Literature Review For Intelligent Umbrella Stand

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1. Background Research

In our daily life, rainy days are a very common kind of weather. Because the product “Intelligent Umbrella Stand” we are going to design is related to rainy days, we first studied the rainfall situation in Hangzhou. The following Figure 1 shows the average monthly precipitation in Hangzhou. According to the concept of meteorology, a rainy month is when the monthly precipitation reaches or exceeds 4 inches (about 100 mm). We can see from the figure that Hangzhou has an average monthly precipitation of more than 4 inches for nearly 7 months (March to September) every year, which proves that Hangzhou has a rainy climate. It is normal to encounter rainy days and people often need to take an umbrella before going out.

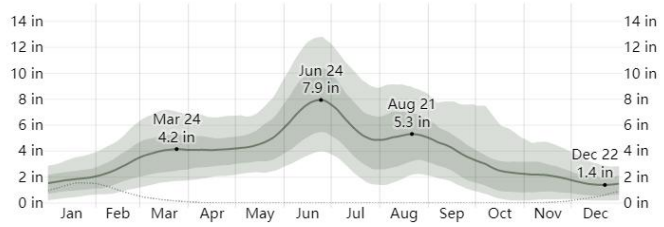

Figure 1: Average Monthly Rainfall in Hangzhou Source: Weather Spark

At the same time, we also noted that short-term heavy precipitation is very frequent in Hangzhou, especially in summer. Short term heavy precipitation refers to the precipitation of more than 0.8 inches (20 mm) in an hour in a place (Jin et al., 2018). This phenomenon often occurs in the afternoon in summer. Generally, it lasts for a short time and the weather will be sunny quickly. As shown in Figure 2, especially in the three months from June to August, the number of short-term heavy precipitation in Hangzhou exceeded 30, which is very frequent.

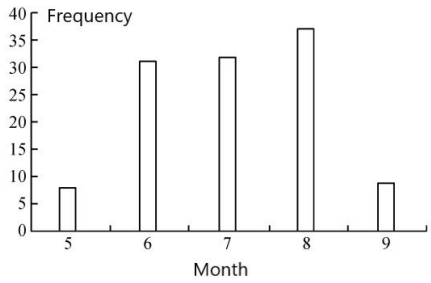

Figure 2: Monthly occurrence times of short-term heavy precipitation in Hangzhou Source: Zhejiang meteorological

Combined with the rainy climate in Hangzhou and the frequent heavy rainfall in summer, it is very necessary for people living in Hangzhou to take an umbrella on rainy days. While everyone is aware of the need to carry an umbrella when going out in the rainy days, there are still some phenomena often occur in our life, especially in

the morning every day. Some people may get up too late and have to rush out to work, so they don't have much time to read the weather forecast. When they go outside, they often find that it's raining at that moment and have to go home to get an umbrella, or it starts to rain after a period of time, but they don't have an umbrella around. This situation often causes a lot of trouble to our daily life.

In order to better define the problems we need to solve, we have designed a questionnaire on umbrella use. The specific survey results of the questionnaire are shown in the following Figure 3:

