the user.

- Second step: At the same time, the system will calculate the processed SQM data through the NELM algorithm and further form a data with a certain reference value. The NELM algorithm is as shown in Formula (1):

$$(NELM = ((SQM - 8.89) / 2) + 0.5)) \qquad (1)$$

- Third step: Then packaged data after SQM and NELM parsing and user uploaded data from the GPS sensor.

- Fourth step: The system generates multiple formats of data for other researchers' needs.

The format includes: Full Dataset (.txt), Full Dataset (.xls), Full Dataset (.csv), Full Dataset (Google Maps,.kmz) and SQM Dataset (Google Maps, .kmz)

The detailed process is shown in Figure 3.

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Figure 3. The detailed process of parsing data

Then the final data generated from the user side includes: ID, ObsType, ObsID, Latitude, Longtitude, Elevation(m), LocalDate, LocalTime, UTDate, UTTime, LimitingMag, SQMReading, SQMSerial, CloudCover, Constellation, SkyComment, LocationComment, Country. There are as shown in Figure 4.

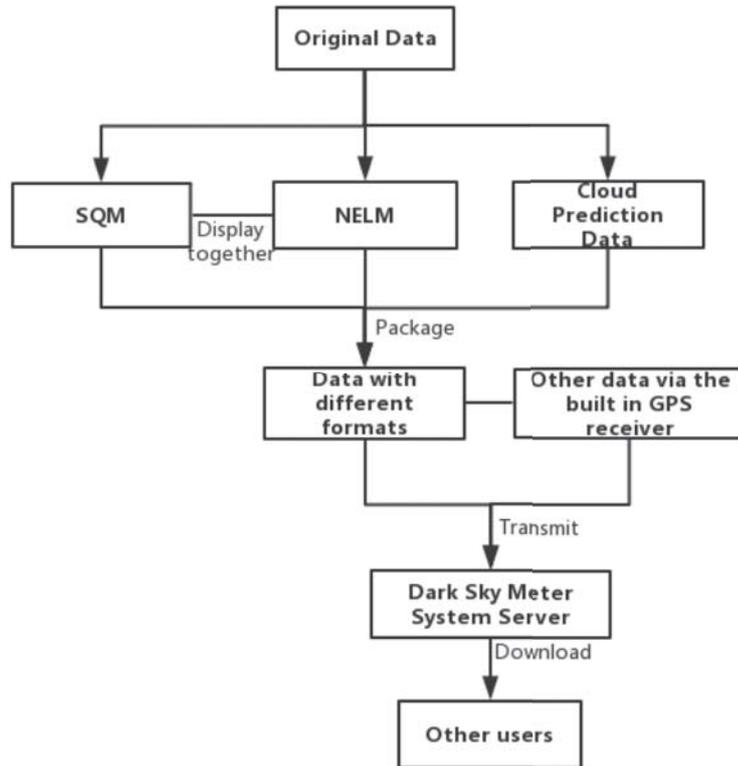|	A	B	C	D	E	F	G	H	I	J	K	L
	ID	ObsType	ObsID	Latitude	Longitude	Elevation(m)	LocalDate	LocalTime	UTDate	UTTime	LimitingMag	SQMReading
	181304	LON	39831	42.2301	-89.0416	247.12	2017/1/1	22:20:12	2017/1/2	04:20	5	
	181305	LON	39840	51.7887	6.0575	19	2017/1/3	00:15:53	2017/1/2	23:15	4	
	181307	LON	39848	34.1919	139.144	188.62	2017/1/3	21:54:21	2017/1/3	12:54	6	
	181320	LON	39892	31.9955	-111.298	975.9	2017/1/7	02:33:33	2017/1/7	09:33	6	21.51
	181349	DSM	18231	52.0685	-0.395234	86.35	2017/1/9	21:28:49	2017/1/9	21:28	4	18.08
	181351	DSM	18233	40.357	-74.6597	54.15	2017/1/7	20:04:13	2017/1/8	01:04	3	16.82
	181352	DSM	18234	41.9368	3.19529	154.95	2017/1/7	19:23:56	2017/1/7	18:23	4	17.48
	181353	DSM	18235	33.8047	-106.891	1378.92	2017/1/7	06:07:16	2017/1/7	13:07	4	18.6
	181354	DSM	18236	41.7044	-86.1575	230.91	2017/1/7	03:09:51	2017/1/7	08:09	5	19.71
	181355	DSM	18237	47.3406	8.0507	426.9	2017/1/7	01:46:37	2017/1/7	00:46	6	21.3
	181356	DSM	18238	41.6999	-86.1563	229.01	2017/1/6	19:38:03	2017/1/7	00:38	5	19.15
	181357	DSM	18239	33.0396	-116.592	1262.98	2017/1/6	13:54:06	2017/1/6	21:54	3	17.01
	181358	DSM	18240	41.9368	3.19538	154.99	2017/1/6	22:41:19	2017/1/6	21:41	4	17.87
	181359	DSM	18241	49.1738	8.75453	167.63	2017/1/6	06:18:55	2017/1/6	05:18	6	20.54
	181360	DSM	18242	49.1738	8.75447	167.61	2017/1/6	06:18:28	2017/1/6	05:18	6	21.05
	181361	DSM	18243	49.174	8.75439	164.57	2017/1/6	06:18:05	2017/1/6	05:18	6	20.43

Figure 4. Example of data downloaded from Dark Sky Meter application

2.3 Other common techniques on generating light pollution maps

At present, the number of big data research based on the global scale is quite large. Among them, the impact of light pollution on the growth, reproduction, and migration of plants and animals is a new research hotspot in biodiversity conservation (Gaston et al, 2015). Based on high precision satellite imaging data (the VIIRS DNB sensor on the Suomi National Polar-orbiting Partnership) and 20,865 global ground site data collected by scientists and the public, the most accurate global light pollution map has been produced by the team led by senior high school physics teacher, Fabio Falchi in Italy(Falchi et al, 2016). The result shows that more than 80% of the earth's human beings live under the sky polluted by artificial light, and this trend is still deteriorating. Nearly 1/3 of the world, including nearly 80% of North America and 60% of Europe, cannot see the Milky way due to light pollution. They point out that these light pollution will also lead to a host of other problems, including the impact on biodiversity. According to the statistics of the public impact assessment system Altmetric, the Altmetric index of Falchi (2016) is 3,020, which is listed in the 2016 paper Altmetric.

Based on the simple mathematical model of Berry (1976), the Poland night sky brightness map of 100 meters resolution was obtained by using field measurement and high-resolution data. The high-resolution input data, combined with a very simple model, can obtain a detailed structure of the night sky luminance without the use of computational complexity (Henryka Netzel&Paweł Netzel,2015).

Mohamed Elsahragty and Jin-Lee Kim (2015) uses the GIS model to determine the level of light pollution in the region. Through a series of steps such as comparison, calculation, and experiment, they created a most reasonable lighting strategy which will not cause huge light pollution, so as to achieve sustainability.

Helga U. Kuechly et al (2012) mainly determines the source of light pollution based on urban land use data and spatial analysis. Using aircraft and remote sensing technology, filter, uniform diaphragm and urban land use data for data collection, image data is converted into coordinates, and light pollution maps are formed with depth learning.

3. Web developing

Although Dark Sky Meter is excellent, only iPhone devices are currently supported. Not long ago, a report on the market share of a mobile device operating system by Kantar Woroldpanel, a data research firm, showed that in addition to Japan, Spain, and Chinese cities, iOS has continued to grow in most parts of the country. Except for the US, Android continues to increase its market share in all regions. So it can be seen that the user share of Android equipment is an important source of big data collection. Therefore, this article will aim at this phenomenon and develop a website that facilitates the upload of images and information of sky to users of Android devices and other single counter devices, based on the working principles of iPhone devices in Dark Sky Meter.

The whole idea of web developing were basically aim to implement a web version of Dark Sky Meter but with more possibilities of extension than this iOS application. We will firstly generate its working principles and its visualizing process, then we will make a brief summary of it so that we can confirm our final idea of wen developing. Finally, we are going to begin this web developing process.

3.1 Developing process

Initially, we will mainly based on these 4 ideas of designing which are as below, and we will put more attention on the last one, which is the overall design of the website. It is the main core of this developing project in our plan:

- The requirement analysis of the website.

- The overall requirements of the website.

- Design goals of the website.

- The overall design of the website.

The development logic of the website is still based on the working mode of Dark Sky Meter, receiving images and information from Android users and single reflex devices in a relatively brief way, while other users can also view the relevant images and its information of this part. At the back-end, a script that has been developed already will classify, compare, process and measure uploaded pictures to get the brightness of the sky depending on the multifaceted information.

In this process, I will mainly use PHP language with the Laravel framework. Laravel is a high-level, concise, elegant PHP Web development framework. And with the help of the Laravel community, the effect of the code can be better, making the effect of the web more friendly, each line of code can be more concise and rich.

3.1.1 Developing Objectives

The overall development goal and logic of the web are based on the work mode of Dark Sky Meter, which is also based on general ideas in theory. So the detailed development goals are as follows:

- Develop a website site to allow users to upload images and information about their observations. Data and images will be available to all users of the website.

Basically, it has to copy all functionalities of Dark Sky Meter in a web version.

It will group images in observations. An observation is a set of images taken by users of the same part of the sky during a specific time. Cardinality -> [1:N]. Users can send us two kinds of images: 'Dark' and 'Normal' images. 'Dark' are images taken with the shutter closed. 'Normal' images are the flat and original images taken of the sky by users without any extra settings. The information that has to be sent to our system includes:

- Exposure time

- Type of image (dark or normal)

- Timestamp

- Latitude + Longitude

- Altazimuth coordinates

- Camera or mobile model

- Cloud density

- Develop a REST API to upload images and information related to them. Also, users will be able to get this information using get requests. And this API may have an authentication mechanism based on session token.

3.1.2 Developing Architecture

There is a preliminary architecture of this developing task to tell those elements and functions of it, as shown in Figure 5.

