

# Design and Research of Umbrella Drying Machines in Public Places

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**Abstract.** Every rainy day, the umbrella can save everyone from the rain, but at the same time, there are many inconveniences such as the dripping of the umbrella, which causes the ground to be wet and slippery, dirty and prone to fall, the umbrella is placed disorderly, and the umbrella is taken and forgotten by mistake. At present, the common solution is that there will be machines to put plastic bags on umbrellas at the entrance of public places. This can not only bring convenience to people but avoid leaving dirty and wet indoors. This may also cause new problems: the waste plastic umbrella bags cause white pollution and environmental protection; some people will inevitably forget to take out the umbrella in time, which will lead to rust and odor. This paper explores and designs a quick drying machine for umbrellas in public places. The target group is people who are troubled by wet weather on rainy days. In terms of function, it uses the triple guarantee of sponge adsorption, centrifugal rotation and strong wind drying, combined with the intelligent Internet of Things system, to provide intimate services and a more personalized quick drying machine for umbrellas

**Keywords:** Umbrella; Quick-drying; Public places; Industrial design

## 1 Introduction of research background

Because of the increasing population of cities, there are more and more people in public places. There is a big problem with dripping umbrellas in public places on rainy days. In crowded public places such as shopping malls, supermarkets, office buildings or school libraries, how to deal with wet umbrellas more conveniently becomes an inevitable problem. People often choose to leave umbrellas to dry in open Spaces, but this behavior can have a bad effect on the landscape and release an unpleasant smell in public places, causing discomfort to others. The functionality and reliability of the umbrella also decreased, as frequent drying in this way caused parts of the umbrella to sag. And the large area of the umbrella creates chaos and is easy to bring a lot of inconveniences. Especially in crowded places, other people's clothes are easy to be wet by the water on the umbrella. More important among them is that dripping wet umbrellas can cause slippery, dirty, and sliding on the ground. There have been about 76,500 cases of disputes over slippery and falling on the ground, with compensation of more than 280 million yuan [1]. Accidental fall is an important cause of falls of the elderly over 65 years old, and also the main cause of death of the elderly over 85 years old. Among people of 70 years old or older, slip and fall accounts for about 40% of all falls [2], which is a serious safety hazard.

We need to address these issues. At present, there are different ways to deal with dripping umbrellas on the market, but each way is not perfect and inconvenient to operate. Thus, it is necessary to reasonably design an umbrella quick drying machine in public places to solve the problem of dripping umbrellas on rainy days and make it more convenient for people to operate.

## **2 Current development status**

At present, the solution on the market is the umbrella bagging machine, which is to put the umbrella into a specific umbrella plastic bag, so that the water drops on the umbrella fall into the plastic bag to avoid dripping. An umbrella bagging machine is placed at the entrance of public places to keep the ground clean and convenient. However, it can be found that the plastic umbrella cover eliminates the rain stains on the ground, but the resulting plastic umbrella cover will be discarded after each use, and it takes 500 years for a plastic bag to degrade after being discarded, causing serious environmental problems.

The high humidity makes the ribs on the umbrella rusty and fragile. For the rain cloth with UV coating, the umbrella should be dried in time to prevent acid rain corrosion, and the umbrella dryer and hourly rain drying should be used to extend the service life of the umbrella [3]. At present, there is no large-scale production of umbrella quick drying machines or similar products in the market, and the current response in the market has not only solved the problem but also caused some harm. For example, the umbrella bagging machine set at the entrance of the shopping mall has caused environmental pollution. Every year, about 10% of plastic waste flows into the ocean in various ways, posing a serious threat to the marine ecosystem, and the scale is still expanding. The remaining plastic pollutes the land environment through recycling, incineration, waste burial, and disposal [4]. Therefore, at present, it is very urgent to place an umbrella dryer in public.

## **3 Research on a design principle, method, and related technology of Umbrella quick drying machines in public places**

### **3.1 Research on the Design Principle of Umbrella Quick Drying Machine**

The paper mainly studies the quick drying function of umbrella quick drying machines. After consulting the data, it can be found that the current research directions on the market are centrifugal rotary drying, absorbent sponge adsorption, wind drying, etc.

(1) Centrifugal spin drying: As shown in Figure 1. The centrifugal principle is used to shake off the water on the wet umbrella in a uniform circular motion under high-speed rotation. The upper and lower ends of the umbrella are fixed respectively, and the bottom of the “V” shape induction clamping device is used for centrifugal movement to remove the water droplets from the umbrella surface.