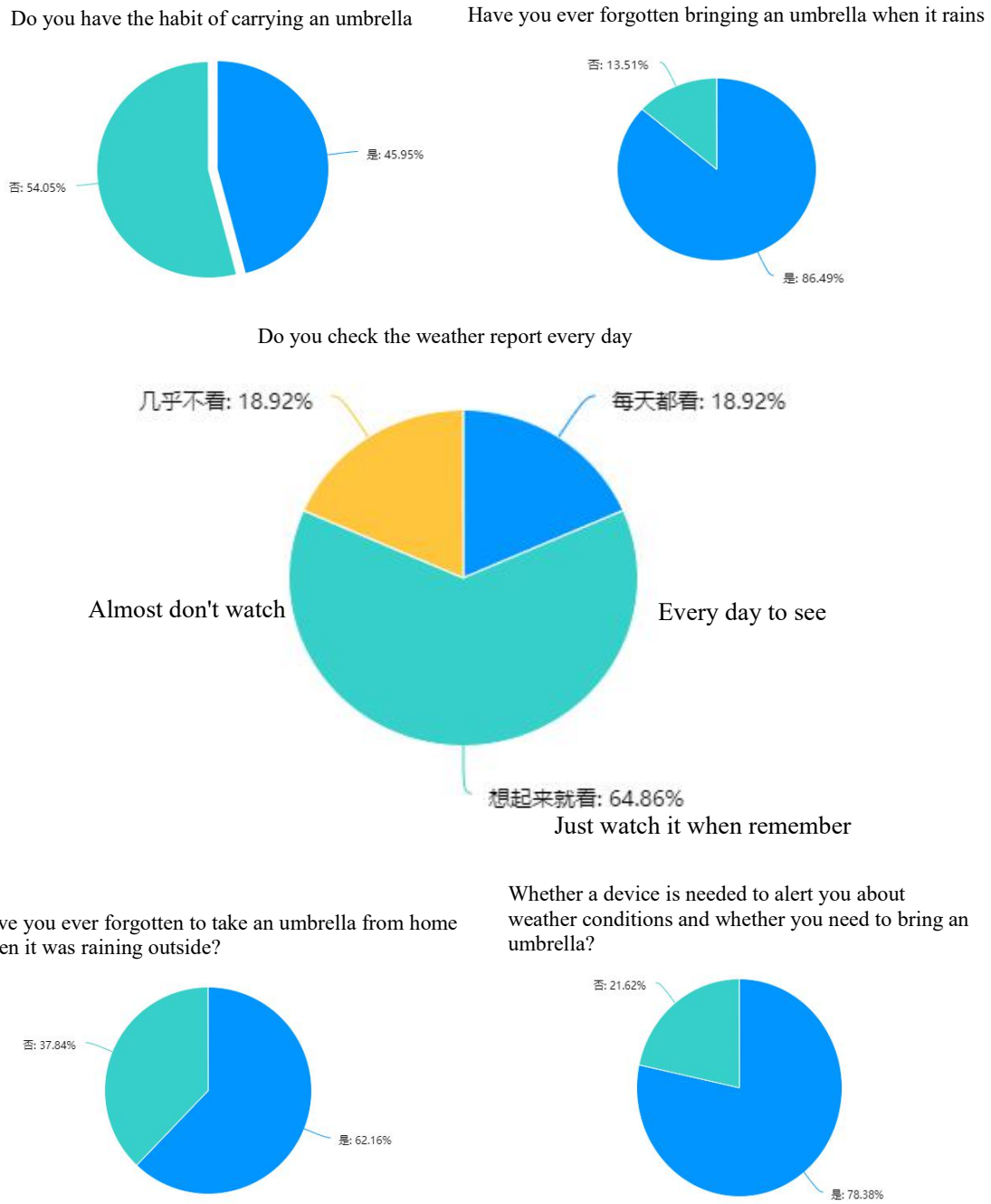

Figure 3: Questionnaire Results

The total number of respondents is 137. We selected representative questions in the questionnaire for analysis. According to the results of the questionnaire, we can see that many people do not have the habit of carrying an umbrella before going out. In addition, 86.49% had the experience of forgetting bringing an umbrella when it was raining, and 62.16% of the interviewees did not bring an umbrella from home when it was raining (37.84% of them bought it directly outside). 78.38% of interviewees hope that there can be a device to remind them to carry an umbrella in rainy days.

According to the results of the questionnaire, we can draw the following conclusions: many people around us often encounter the problem of forgetting to bring umbrellas in rainy days, and do not have a good habit of watching the weather forecast and taking umbrellas, which sometimes brings great trouble to people in rainy days. At the same time, many people also hope to have an item at home that can remind people to bring umbrellas in rainy days. Therefore, the product “Intelligent Umbrella Stand” we are going to design has a good commercial prospect.

2. Existing Solution and Analysis

In the first background introduction, we have identified the problem about people forgetting to bring umbrella in daily life. After looking up some information, we have found that there are two main ways to solve this kind of problem: shared umbrella mode and smart umbrella.