So the main tasks of this developing architecture which is the blue part are:

- Design and develop the website with HTML, CSS, and JAVASCRIPT

- Design & implementation of the API REST (database schema & methods). Here I used PHP with Laravel open-source framework to develop it.
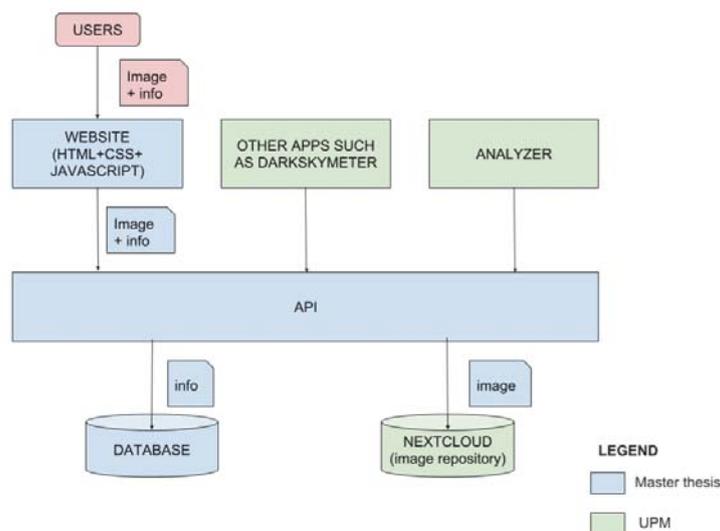

Figure 5. The developing architecture of the website

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3.1.3 Developing tools and environment

- PHP 7.1

- Laravel

- Apache2

- Sequel-pro

- CSS

- Javascript

- HTML5

- MySQL

- Axure PR 8

- mac OS High Sierra 10.13.03

3.1.4 Initial rapid prototyping design

In this part, our first job is to design a basic prototype for the entire website style, and then design it in depth according to the concept of the prototype, so that the development of the website can have a reference to facilitate the development of the new product cycle. At the same time, it can also help us find product design errors in time, make early mistakes, change early, avoid changing the losses caused by subsequent processes.

Here we used the Axure PR 8 software, which allows the designers of desktop applications and Web websites to create wireframe, flowcharts, prototypes and specification documents, which are faster than any other current tool for creating static prototypes such as Visio, Photoshop, Dreamweaver, and Visual Studio. Because it is a real prototype tool and supports multi-person writing design and version control management.

In this section, we will show the rapid prototyping designs of those main pages of the website.

Generally before the design, we will organize the requirements according to the original design concept, and integrate the functions of Dark Sky Meter, so as to design the framework of the original modules, which is a more concise flow chart. It can help us manage the every module better than designing by imagination, so that we can carry out the efficiency of highland design and follow up development.

As for the design of the front-end, its initial conceptual flow chart is as shown in Figure 6 and our original rapid prototype design oft the 'Homepage' is as shown in Figure 7. The design is basically consistent with the original archetype and makes more polish to make it look more beautiful.
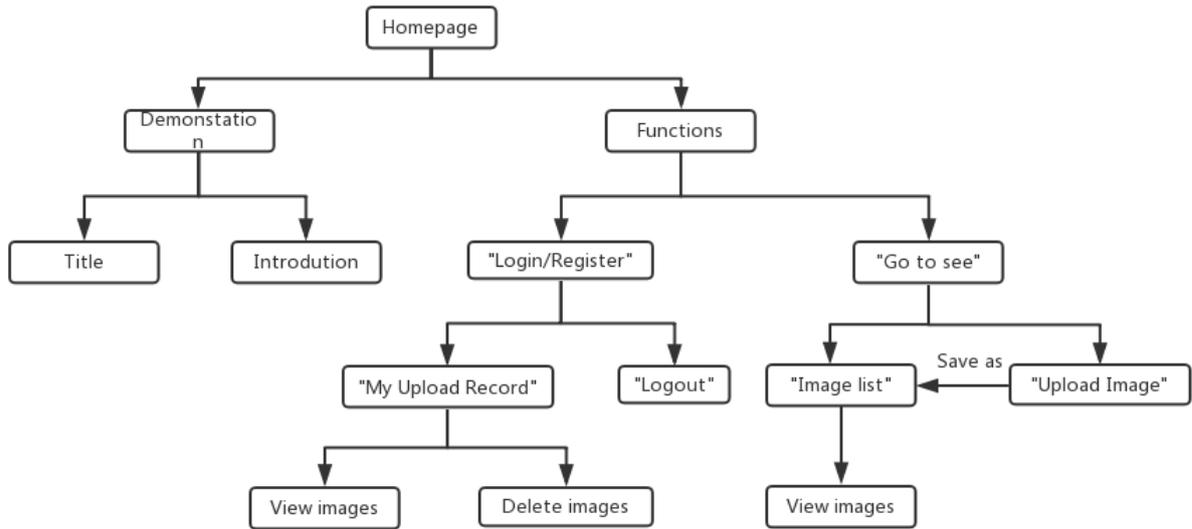
Figure 6. The initial conceptual flow chart of the front-end

Figure 7. The rapid prototype of the 'Homepage'

The initial conceptual flow chart of the 'Upload image' page is as shown in Figure 8 and the rapid prototype design of the 'Upload image' page, as shown in Figure 9, may be adjusted in the later stages of the sequence of each item, but basically the same as the interface of the prototype design. This part was designed separately because of the specificity of each item. Each of them determines the dimensions and available value of image information and also helps the background script to get more accurate results when measuring.
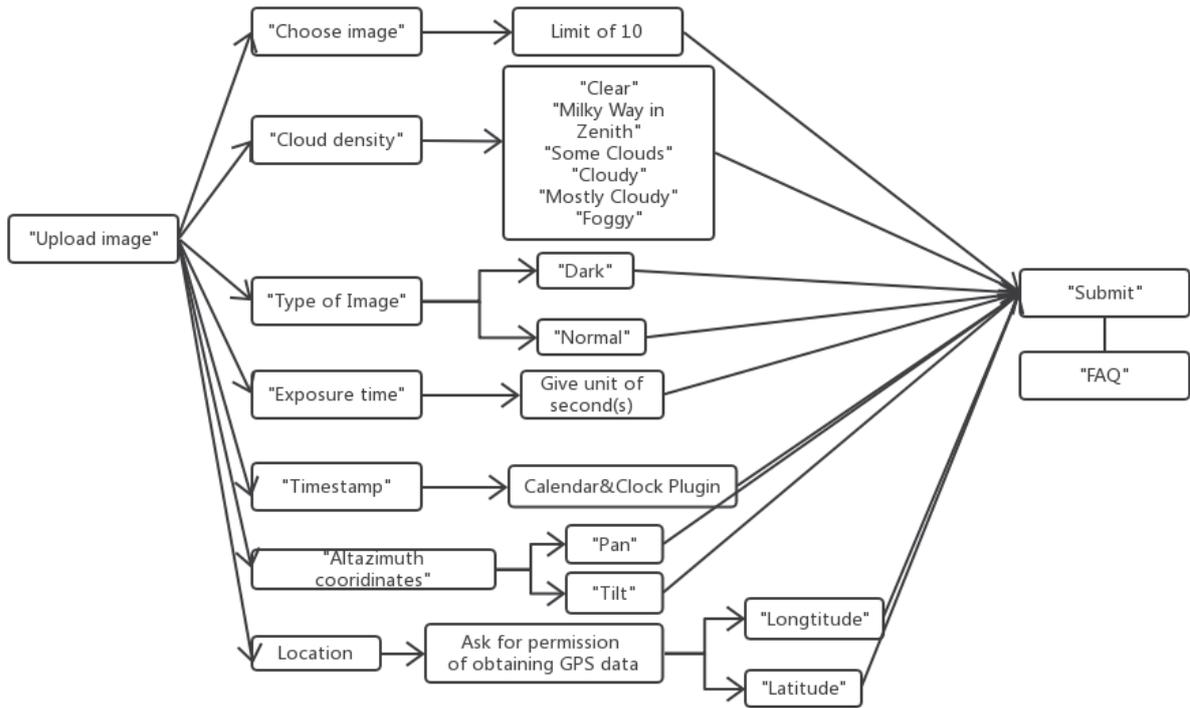
Figure 8. The initial conceptual flow chart of the 'Upload image' section

Figure 9. The rapid prototype of the 'Upload image'

The initial rapid prototyping of the 'Image list' interface is shown in figure Figure 10. There is no big difference between modification and re-design.

Figure 10. The rapid prototype of the 'Image list'