(2) Absorbent sponge adsorption: The sponge with its own porous characteristics is used to absorb water. When the umbrella rotates, the water droplets on the umbrella surface are absorbed by the absorbent sponges on both sides to achieve the basic absorbent effect. It is simple and easy to operate, energy-saving and environmentally friendly. But the choice of

absorbent sponge because of its short service life needs to be replaced regularly or set the water outlet hole, so that the sponge becomes dry.

(3) Rapid drying by wind: Improving the liquid surface temperature and accelerating the liquid surface air flow can accelerate the liquid evaporation, and this principle is fully utilized in this design [5]. The fan is driven by the motor to rotate, and all the air heated by the electric heating wire is blown into the inner cylinder to form hot air. The umbrella fixed in the cabin is constantly blown to make the residual small water on the umbrella surface disappear to achieve the drying effect. Using hot air to dry the umbrella quickly is more efficient, but it consumes relatively more energy. To control the temperature, there are two kinds of household umbrellas, two-layer umbrellas, and one-layer umbrellas, but the drying temperature must be kept below 100°C. Otherwise, the structure of the umbrella may be damaged and the safety of personnel may be threatened [6]. Therefore, we should also pay attention to the safety risks of use.

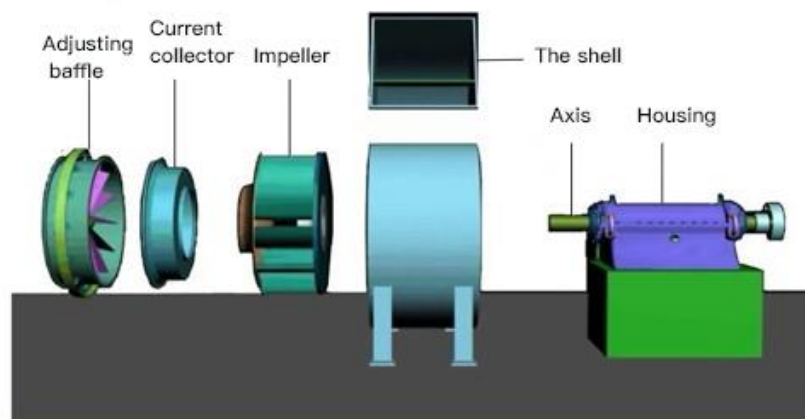


Figure 1. Centrifugal fan.

### 3.2 Research on Design Technology of Umbrella Quick Drying Machine

(1) According to the specific rules for transmitting, processing, storing, displaying, recording and controlling information, the sensor will sense the measurement information and convert it into electrical signals or other required information output forms in order to meet the requirements. A sensor is installed under the “V” shaped fixing clip at the lower end of the fixed umbrella. Since each umbrella has a different length, it needs to be induced according to each umbrella, and then telescoped to a proper height and fixed.

(2) The temperature controller is a group of automatic control components, which can produce special effects such as switching or switching off based on changes in the working environment caused by physical deformation inside the switch. The temperature controller is mainly based on the temperature of the device to control the heating tube to start and stop. The thermostat is placed in the center of the bottom of the umbrella dryer to ensure that the temperature of the device is within the normal range.

(3) A fan is a machine that raises the air pressure and emits gas according to the input mechanical energy. It is the driving fluid machine. The fan is arranged in the air outlet plate on both sides

of the umbrella, and the hot air is heated through the electric heating wire to blow to the umbrella.

### **3.3 Design feasibility analysis**

According to the principle and technical analysis, the structure is redesigned to increase the interactive function. The structure design of the quick-drying function is the core technology of this paper.

(1) Security. To complete the fast drying function safely, the temperature of the wind drying must be properly controlled. Temperature controller mainly according to the internal temperature of the equipment to control the heating tube start and stop. Here, we keep the temperature inside the device between 40 and 45 degrees Celsius. This temperature range can dry the umbrella without damaging it [7].

(2) Stability. After putting the umbrella into the corresponding umbrella stand, the latch on the upper part is used to fix the umbrella handle and the “V” shaped fixing device on the lower part is used to fix the umbrella head, which ensures that the umbrella can be rotated stably. The convex design of the exterior molding and the internal reinforcement design also ensures the stability of the product.