2.1. Shared Umbrella Mode

Shared umbrella refers to the shared services provided by enterprises in subway stations, commercial areas, residential areas, campuses and hotels. It is a new form of sharing economy. Shared umbrella adopts the principle of big data, combines Internet plus technology, and combines common umbrella with Internet technology to upgrade to become controllable and visible umbrella. Users can scan the shared umbrella enterprise QR code, view the umbrella site, scan the code and borrow the umbrella through their mobile phone, so as to achieve the goal of quickly borrowing the umbrella. Shared umbrellas can effectively solve the problem that people forget to bring umbrellas in rainy days, because in this case, people only need to borrow umbrellas in the nearby commercial and residential areas, which can well solve the problem of no umbrellas around them. Research shows that in 2020, the number of

users sharing umbrellas in China will reach 8.35 million, and the number of users is very large (Development status and trend analysis of shared umbrellas in China in 2020, 2021).

Figure 4: Shared Umbrellas

However, shared umbrella mode has its own drawback. First of all, the user's deposit is a sensitive issue. Due to the frequent occurrence of similar problems in shared bicycles, people's trust in new things of shared products has gradually shrunk. Secondly, the site of shared umbrellas is still relatively small, which can not be used directly when it rains. Finally, because of the lack of maintenance, most of the umbrellas in the shared umbrella site are damaged and cannot be used properly. Therefore, we believe that sharing umbrella mode is a good solution, but there are still many problems that need to be solved in time.

2.2. Smart Umbrella

Smart umbrella is the embodiment of IOT under the influence of the Internet. The smart umbrella connects the equipment together through the Internet of things technology, providing remote control, remote control, anti-theft alarm and other functions. A typical example is called "Oombrella", which is an smart umbrella that can predict the weather in real time. It contains sensors, which can collect humidity, temperature, air pressure, light intensity and other information, and connect it with the weather broadcast and location services on the mobile phone through Bluetooth to send the weather changes to the mobile phone in time. At the same time, it uses the buzzer and indicator light on the umbrella handle to give tips, so as not to miss the bell.

Figure 5: Oombrella Source: Bloomberg CityLab

However, although technically speaking, embedding the smart system into the umbrella is in line with the design concept of the Internet of things, it is relatively expensive and the R&D cost is very high. The most critical point is that ordinary people will not choose to buy this kind of umbrella, because in most people's opinion, an ordinary umbrella that can keep out the rain is enough, so this kind of smart umbrella doesn't have a good market prospect.

3. Project Objective and Research Problem

Based on the previous background introduction and the analysis of existing solutions, we think it is more feasible to design an intelligent umbrella stand that can be used at home, place umbrellas and remind people to bring umbrellas in rainy days. Therefore, the objective of our project is to make an intelligent umbrella stand based on Raspberry Pi and in accordance with the design concept of the Internet of things. The umbrella stand is put at the door and we plan to connect the intelligent umbrella stand to a weather API, obtain the weather data of the city through the python script, and feed back the possibility of raining in the city. If it exceeds our preset threshold, we will be reminded to bring an umbrella. Once the project is designed successfully, people will no longer have to worry about going out in a hurry but forgetting to bring an umbrella in rainy days.

The key problem we need to pay attention to in product design is whether the product can accurately remind people to bring umbrellas in rainy days. In order to solve this problem, we expect to test the product for at least one week after successful production, analyze the test data and make improvements on this basis.

4. Components

4.1. Raspberry Pi

Raspberry Pi is a microcomputer motherboard based on ARM. It is a card computer equipped with Linux system. Raspberry Pi can replace many uses of daily desktop computers, including word processing, spreadsheets, media centers and even games(Li, 2019). Compared with common computers, Raspberry Pi takes up less space, which is cheap and portable. So far, Raspberry Pi can carry and run many open source systems and programs.