The initial conceptual flow chart of the back-end page is as shown in Figure 11 and its rapid prototyping design of 'background management' page is as shown in Figure 12.
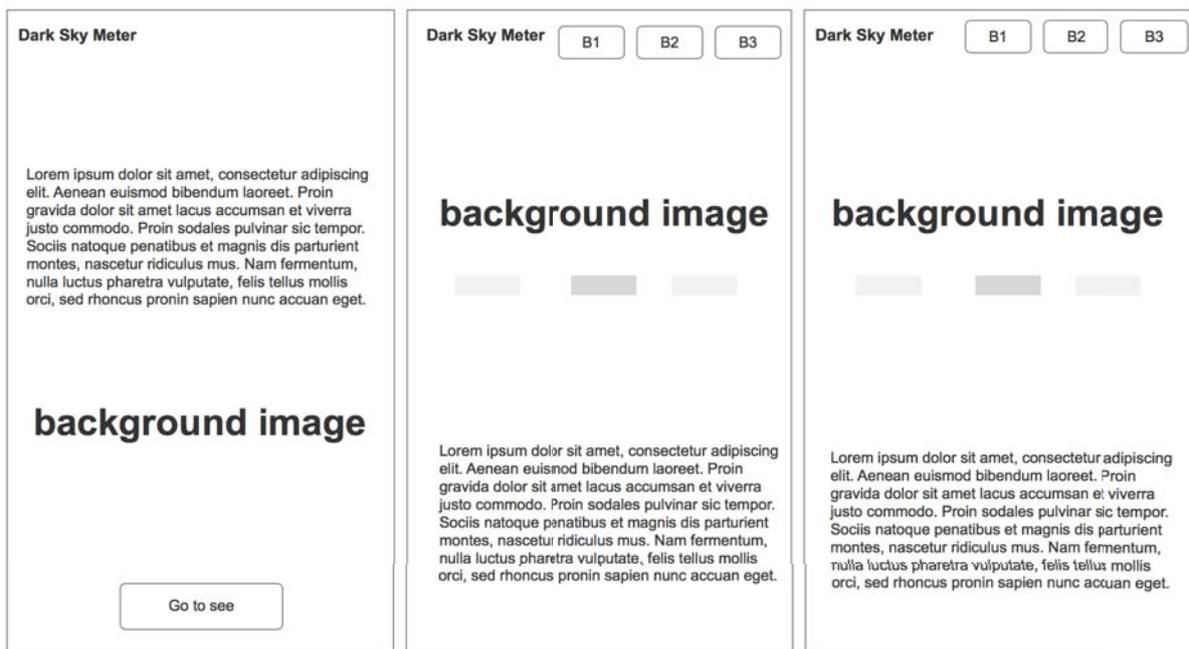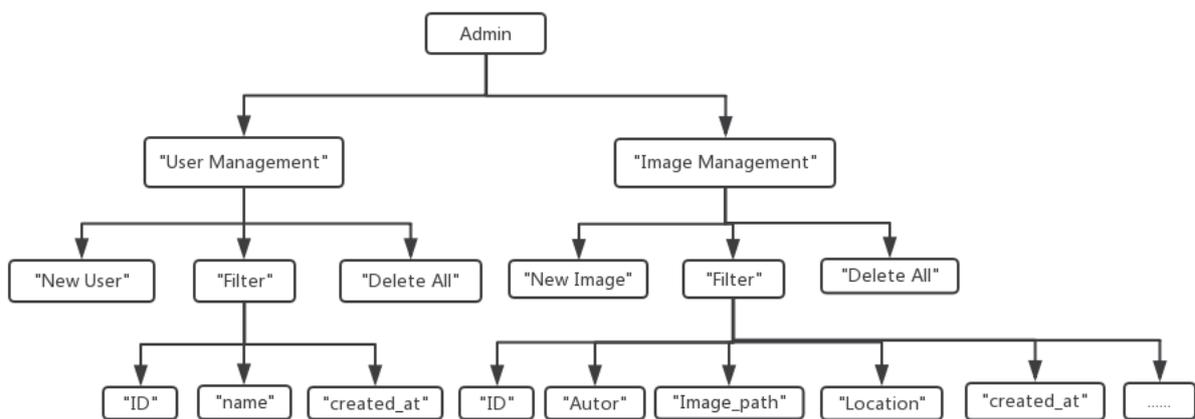

Figure 11. The initial conceptual flow chart of the back-end
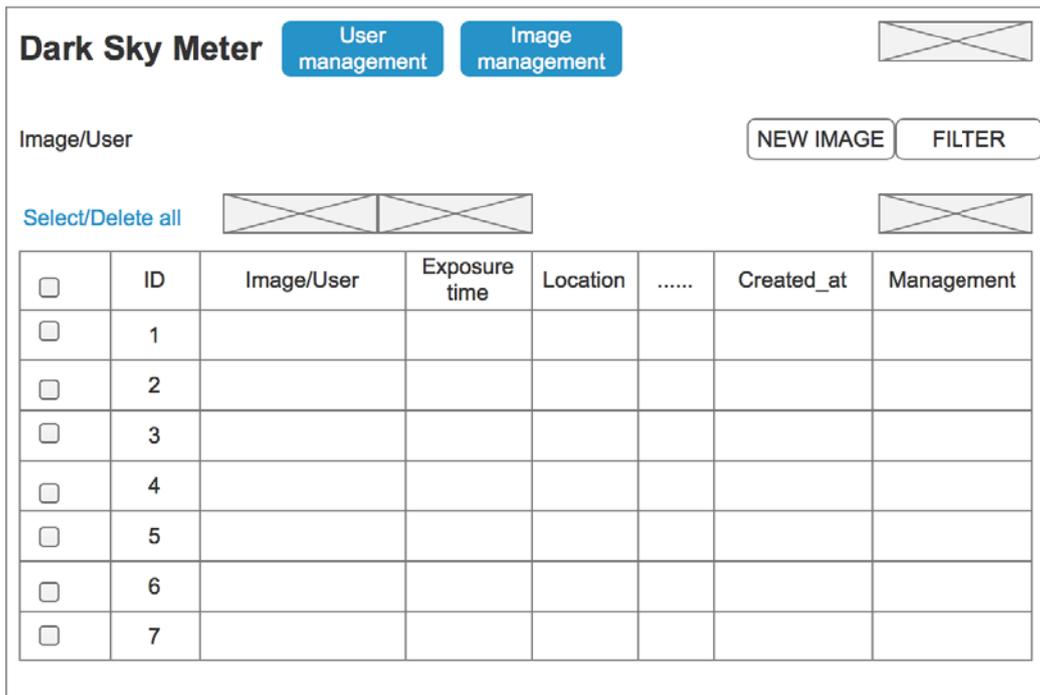
Figure 12. The rapid prototype of the 'Background management' page

We also gave the rapid prototyping design of 'FAQ' page which is as shown in Figure 13.
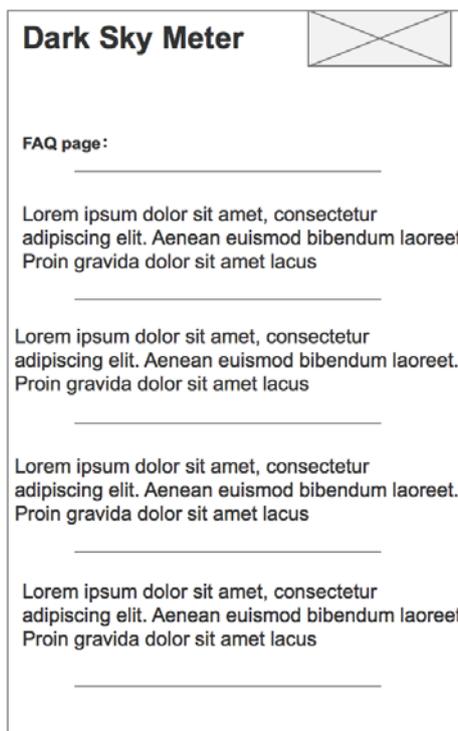
Figure 13. The rapid prototype of the 'FAQ' page

After determining the rapid prototyping design of the original plates, we started a real website design process. On the standard of rapid prototyping design, we have made some logical adjustments and modifications in the following

designs. So that we can obtain a final molding of the website which is more convenient for the user to use and more beautiful with the outline.

3.1.5 Front-end presentation

Since the webpage is in the initial stage of design and evaluation, the presentation of the front end is still presented in a relatively simple way, which can be intuitively and concretely showing the location and use of each module and its functions.

In this page, in addition to the registration and login functions of users and administrators and the plate of all picture information, we will also display the functions of the website in a user friendly way, so that the user can understand the main function of the website before use-measuring the sky light pollution condition, and can be intuitionistic. Understand the working mode of the website so as to help users quickly understand the operation process of the website. So the main function section of the initial front-end and its effect of the functional interpretation page are shown in Figure 14.
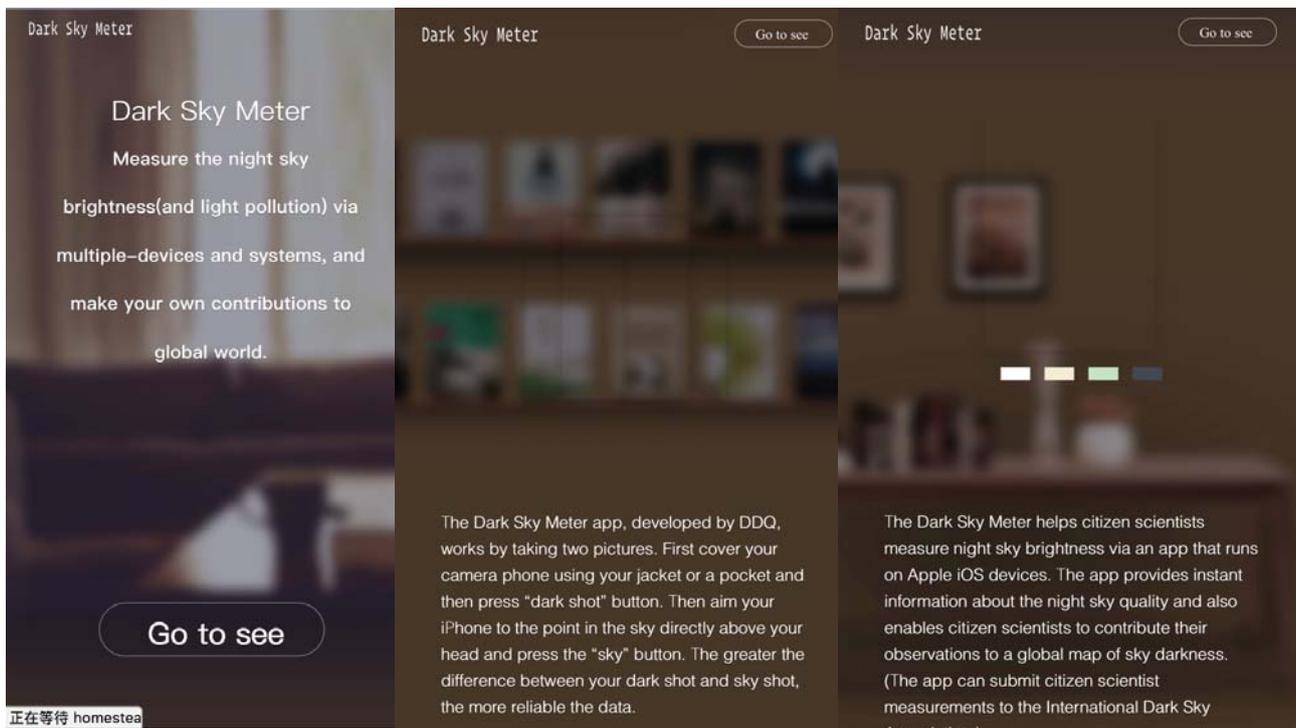
Figure 14. Function and Description sections of the Homepage

The main contents of the front end are: the user uploads the entry of pictures. After classification, other users can view the resources of the picture at will. This section will detail the main functions and applications of the preceding section.