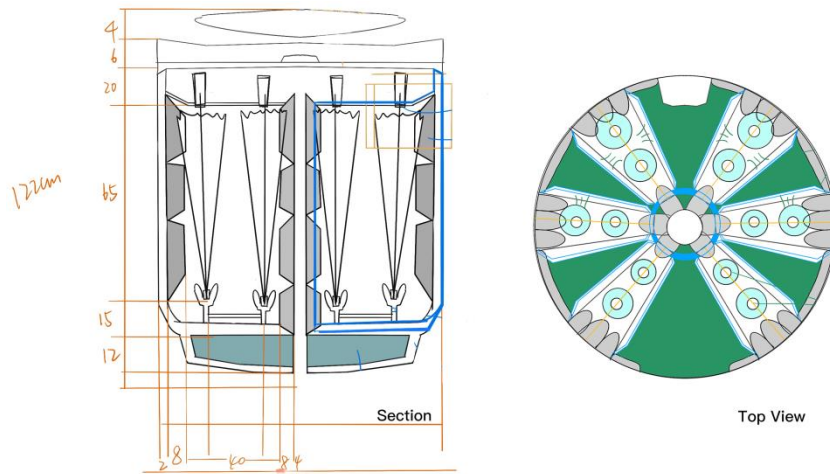
(3) Efficiency. The drying principle of absorbent materials, centrifugal drying principle and hot air drying principle are used to make the rain attached to the umbrella rain dry quickly, and the water droplets on the umbrella cloth are thrown off under the action of centrifugal force and fall into the rainwater collection box [8]. It is ensured that the umbrella does not drip when removed and that it dries just right while increasing speed.

(4) Interactivity. The product focuses on more than quick drying. While ensuring quick drying efficiency, a display screen is designed directly in front of the product as an interactive screen. On the screen, pixel emojis represent the working status of the speed dryer, as well as the date and weather display. When the umbrella dries quickly, the door indicator will also light up with a prompt tone to remind the user in time, which reduces the waiting time and provides convenience for the user.

## **4 Appearance design**

### **4.1 Appearance design**

After the appearance is roughly determined, the preliminary structural sketch is designed and drawn according to the preliminary conception and actual size of the umbrella according to the preliminary technical principle investigation and appearance modeling. As shown in Figure 2.



**Figure 2.** Sketch design.

To facilitate the placement of more than one umbrella, the umbrella dryer is designed as a cylinder that can be easily inserted from all directions. There are six switches on the top of the product to control the corresponding automatic pulling door. At the same time, the frame of the door is designed as an indicator light. When the umbrella is ready for quick drying, the indicator light will remind the user to take it out in time, which can achieve better human-computer interaction. The display screen in front of the quick drying machine is an intelligent robot, which can display the working state, temperature and weather of the umbrella quick drying machine in the way of pixel expression, increasing the interest in human-computer interaction. As shown in Figure 3.



**Figure 3.** Appearance design drawing.

#### 4.2 Structural design

As shown in Figure 4. The structure design of the umbrella dry machine in public places is mainly composed of absorbent sponge, umbrella fixed frame, rain collector, rain diverter, infrared sensor, temperature and humidity sensor, display, indicator light, control circuit board, hair dryer, small motor and so on.

The outer shape of the umbrella drying machine in public places is roughly cylindrical, and the whole structure is designed in the form of pulling. Six sliding doors are placed around the cylinder, which can be pulled inside and out by sliding rails. Each pulling part can be placed with two umbrellas, which are respectively fixed through the upper and lower ends of the umbrella by locking and rotating rubber clips. The fixing device restricts the axial movement of the umbrella by clamping at both ends. In order to avoid the danger caused by the rotation and jumping of the umbrella due to the Angle between the umbrella handle and the rotating axis line in the process of drying, “V” type is adopted at both ends [9]. At the same time, the lower fixed device is equipped with infrared sensors, which can automatically expand and expand according to different lengths of each umbrella until the stable fixed umbrella can perform better centrifugal rotation.

In addition to the raised pattern on the shell of the quick drying machine, a layer of reinforcement is added to the shell. While ensuring the stable centrifugal rotation of the umbrella, the wind drying on both sides is driven by the motor to rotate the blower fan. At the same time, the wind heated by the electric heating wire is blown into the umbrella surface through the air exhaust plate, forming the effect of hot air drying. When the humidity detector detects that the surface humidity of the umbrella has reached the drying requirement, it will stop the hair dryer, and the small DC motor will slowly stop rotating, rotating and drying, and then dry the umbrella and keep it clean [10]. A long strip of absorbent sponge is arranged in the inner side of the sliding door and the center of the quick drying machine. During the centrifugal rotation of the umbrella, some water droplets on the umbrella surface are absorbed by sponge through rotation. Through structural design, these three drying methods all achieve the maximum bonding effect, thus significantly reducing the working time, energy loss in the working process, and damage to the umbrella itself in the drying process [11].