In our "Intelligent Umbrella Stand" project, we will use the Raspberry Pi system to remind people to go out and carry an umbrella in rainy days. We will install the Raspberry Pi system on an ordinary umbrella stand. By connecting the Raspberry Pi system to a Weather API, we can obtain the meteorological data of the city and return the results of the possibility of rain at the same time. At the same time, the infrared sensor is used to detect whether someone has passed by the umbrella stand. When the infrared sensor detects that someone has passed and the possibility of rain exceeds the preset threshold, the LED light of the system will flash and the loudspeaker box will prompt people to go out with an umbrella in rainy days.

4.2. Infrared Sensor

Infrared sensor is a kind of sensor that uses infrared to process data. It has the advantages of high sensitivity. Infrared sensor can control the operation of driving device. The infrared sensor includes an optical system, a detection element and a conversion circuit. At the same time, infrared sensors are often used in contactless temperature measurement, gas composition analysis and nondestructive testing. They are widely used in the fields of medicine, military, space technology and environmental engineering(Lei, 2021).

Infrared sensors are mainly used in flame sensors, infrared thermometers, infrared imaging, etc. Infrared sensor is a very important component in infrared detection system, but it is also easy to be damaged. Therefore, in our daily life, we need to first pay attention to understand the performance index and application range of infrared sensor and master its service conditions. At the same time, we must pay attention to the working temperature of the sensor. Generally, we choose to work at room temperature for convenient maintenance.

4.3. LED Light

LED light is a semiconductor material chip, which is solidified on the support with silver glue or white glue, and then connected with the chip and circuit board with silver wire or gold wire. The periphery is sealed with epoxy resin to protect the internal core wire. Finally, the shell is installed, so the seismic performance of LED lamp is good.

4.4. Loudspeaker Box

The loudspeaker box is the terminal of the whole sound system. Its function is to convert audio electric energy into corresponding sound energy and radiate it to space. It is an extremely important part of the sound system. It undertakes the task of transforming electrical signals into acoustic signals for people's ears to listen directly.

4.5. Umbrella Stand

In order to save costs, in addition to the basic hardware equipment, we will use environmental protection materials to design the prototype of umbrella stand, which can achieve the function of saving and environmental protection, and also comply with the design concept of the Internet of things.

5. Cost Estimate

Components	Price(RMB)
Raspberry Pi 4B Foundation Kit	509
Infrared Sensor	5
LED Light	3
Loudspeaker Box	30
Material of making the prototype of the umbrella stand	15
Total	562

The above table lists the basic hardware materials and price estimates required for our project, in which the basic hardware and sensors of Raspberry Pi system account for most of the expenditure. At the same time, we need to design a basic umbrella stand prototype and connect the Raspberry Pi system to the umbrella stand prototype, so as to finally complete the design of intelligent umbrella stand. In order to save the cost, we consider using the environmental protection materials around us to design the umbrella stand prototype, rather than buying an ordinary umbrella stand

directly from the Internet, so as to achieve the effect of environmental protection and meet the design concept of the Internet of things. The above costs are only estimates, and there may be some deviation in the final cost expenditure according to the actual situation.