- Website introduction: in order to show the friendliness of the front page, we have designed a more beautiful home page to explain the working principles of the website, the development purpose and the display of the results. This plate can help new users quickly and intuitively get guidance on the use of the website, but also in a concise way to have a general understanding of the function and value of the site.

- Login and register: This part allows users to do the login and register(also include logout) operation. It can be found directly in the homepage's top right corner.

- Upload image: After the user clicks on the upload picture, the system automatically pops out the window to ask whether the user allows the system to get the location of the device, so as to locate the longitude and latitude of the picture for other users to refer to the sky position. This section include many different items and information and they are all displayed at the 'Function details' section.

- Image list: In this section, other users can freely view the public sky image resources, and include all the details of the pictures that users upload. Here, we can achieve an open resource environment and maximize the application of resources.

3.1.6 Back-end presentation

The function of the back end mainly focuses on the administrator's efficient management of various information sets. In this part, the full authority of the administrator is to manage the personal information of the user, manage the detailed information of the picture, and modify and delete all kinds of information. The initial conceptual flow chart of the back-end page is as shown in Figure 15 and its detailed pages are as shown in Figure 16 and Figure 17.
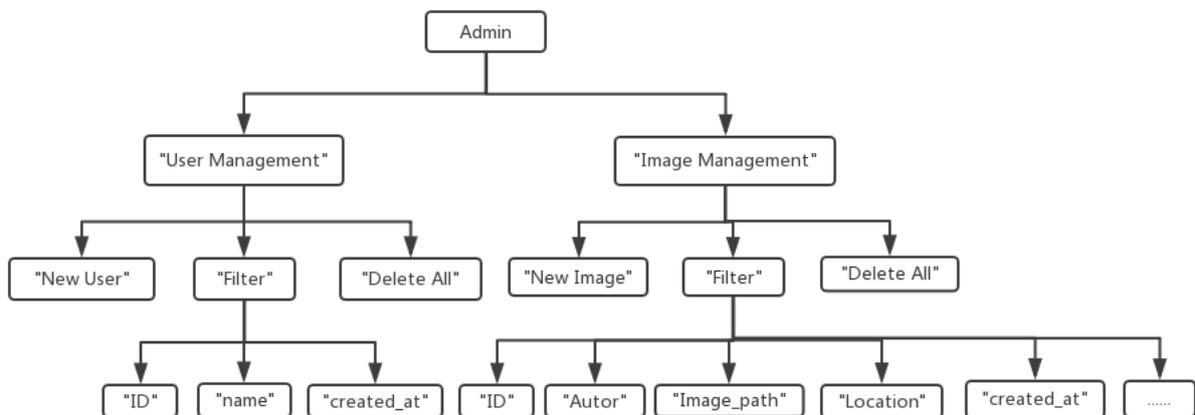
Figure 15. The initial conceptual flow chart of the back-end page
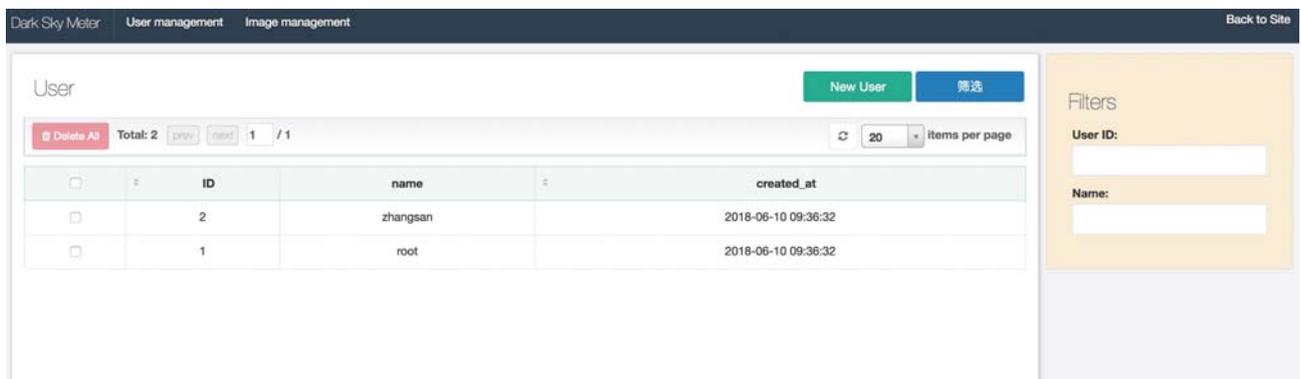
Figure 16. The initial back-end of the webpage of 'User management' page
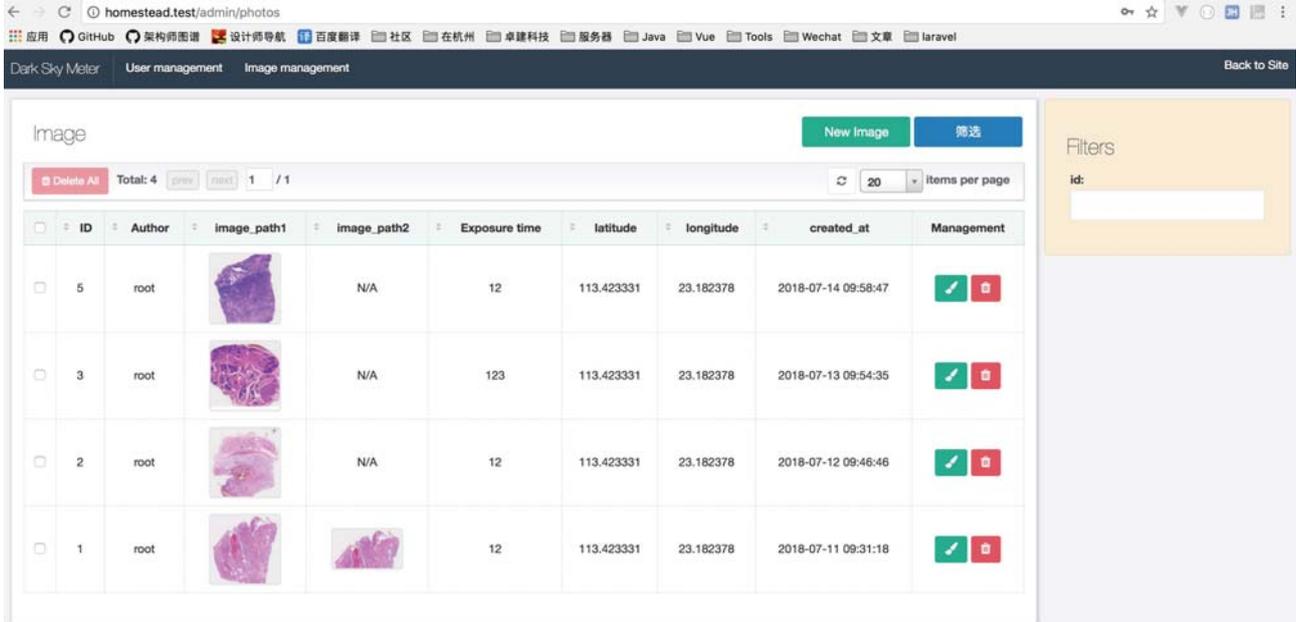
Figure 17. The initial back-end of the webpage of 'Image management' page

From the figure, we can see that all pictures uploaded by the user and their details can be viewed very intuitively and succinctly. In this page, its main functions are divided into user management and picture management. In the picture management section, the administrator can select and classify the Image ID, the author, the exposure time, the latitude and longitude, and the creation time, and can modify and delete it to a certain extent. In the user management section, the administrator can modify the selected user information to a certain extent through the classification results of user ID, users' name and account creation time.

3.1.7 Main core code

In view of the fact that this is a function of the website, so it is the main function of the code presented in the functional area, the main function of the code is as 'Appendix' shows.

3.2 Function, docking and testing process

After the website research and development, the function is basically satisfied with the original purpose of website design. Here we will give a detailed description of the final functional presentation of the website. First, in the upload interface, as shown in Figure 18, we can see all the information in the fill box, most of the information is required by the user to manually fill it into the system background, so it may require a user to have a certain understanding of the detailed information of their own pictures, in order to make the follow-up measurement results as good as possible, it may be accurate. When users fill in all necessary information, click Submit. After successful, the system will jump to the front page. Users can view or choose to continue uploading. After uploading the image, all the information of the image will be automatically calculated by the system to get a result of the sky light pollution. This information will be automatically added to the detailed information of the picture. All the other users can view it. After this picture is uploaded successfully, the system will automatically return to the previous page.
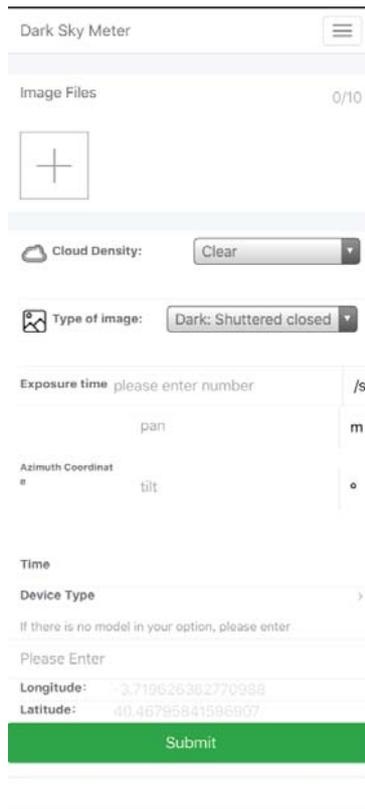
Figure 18. Interface of 'Image upload'

3.2.1 Function details

Upload image: Here in this section, the system allows users to upload four formats of pictures, namely "PNG", "JPG", "GIF" and "JPEG". There is no limit to the content, size, and quality of the picture, and of course, we expect the user to upload a higher reference image to make the results more specific and useful.