The display screen and control panel are located on the front of the umbrella dryer. The rainwater flow pipe is connected to the rainwater collector and placed under the umbrella stand. The bottom of the umbrella storage shelf is reticulated to facilitate ventilation and drainage [12].

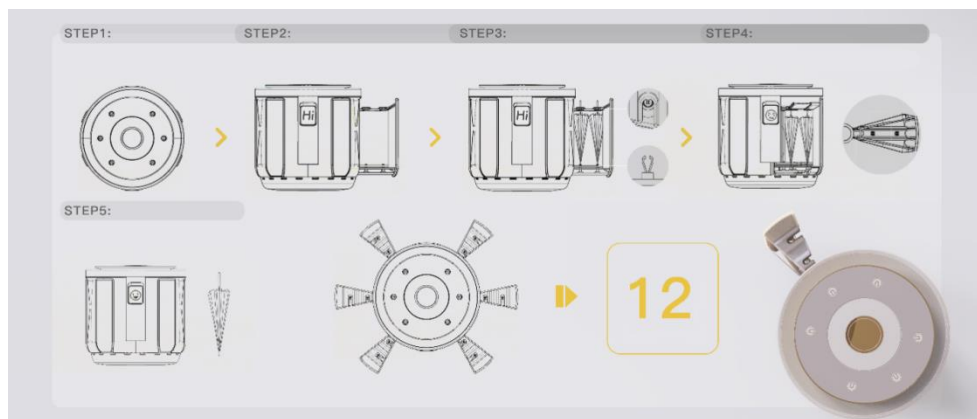


**Figure 4.** Structural explosion pattern.

### 4.3 Product use process

First, we touch the button on the top of the quick dryer and the corresponding door will automatically pull out. We put the umbrella into the corresponding umbrella frame and ensure that the upper and lower parts are fixed (two umbrellas can be put into each door). After the machine is confirmed to be put in place, we push the umbrella in for quick drying. The umbrella

is quickly dried through the triple guarantee of sponge adsorption, centrifugal rotation and strong wind drying. After the quick drying is completed, the door frame indicator lights up, the pull-out door is pushed out, and the umbrella that is basically dry can be taken out. As shown in Figure 5.



**Figure 5.** Use flow chart.

#### **4.4 Description of design innovation**

The main innovation of this research is to carry out a new structural design arrangement through the concept of umbrella quick drying machines, which takes sponge adsorption, wind quick drying and centrifugal rotation as the supporting technology, and intelligent human-computer interaction as its auxiliary as the core of the product, showing the safety, stability, efficiency and interactivity. It not only focuses on the function but also meets the psychological needs of the crowd on the basis of the function. It has an interactive function and provides a more comfortable way for the user. The design focuses on the quick drying umbrella and contacts the intelligent robot for interaction. The pixel expression of robot interaction is appropriately added in the design so that users will not feel bored while waiting for the umbrella to dry quickly.

### **5 Design conclusion**

This paper presents a new design for umbrella quick drying. The problem of dripping umbrellas on rainy days has been solved according to available research results. Through preliminary research, design literature, principle, and technology, this paper analyzes the technical principle of the quick drying machine, re-designs the structure, looks up the knowledge of various quick drying methods, and analyzes the technology needed by the umbrella quick drying machine. After sorting out and summarizing all the data, we designed the umbrella quick drying machine in public places. Finally, we made modeling and rendering, made a physical model, and carried out a model operation. As shown in Figure 6. Through the simulation results, it was found that the umbrella could be turned into a semi-dry state without dripping water within two to three minutes through adsorption, centrifugal rotation, and strong wind heating.



**Figure 6.** Real picture of the model.

After ensuring the feasibility and effectiveness of this design, we can then improve the internal structure principle, reduce the umbrella drying time, and make it more reasonable, so that it can be processed and manufactured into a mass production product. This design has a broad market. Finally, we hope to develop the use of umbrella quick drying machines to replace automatic plastic umbrella cover machines, reduce the white pollution caused by plastic umbrella covers, provide convenient services for public health on rainy days, and also provide help for environmental protection and sustainable development.

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