6. Prototype and Network Structure

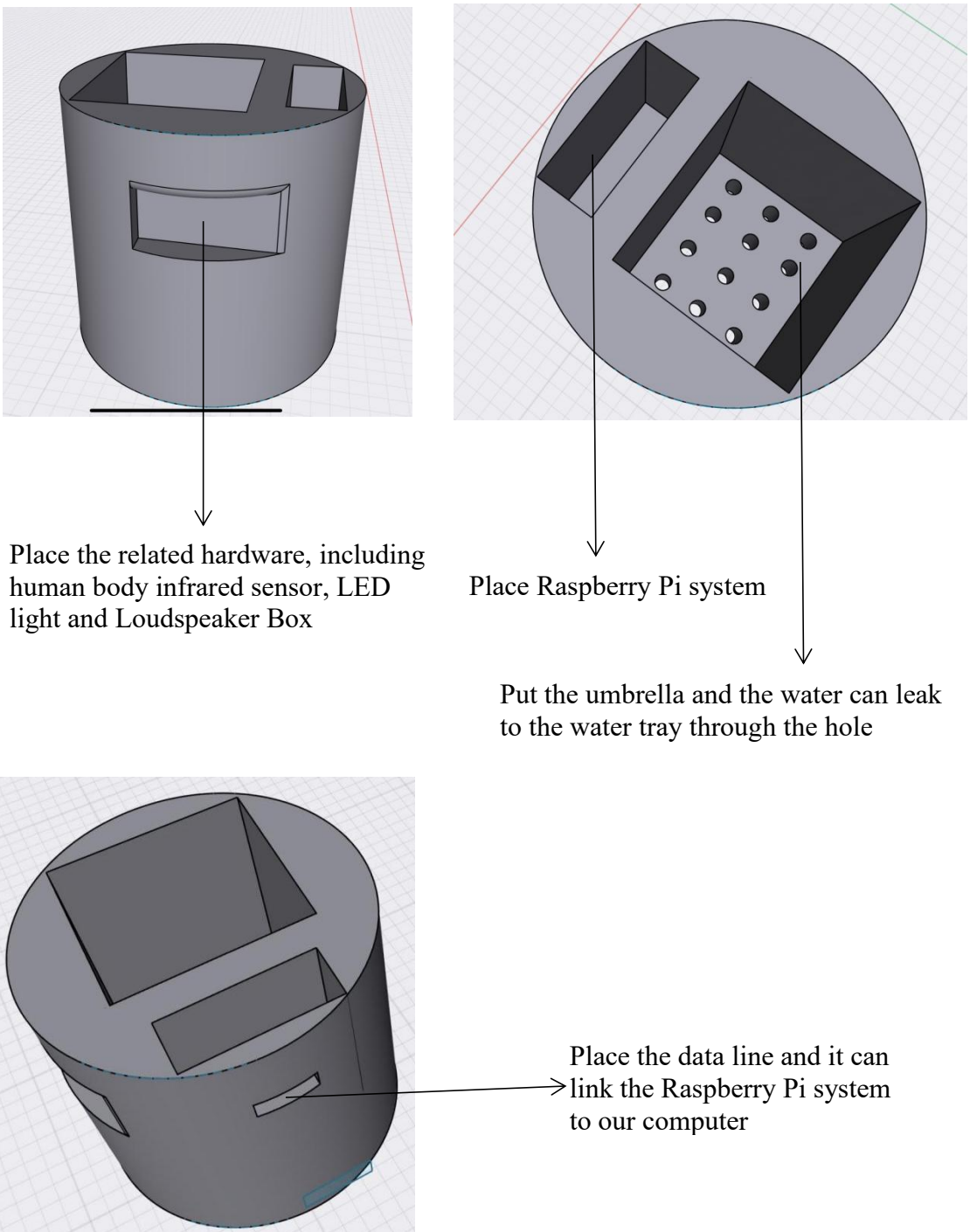

Figure 6: Prototype Preliminary Design Structure

Figure 6 shows the preliminary prototype structure of our designed product. We will embed the Raspberry Pi system in our umbrella stand and connect the data line to our computer program through a hole on the umbrella stand. At the same time, a position is designed on the umbrella stand to place other hardware we need, such as human body infrared sensor, LED light and loudspeaker box, which are also part of our whole Raspberry Pi system. Finally, in order to recycle the water on the umbrella, we also made several holes in the place where the umbrella was placed, connected with the water pan at the bottom of the umbrella stand, and regularly deal with the water in the water pan, so as to achieve the role of environmental protection.

We also preliminarily planned the network structure of our "intelligent umbrella stand" project. The general idea is to embed the Raspberry Pi system into our DIY umbrella stand and connect the computer program through USB interface. At the same time, our program is written in Python and we call a weather API to obtain the meteorological data of the city and feed back the query results. According to the test results, we call the program respectively to make the hardware work which involved in our product. The whole prototype and network structure are our preliminary ideas, and we will adjust it according to the actual situation later on.

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