- Cloud density: This item is manually filled by users to calculate the synchronization reference after the result is calculated. Because of the degree of abstraction of cloud density and the difficult technical measurement, here we used the format of Dark Sky Meter for reference. There are 6 items that users can choose depends on their current weather condition. There are:'Clear', 'Milky Way in Zenith', 'Some Clouds', 'Cloudy', 'Mostly Cloudy' and 'Foggy'. With different cloud density for the user to refer to, select the specific circumstances of the item, and then adjust the results to a certain extent according to the range of data that the different icons point to. This part is as shown in Figure 19.
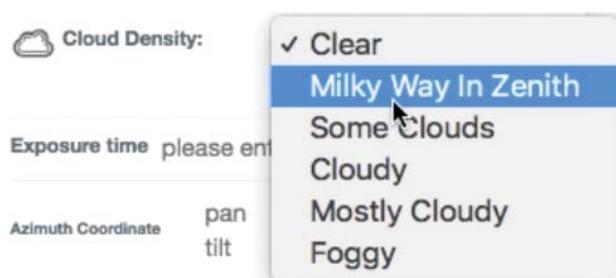
Figure 19. The 'Cloud density' item

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- Type of image: In this section, the types of pictures are divided into dark and normal. Dark are images taken with the shutter closed. Flat images are the normal images taken of the sky by users. Here, the Dark image is the sky image captured after shutting down the shutter. Normal is the sky image captured by the user under normal operation. Since the two types of Dark and Normal are easily confused by the user, we will give the two text hints to ensure that the user can easily identify the specific types of the pictures. In addition, because of the differences in equipment and light in the recognition process of class Dark images in the two types of images, the images in the final image are distorted to a certain extent, so we need to remove the imperfect pixels by some technical means. The noise of the image is reduced to ensure the accuracy of the measurement results to a certain extent. Here, we de-noise this series of images periodically through the noise reduction algorithm contained in the background scripts. We will ask the user to upload a set of images, up to 10, and label them for NOT_PROCESSED, PROCESSED. Later, the backstage script will identify the labels for all the pictures, process the onion noise-free images, and the processed photos will become the final measured images in the system so that we can help to some extent the gap between the measurement results of the Dark class and the Normal class. This part is shown in Figure 20.
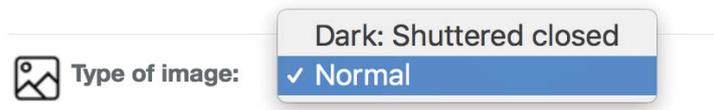
Figure 20. The 'Type of image item

- Exposure time： This item is manually filled by users to calculate the synchronization reference after the result is calculated. In the exposure time, we give a unit of detail to second that users can fill out and we provide detailed data input units for more professional users, such as SLR users, to guide the user and help us to make the most accurate judgment and measurement of the detailed information of the image. This part is as shown in Figure 21.
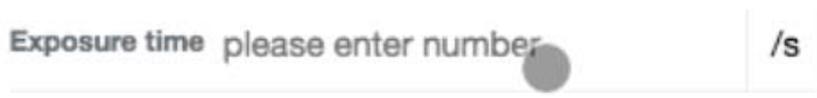
Figure 21. The 'Exposure time' item

- Camera or mobile: The options in the drop-down box are a camera and mobile model, which are used to distinguish photographing devices. Here, in detail, we investigated most of the most common versions of the camera and mobile models in the current market, and integrated these data manually, then put them systematically into the plugin to facilitate users' search.we provide as much as possible the common mobile phone brand and single - counter brand on the market to help users intuitively find the equipment they are using, and make a detailed distinction between the differences between different devices. When the users are not able to find the corresponding camera or mobile model , they can also select the "other" option to add to their own device manually and this new information will be displayed in the 'Image list' as well. This part is as shown in Figure 22.

Figure 22. The 'Camera or mobile model' item

- Altazimuth coordinates: Here, in altazimuth coordinates, because of the difference between the technical and different users of the picture, this data is still acquired by the user manually, where we will divide the altazimuth coordinates into two fields, pan and tilt, and we also add some icons to help users to be able to visualized geography. The unit of 'pan' we give it as miles(m) and the 'tilt' item we give it as degree(°). The purpose and meaning of the block will be solved in this way. This part is as shown in Figure 23.

Figure 23. The 'Altazimuth coordinates' item

- Time: There are a calendar and clock component for users to quickly position the time. The time when the user is required to manually enter the photograph, the format is shown in the input box for Y/M/D H:i:s, and the purpose is to make the later classification and view of the image clearer. It's as shown in Figure 24.

Figure 24. The 'Timestamp' item

- Longitude & Latitude: In these 2 sections, which is the initial location section, the website will ask a permission about the using of GPS sensor from the devices that users have, then the location of the picture will be automatically acquired if users choose 'OK', and the location of the user can be obtained. Otherwise, the location area will be null. This part is as shown in Figure 25.
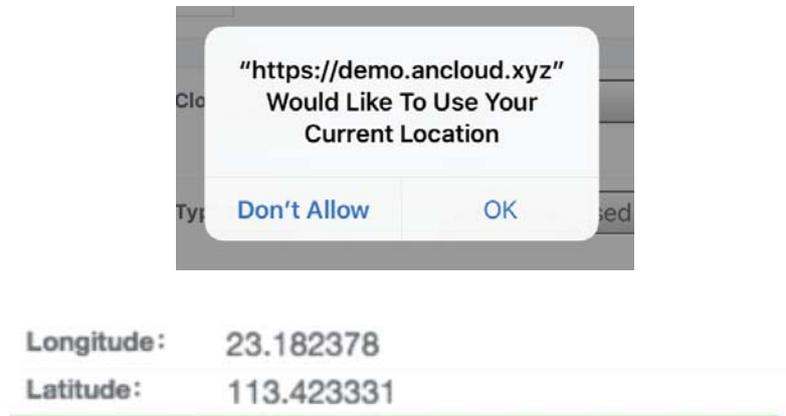
Figure 25. The 'Location' item and 'Permission' box

Image list: In this part, all users can view the pictures and their detailed information in the system at random, and the visualized results are as shown in Figure 26. This page is located after the 'homepage'. When you select the go to see button, it will automatically jump to the page. This part of the picture is classified according to the shooting time and geographical location to ensure the efficiency and clarity of the user's view of the picture information.
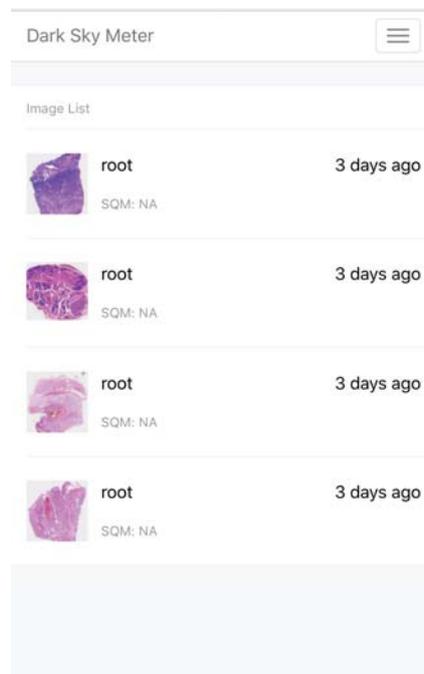
Figure 26. The 'Image list' item

- Classification of images：In this section, we sort the pictures at the time of release, and other users can screen the images according to different shooting times so that they can quickly locate the required image information and check them.

- Image information: When other users browse all the public picture information, they will see all the information describing the picture, including the results of the sky luminance after measuring the picture. The result is that the running rules of background scripts will be displayed periodically.

My upload record：In this interface, we also call it as 'the users' personal page', we mainly allow users to register their accounts and have a private area that allows users to view all their uploaded information and performs a certain operation so that users can better browse their own history of uploading images and enables users to quickly view their own contributions. This part is as shown in Figure 27.
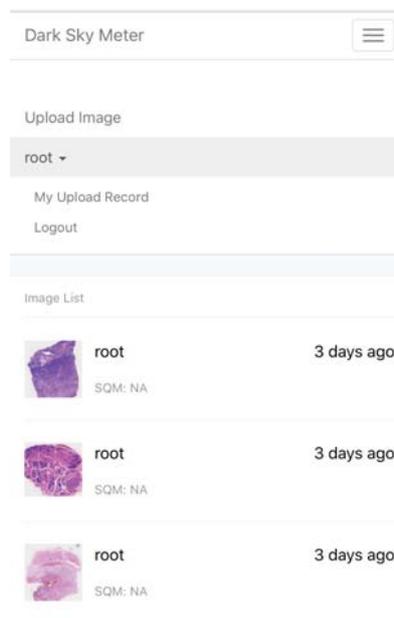
Figure 27. The 'My upload record' item

- Viewing the history of uploading images: on the user's personal page, the user can view all the history of the uploaded image, which has a good control over the private image, all the information of the individual's uploaded pictures, and the value returned by the background script, which is intuitively viewed by the user, not by searching through the 'Image list' interface and check and seek the personal uploaded image with a great workload.

- Delete images: The function of removing the picture is completed in the user's operation history page. The user has the authority to delete the individual's upload record which will help the user to efficiently manage the personal uploaded image information. It is shown as Figure 28.
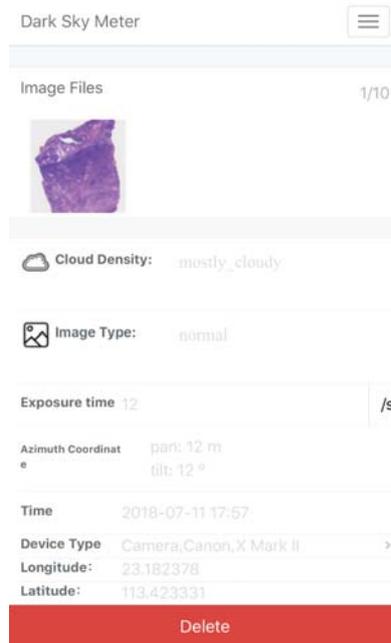
Figure 28. Interface of 'Delete images"

- FAQ page: We have generated a FAQ page which contain many explanations and question that users may be interested in. It locates in the bottom of 'Upload image' page. It will not only provide some filling guidance, but also give users a general idea of why developing this website and its idea of image data visualization. This page is feasible, it has possibilities to be improves with more information in the future when we get many different feedback from users. This page is as shown in Figure 29.
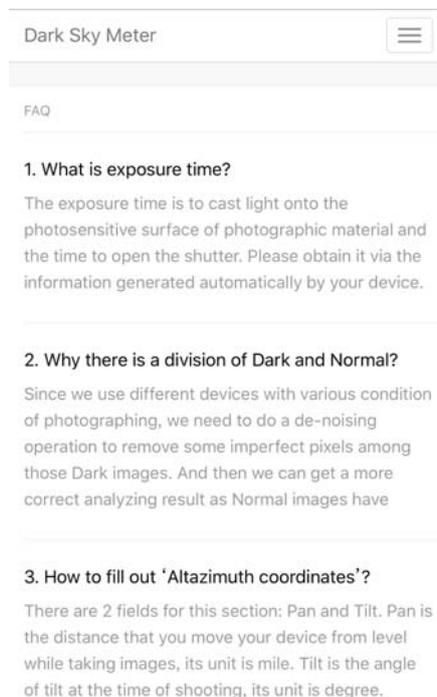
Figure 29. Details of the 'FAQ' page

3.2.2 Web site docking process

When the whole website is basically formed well with every function done, it needs to be butted with the script of the back-end measurement operation. The script is a daemon project, the project is not working on demand, which will work periodically in the background, and its workflow is:

⁻ Check if there are any pending images to be processed or not yet to be processed.

⁻ Process all the images of one observation.

⁻ Calculate the sky brightness based on the core of relevant algorithm.

⁻ Modify the SQM and other relevant values in the database.

⁻ Copy all the images information from the website to another private cloud.

⁻ Modify the URI field in the table as it could be needed in the future.

Then we will give this background script an private authorization to access to our database so that it can obtain, operate and copy all this part of data to do the processing operation with the sky brightness analyzing. Then it has to return a value which is the final analyzing result, the SQM value to us after reading all the necessary data from our database. We will save this value at the same time it copies our information. It will be two different system running at the same time and the workflow will cooperate well with each other. Finally, our initial purpose of developing this website will be completely finished.

3.2.3 Testing of general functions

In the test section, we design different projects based on the functional requirements to test whether the workflow and logical relationship of the functions of the web pages are correct, and help to view and correct the usefulness of the functions of each part. The test items and details are as follows:

⁻ Registration and login function: In view of the user's registration and login function, several different character tests have been carried out to ensure the convenience and clarity of user use.

⁻ Upload images: In view of the uploading of pictures, we have tested different types of pictures, and we can get stable and correct information results. As for the speed of picture uploading, because of the upload mode of single picture we use, from the point of view of upload speed, based on the smooth network, the picture can be uploaded smoothly within a few seconds, and it will not make the user discomfort on this plate.

⁻ Public information of all images: In view of the image information of other users, we found that after testing, the information has the integrity of being viewed, and the format is correct.

⁻ Back-end management: In view of the management of the picture in the background, it can be found that the administrator has all the rights to edit and manage all the users' personal information and uploaded image information. The operation is clear, and the various text information is also clean and orderly.

⁻ Home page display area: In the home page, our main function is to display information, so the testing process is relatively simple, that is, to observe the rationality of the layout of the home page, the correctness and clarity of the

information, and whether the operation is reasonable. After several constructions and proofreading of the front page, we can guarantee that the content and the functional distribution on the front page can make the user's operation experience achieve our expected idea.

- My upload record: The function of this page is relatively simple, so the probability of problems is slightly smaller than that of other items. After testing, the user's personal upload accuracy of the image record is 100%, and the connection error of the image and the user will not appear. All information and delete function of the images were tested well and no major problems occurred.

- Image de-noising effect: Because our pictures are divided into Dark and Normal classes, and we want to link and de-noise the Dark class pictures, so when uploading the pictures, we selected the same group of Dark images for Dark and Normal, respectively, to observe the results of the photometric measurement of the two people before and after the noise reduction. The results of a series of comparisons show that the sky pollution measurement results are more stereoscopic after the noise reduction of the real Dark class images, which is closer to the results of the professional instruments to measure the sky. It can be seen that the script program we execute in the background is indeed feasible and correct in noise reduction operation.

- Visualizing results: In the test section of all visualizing results, we have not only tested the docking of each module and functions after the website was totally formed, but we have also had a certain test on the accuracy rate by doing a brief and direct comparison between those various measured data obtained from different devices. We used different devices to take sky images and tested the level of sky brightness of the same location, using Dark Sky Meter to take a picture of the sky, and use Android and other digital equipments which are Mirrorless camera and SLR camera, to take pictures of the sky from the same location, same timestamp, and then compared the final results of those two systems so that we can see the obvious difference between the each of them. The Dark Sky Meter application will obtain the image data inside of the software so we cannot show the image took by the application and others three sky images are as shown in Figure 30. (a) was took by Android device: Huawei P20; (b) was took by Mirrorless camera: Sony α6000; (c) was took by SLR camera: Canon 5D Mark IV.
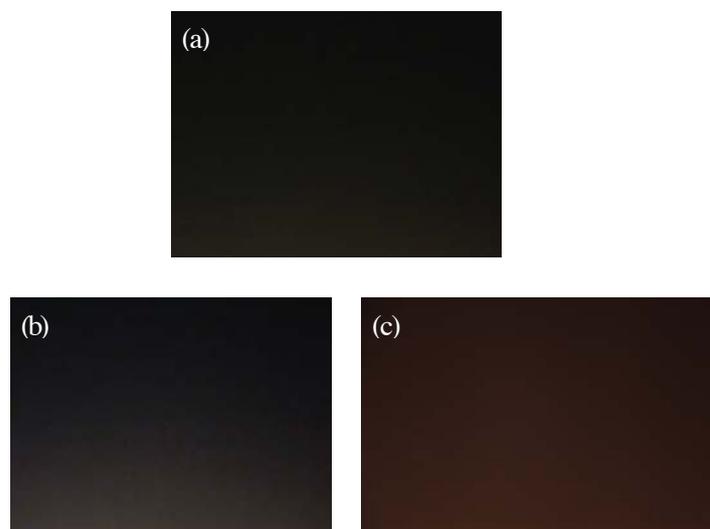

Figure 30. Sky images from different devices

4. Conclusion

Objectively speaking, the needle for this task, although the overall function of the basic standard, but the design of the web is still a more diversified task, not only requires technical stability, of course, there is also a visual maturity and excellent, so the overall view, I still have a certain distance from the goal. But through this webpage design, I also gained a lot of knowledge, especially about light pollution. In the whole process of exploration and development, through some literature, news and industry communication about sky light pollution, web design and image acquisition, I have also experienced a real experience in integrating computers into social applications and is very helpful to the research and learning that I will be able to do next. So, I also want to thank my thesis mentors for giving me this opportunity to feel such an interesting and meaningful topic in this field.

In addition, it still has a lot of space for this topic, although it is based on the two development of the Dark Sky Meter work logically, but with the expansion of user needs and the constant diversification of the equipment, it is very possible in the space of functional expansion and development, so here, I also feel very sorry, because of the technical level and the time limit, I did not be able to do the best of the website project for more innovation and development.

The following problems have occurred throughout the project:

- There is no understanding of the process and logic of Dark Sky Meter: for this problem, I have consulted a certain amount of literature and related news, also carried out a certain search and analysis in the field of light pollution. After several personal uses, I finally based on my personal understanding of the soft piece if it was born into light. The understanding of the pollution map has completed the first step of the investigation. But honestly, I still don't have a high depth of understanding of Dark Sky Meter, plus the limited number of documents on the software in this field, so I can't ensure the correctness of the flowchart, and the relevant practitioners will be able to point out the shortcomings.

- About the website itself some technical operation: Because of the limited technical level, I have sought help from the relevant people in this field. In the process of explaining the professor, I can depict the embryonic form of the site and add more personal colors, but it is a pity that some more complex ideas and designs have not been achieved on time. So, in this field, I still need to continue to learn a lot, so that I can handle the tasks with ease and accomplish a project as independent and as possible.

- In the management of the picture, the number of pictures in the early development process is always in the minority, so there is no consideration for the speed of loading and the collapse of the server for the time being. In later tests, we found that the largest data stream of the website was pictured, and the detailed information carried by each picture. Because the quality and size of the picture will vary greatly from the user's device, when the overall number of pictures grows, we have to consider the capacity of the server to the picture, and a series of problems that may occur in the water storage, such as the server crash. Our initial idea is to use CDN server to process and store pictures in the light of other large traffic websites. But because the workflow of the back end script is a daemon, the script will copy the image information on the website and return the corresponding value. In this process, most of the information in

the picture will be diverted, so the workload of the server is not very difficult. So here we are lucky to communicate and solve this problem, but I always need to explore and practice the problems on the loading and type of the server.

- The process of docking, because there is a grammatical and operational difference between the website and the back end script, so this process takes a certain amount of time to communicate, debug and process. After sorting out the database's schema, the version of the system and the debugging tools, the initial docking of the website was successful. After the site is online, a series of data and functional tests are carried out, and the performance is basically good, but it still exists the possibility that some details may be improved, which is also a point worth continuing to follow in the future.

Finally, I would like to say that the completion of this website is inseparable from the help of teachers and the technical advice of my friends. Nowadays, everyone's life is basically inseparable from the mobile application, the use rate of the website is gradually decreasing, but the importance of this plate can not be replaced quickly. The development of the website still has a key role in all walks of life. In the field, I still need to constantly learn and explore, and this website that analyzes image data, I hope that it could also bring some helps to people with these relevant needs.

References

[1] Jian Zhang, Biodiversity science and macroecology in the era of big data, Biodiversity Science, 2017, 25 (4): 355–363

[2] Yali Katz, Noam Levin, Quantifying urban light pollution — A comparison between field measurements and EROS-B imagery, Remote Sensing of Environment 177 (2016) 65–77

[3] Henryka Netzel, Paweł Netzel, High resolution map of light pollution over Poland, Journal of Quantitative Spectroscopy & Radiative Transfer (2016,7 March)

[4] Mohamed Elsahragty, and Jin-Lee Kim, Assessment and Strategies to Reduce Light Pollution using Geographic Information Systems, Procedia Engineering 118 (2015) 479 – 488

[5] Matys, Mrazek, Naked Eye Limiting Magnitude： http://www.project-nightflight.net/

[6] Fabio Falchi, Pierantonio Cinzano, Christopher D. Elvidge, David M. Keith, Abraham Haim, Limiting the impact of light pollution on human health, environment and stellar visibility, Journal of Environmental Management 92 (2011) 2714e2722

[7] Steve Richards, Dark Sky Meter Review, BBC Sky at Night Magazine

[8] Yali Katz, Noam Levin, Quantifying urban light pollution-A comparison between field measurements and EROS-B imagery, Remote Sensing of Environment 177 (2016) 65–77

[9] Helga U. Kuechly , Christopher C.M. Kyba, Thomas Ruhtz, Carsten Lindemann , Christian Wolter , Jürgen Fischer , Franz Hölker, Aerial survey and spatial analysis of sources of light pollution in Berlin, Germany, Remote Sensing of Environment 126 (2012) 39-50

[10] Chun Shing Jason Pun, Chu Wing So, Wai Yan Leung, Chung Fai Wong, Contributions of artificial lighting sources on light pollution in Hong Kong measured through a night sky brightness monitoring network, Journal of Quantitative Spectroscopy & Radiative Transfer 139 (2014) 90-108

[11] Fabio Falchi, Pierantonio Cinzano,Dan Duriscoe,Christopher C. M. Kyba,Christopher D. Elvidge, Kimberly Baugh, Boris A. Portnov, Nataliya A. Rybnikova,7Riccardo Furgoni , The new world atlas of artificial night sky brightness, Science Advances 2.6 (2016)

[12] Pan Xiaohan, The Stereometric Observation and Experiment of Urban Lighting-As An Example of Dalian,2014

[13] Li Yuan, Ma Jian, Cao Lei, Behavioral Effects of Monochromatic light of different wavelengths on Siberian Rubythroat Luscinia calliope, 2011

[14] Jennifer Birriel , Jaclyn Wheatley, Christine McMichael, Documenting Local Night Sky Brightness Using Sky Quality Meters: An Interdisciplinary College Capstone Project and a First Step Toward Reducing Light Pollution, JAAVSO Volume 38, 2010

[15] B Espey, J McCauley, Initial Irish light pollution measurements and a new Sky Quality Meter-based data logger, Lighting Res. Technol. 2014; Vol 46: 67-77

[16] Dominic Sunnebo, iOS and Android push towards a Two-OS world: https://www.kantarworldpanel.com/global/News/iOS-and-Android-push-towards-a-Two-OS-world

[17] HU Jun, CHENG Jing, WANG Min, Design and implementation of XML-based REST API, Microcomputer Information, 2010, 26(9):166-16

[18] Wang Hao, Web Picture Management Based on PHP, New Technology of Library and Information Service, 2004, 20(5): 30-34

[19] Zhang Jinfang, Advantages of PHP in the design of Website Background, Computer Development and Applications, 2012, 25(12): 39-40

[20] Huang Jianrong, Image processing of PHP Website Information Releasing System, Journal of Wuzhou University, 2008, 18(3): 57-59

[21] Qiu Peng, Design and Implementation of Web Page Transformation System for Mobile Terminals, Dalian University of Technology, 2012, 01(3)

[22] Xiang Xuesong, Wang zhen, Lian Cheng, System and method for providing real-time web browsing service for browsers, Baidu Online Network Technology, 2016,09(6)

[23] Armel, Jamal, Web application development with Laravel PHP Framework version 4，Metropolia Ammattikorkeakoulu, 2014

[24] Chen Hao, Analysis of key technology of Laravel framework, Beijing, Electronic Industry Press, 45-102, 255-294

[25] Guo Xin, Front end design and implementation of general WebIM component based on HTML5, Huazhong University of Science and Technology, 2011, 10(5)

[26] Bai Lei, Guo Qingju, HTML5 and CSS3 design patterns, Intelligent Computer and Applications, 2016 (2): 104-105

[27] Xu Ke, Web Application Front--end CSS Optimization and Back-·end Log Analysis, Hu Nan University, 2013, 29(11)

[28] Zhang Cunye, Some suggestions on writing CSS code in the Web front-end project, Computer Programming Skills & Maintenance2017(22): 71-73

[29] Xue Min, Design and implementation of P2P net loan system based on Laravel framework, Ji Lin University, 2016

[30] Zhu Xiaoyan, An Rongyu, The advantages of PHP language in the construction of the background of the website, Practical Electronics 2013(9): 100-100

[31] Zhao Qian, Realization and Design of Image Acquisition Terminal about Web Server Based on Embedded system, Coal Technology, 2010, Vol.29, No.03

[32] Ni Hao, Easily fix web images with cloud storage and CDN, Programmer, 2012-02

[33] Wang Qian, Liu Jianhua, Zan Linping, The deployment strategy of image cutting in the cache server, Computer and Digital Engineering, 2015(2): 320-324

Appendix

Some main code of the web system is as follows:

- Main code of front-end page :

```html
</head>
<body scroll="no">
<div id='view'>
    <div id='background'></div>
    <div id='page'>
        <div class='page' id='page_download'>
            <div class='img' id='page_download_hand'></div>
            <div id='page_download_show'>
                <div id='page_download_show_top'>
                    <div id='page_download_text'> Dark Sky Meter
                        <div>
                            <h6>
                                Measure the night sky brightness(and light
pollution) via multiple-devices and systems, and make your own contributions to
global world.
                            </h6>
                        </div>
                    </div>
                </div>
            </div>
            <a href="/image" id='page_download_button'>
                <div id='page_download_button_top'>
                    <div id='page_download_mobile_iPhone'>
                        <p style="font-size: 30px;color: white;padding-left:
11px;">Go to see</p>
                    </div>
                </div>
            </a>
            <div id="page_download_pc_button">
                <a href="/image" id="page_download_button_iPhone">
                    <div id="page_download_pc_iPhone"></div>
                </a>
            </div>
        </div>
        <div class='page' id='page_function1'>
            <div id='page_function1_text'>
                <h1 id='page_function1_text_title'></h1>
                <h2 id='page_function1_text_sub'>The Dark Sky Meter helps
citizen scientists measure night sky brightness via this website system that
could run on multiple devices. This system provides instant information about
the night sky quality and also enables all citizen scientists to contribute
their observations to a global map of sky darkness condition.All users can
obtain their demanding image data from this website.</h2>
            </div>
            <div id='page_function1_show'>
                <div id='page_function1_show_top'>
                    <div id='page_function1_book'>
                        <div id='page_function1_book_page3'></div>
                        <div id='page_function1_book_page2'></div>
                        <div id='page_function1_book_page1'></div>
                    </div>
                    <div id='page_function1_skin'>
                        <div id='page_function1_skin_icon'></div>
                        <div id='page_function1_skin_block1'></div>
                        <div id='page_function1_skin_block2'></div>
                        <div id='page_function1_skin_block3'></div>
                        <div id='page_function1_skin_block4'></div>
                    </div>
                    <div id='page_function1_font'></div>
```

```
                </div>
            </div>
        </div>
        <div class='page' id='page_function2'>
            <div id='page_function2_text'>
                <h1 id='page_function2_text_title'></h1>
                <h2 id='page_function2_text_sub'>This system operates and
visualizes image data based on the working principles of Dark Sky Meter in iOS.
Here it will allow you to upload the images you want and input those detailed
information about images. It will also provide you multiple options to input
more professional data of images. When finishing the uploading process, our
system will return you the final sky rightness result which is the SQM value.
Please check the FAQ page in 'Upload image' page for more information.</h2>
            </div>
            <div id='page_function2_show'>
                <div id='page_function2_show_top'>
                    <div id='page_function2_face'>
                        <div id='page_function2_face_left'></div>
                        <div id='page_function2_face_right'></div>
                        <div id='page_function2_face_main'></div>
                        <div id='page_function2_face_text'></div>
                    </div>
                    <div id='page_function2_book'>
                        <div id='page_function2_book_07'></div>
                        <div id='page_function2_book_06'></div>
                        <div id='page_function2_book_05'></div>
                        <div id='page_function2_book_04'></div>
                        <div id='page_function2_book_03'></div>
                        <div id='page_function2_book_02'></div>
                        <div id='page_function2_book_01'></div>
                    </div>
                </div>
            </div>
        </div>
```

- Main code of 'Upload image' page:

```
@extends('layouts.app')
@section('title', 'Image Uploading')
@section('content')
    <div class="weui-cells weui-cells_form">
        <div class="weui-cell">
            <div class="weui-cell__bd">
                <div class="weui-uploader">
                    <div class="weui-uploader__hd">
                        <p class="weui-uploader__title">Image Files</p>
                        <div class="weui-uploader__info"><span id="image-
num">0</span>/10</div>
                    </div>

                    <div class="weui-uploader__bd">
                        <ul class="weui-uploader__files" id="uploaderFiles"></
ul>
                        <div class="weui-uploader__input-box">
                            <input id="uploaderInput" class="weui-
uploader__input js_file" type="file" accept="image/*" multiple>
                        </div>
                    </div>
                </div>
            </div>
        </div>
    </div>

    <div class="weui-cells weui-cells_form">
        <div class="weui-cell">
            <div class="weui-cell__hd">
```

29

```
                <img src="/icon/cloud.png">
                <label class="weui-label" style="font-size: 14px;    position:
relative;
    top: -29px;
    left: 36px;">Cloud Density:</label></div>
            <div class="weui-cell__bd">

                <div class="weui-cell__hd">
                    <select class="cloud-density"  id="cloud-density"
name="cloud-density" style="    position: relative;
    top: -15px;
    left: 90px;">
                        <option selected value="clear">Clear</option>
                        <option value="milky_way_in_zenith">Milky Way In
Zenith</option>
                        <option value="some_clouds">Some Clouds</option>
                        <option value="clody">Cloudy</option>
                        <option value="mostly_cloudy">Mostly Cloudy</option>
                        <option value="foggy">Foggy</option>
                    </select>
                </div>
            </div>
        </div>


        <div class="weui-cell">
            <div class="weui-cell__hd">
                <img src="/icon/image_type.png">
                <label class="weui-label" style="font-size: 14px;    position:
relative;
    top: -29px;
    left: 36px;">Type of image:</label></div>
            <div class="weui-cell__bd">

                <div class="weui-cell__hd">
                    <select class="cloud-density"  id="image-type" name="image-
type" style="position: relative;
    top: -15px;
    left: 60px;">
                        <option selected value="0">Dark: Shuttered closed</
option>
                        <option value="1">Normal</option>
                    </select>
                </div>
            </div>
        </div>

        <div class="weui-cell weui-cell_vcode">
            <div class="weui-cell__hd">
                <label class="weui-label" style="font-size: 14px" >Exposure
time</label>
            </div>
            <div class="weui-cell__bd">
                <input class="weui-input" type="number" id="exposure-time"
name="exposure-time" pattern="[0-9]*" placeholder="please enter number">
            </div>
            <div class="weui-cell__ft">
                <button class="weui-vcode-btn" style="color: #000000">/s</
button>
            </div>
        </div>


        <div class="weui-cell">
            <div class="weui-cell__hd"><label for="time-format" class="weui-
label" style="font-size: 11px">Azimuth Coordinate</label></div>
```

```
            <div class="weui-cell__bd" style="    position: relative;
    left: 30px;">
                    <input class="weui-input" type="text" name="pan" id="pan"
placeholder="pan"><button class="weui-vcode-btn" style="color: #000000;position:
relative;top: -33px;
    left: 218px;">m</button>
                    <input class="weui-input" type="text" name="tilt" id="tilt"
placeholder="tilt"><button class="weui-vcode-btn" style="color:
#000000;position: relative;top: -33px;
    left: 218px;">º</button>
            </div>
        </div>

        <div class="weui-cell">
            <div class="weui-cell__hd"><label for="time-format" class="weui-
label" style="font-size: 14px">Time</label></div>
            <div class="weui-cell__bd">
                <input class="weui-input " id="datetime-picker" name="time"
type="text" value="" readonly="">
            </div>
        </div>

        <div class="weui-cell weui-cell_select weui-cell_select-after">
            <div class="weui-cell__hd">
                <label for="" class="weui-label" style="font-size: 14px;">Device
Type</label>
            </div>
            <div class="weui-cell__bd">
                <input class="weui-input" id="device-type" name="device-type"
type="text" >
            </div>
        </div>

        <div class="weui-cells__title">If there is no model in your option,
please enter</div>
        <div class="weui-cells">
            <div class="weui-cell">
                <div class="weui-cell__bd">
                    <input class="weui-input" type="text" id="device_content"
placeholder="Please Enter">
                </div>
            </div>
        </div>

        <div class="weui-cell weui-cell_vcode">
            <div class="weui-cell__hd">
                <label class="weui-label" style="font-size: 14px" >Longitude: </
label>
            </div>
            <div class="weui-cell__bd">
                <input class="weui-input" id="longitude" name="longitude"
placeholder="longitude" required disabled>
            </div>
        </div>

        <div class="weui-cell weui-cell_vcode">
            <div class="weui-cell__hd">
                <label class="weui-label" style="font-size: 14px" >Latitude: </
label>
            </div>
            <div class="weui-cell__bd">
                <input class="weui-input" id="latitude" name="latitude"
placeholder="latitude"  required disabled>
            </div>
        </div>
```

```
        <button class="weui-btn weui-btn_primary" id="my-btn"
onclick="storeImage()" >Submit</button>
        <button class="weui-btn weui-btn_danger" id="about" onclick="about()"
>FAQ</button>

    </div>
@stop

@section('js')
    <script>
        $(function () {
            var options = {
                enableHighAccuracy : true,
                maximumAge : 1000
            }
            if (navigator.geolocation) {
                //浏览器支持geolocation
                navigator.geolocation.getCurrentPosition(onSuccess, onError,
options);
            } else {
                //浏览器不支持geolocation
                alert('Your browser does not support location targetting!');
            }
        })

        function onSuccess(position) {
            var longitude = position.coords.longitude;
            var latitude = position.coords.latitude;
            $('#longitude').val(longitude)
            $('#latitude').val(latitude)
        }

        function onError(error) {
            var longitude = 23.1823780000;
            var latitude = 113.4233310000;
            $('#longitude').val(longitude)
            $('#latitude').val(latitude)
        }
    </script>

    <script>
        $("#datetime-picker").datetimePicker();
    </script>

    <script type="text/javascript">

        $(function(){
            var tmpl = '<li class="weui-uploader__file" ><img  src="#url#"
alt="" id="image" style="width: 80px; height: 80px"></li>',
                $gallery = $("#gallery"), $galleryImg = $("#galleryImg"),
                $uploaderInput = $("#uploaderInput"),
                $uploaderFiles = $("#uploaderFiles");

            $uploaderInput.on("change", function(e){
                var num = parseInt($('#image-num').html());

                if (num >= 10) {
                    $.alert("Sorry,You can only upload 10 pictures at most");
                    return ;
                }

                var src, url = window.URL || window.webkitURL || window.mozURL,
files = e.target.files;
                for (var i = 0, len = files.length; i < len; ++i) {
```

```
                    var file = files[i];

                    var formData = new FormData();
                    formData.append('image', file)

                    $.ajax({
                        headers: {
                            'X-CSRF-TOKEN': "{{ csrf_token() }}"
                        },
                        type:'POST',
                        url :'/image/upload',
                        dataType:'json',
                        data: formData,
                        processData: false,
                        async:false,
                        contentType: false,
                        cache: false,
                        success:function (data) {
                            if (data.status_code == 200) {
                                var num = parseInt($('#image-num').html());

                                $('#image-num').html(num+1);
                                localStorage.setItem('image_path' + (num+1),
data.data)

                                $uploaderFiles.append($(tmpl.replace('#url#',
data.data)));
                            }
                        },
                        error:function (xhr,status) {
                            console.log(xhr);
                            console.log(status);
                        }
                    });
                }
            });
            $uploaderFiles.on("click", "li", function(){
                $galleryImg.attr("style", this.getAttribute("style"));
                $gallery.fadeIn(100);
            });
            $gallery.on("click", function(){
                $gallery.fadeOut(100);
            });
        });
    </script>

    <script src="/js/city-picker.js">
    </script>

    <script>
        $("#device-type").cityPicker({
            title: "Choose Your Device",
            onChange: function (picker, values, displayValues) {
                localStorage.setItem('device_type', displayValues)
                console.log(displayValues);
            }
        });

        function storeImage(){
            var longitude = $('#longitude').val();
            var latitude = $('#latitude').val();

            var exposure_time = $('#exposure-time').val();

            var cloud_density =  $("#cloud-density option:selected").val();
            var image_type =  $("#image-type option:selected").val();
```
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```
            var pan = $('#pan').val();
            var tilt = $('#tilt').val();
            var device_content = $('#device_content').val();
            var timestamp = $('#datetime-picker').val();

            var device_type = localStorage.getItem('device_type')

            var image_path1 = localStorage.getItem('image_path1');
            var image_path2 = localStorage.getItem('image_path2');
            var image_path3 = localStorage.getItem('image_path3');
            var image_path4 = localStorage.getItem('image_path4');
            var image_path5 = localStorage.getItem('image_path5');
            var image_path6 = localStorage.getItem('image_path6');
            var image_path7 = localStorage.getItem('image_path7');
            var image_path8 = localStorage.getItem('image_path8');
            var image_path9 = localStorage.getItem('image_path9');
            var image_path10 = localStorage.getItem('image_path10');

            $.ajax({
                headers: {
                    'X-CSRF-TOKEN': "{{ csrf_token() }}"
                },
                type: 'POST',
                url: '/image',
                dataType: 'json',
                data: {longitude: longitude, latitude:
latitude,device_content:device_content,exposure_time:
exposure_time,pan:pan,tilt:tilt,image_type:image_type,cloud_density:cloud_densit
y,
timestamp:timestamp,device_type:device_type,device_content:device_content,image_
path1:image_path1,
image_path2:image_path2,image_path3:image_path3,image_path4:image_path4,image_pa
th5:image_path5,image_path6:image_path6,image_path7:image_path7,image_path8:imag
e_path8,image_path9:image_path9,image_path10:image_path10},
                success:function (data) {
                    if (data.status_code == 201) {
                        localStorage.clear();
                        $.toast("Success", function() {
                            location.href = '/image';
                        });
                    }else {
                        $.toast(data.msg, 2000);
                    }
                },
                error:function (xhr,status) {
                    console.log(xhr);
                    console.log(status);
                }
            });
        }
    </script>
    <script>
        function about(){
            location.href= '/image/about'
        }
    </script>
@stop

- Main code of 'Image list' page:
@extends('layouts.app')
@section('title', 'Image')
@section('content')
    <div class="weui-panel weui-panel_access">
        <div class="weui-panel__hd">
            <a href="/image">Image List</a>
```

```
                <label for="date" class="weui-label" style="position: relative;top:
-19px;left: 200px;">filter</label>
                <input class="weui-input" id="date" onchange="queryDate()"
type="text" value="{{ $date ?? "" }}" style="position: relative;left: 245px;top:
-42px;">
        </div>
        <div class="weui-panel__bd">
            @foreach($images as $image)
            <a href="/image/detail?id={{ $image->id }}" class="weui-media-box
weui-media-box_appmsg">
                <div class="weui-media-box__hd">
                    <img class="weui-media-box__thumb" src="{{ $image-
>image_path1 }}" style="width: 60px;height: 60px;">
                </div>
                <div class="weui-media-box__bd">
                    <h4 class="weui-media-box__title">{{ $image->user->name }}
<p style="float: right">{{ $image->created_at->diffForHumans() }}</p> </h4>
                    <p class="weui-media-box__desc">SQM: {{ $image->sqm ??
"NA"}}</p>
                </div>
            </a>
            @endforeach
        </div>
    </div>
    <script type="text/javascript" >
        function toDetailPage(id) {
            window.location.href = "/image/detail?id=" + id;
        }
    </script>
    <script src="{{ asset('js/jquery.min.js') }}"></script>
    <script>
        $(function() {
            $("#date").calendar({
                onDayClick: function (p, dayContainer, year, month, day) {
                    localStorage.setItem("date", year + '/' + (Number(month) +
1)+'/' + day);
                }
            });
        })
        function queryDate(){
            if(localStorage.getItem('date') == '' ||
localStorage.getItem('date') == null) {
                return;
            }
            var date = localStorage.getItem('date');
            localStorage.clear()
            window.location.href = 'image?date=' + date;
        }
    </script>
@endsection
```