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Master's Thesis
Academic Year 2022

Taste Radar: Generating A Taste Match to Help Users Select Ready-to-Drink(RTD) Coffee That Meets Their Taste During the Purchasing

Keio University
Graduate School of Media Design

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A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

YUANKEJIAN DING

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Abstract of Master's Thesis of Academic Year 2022

Taste Radar: Generating A Taste Match to Help Users Select Ready-to-Drink(RTD) Coffee That Meets Their Taste During the Purchasing

Category: Design

Summary

How to choose and buy the right coffee for our taste even before we drink it? At present, coffee is the most popular drink globally, and become the second most traded commodity in the world. In the mind of frequent coffee drinkers, coffee is high-quality food, and coffee beverages are more frequently associated with pleasure and positive experiences. What's more, to satisfy the preferences of consumers, coffee makers offer numerous different flavors each year. However, sometimes it is hard to choose the suitable coffee for our taste from so many flavors.

This research develops a Coffee Radar design for a wearable device that can combine personal taste preferences and identify the many flavor characteristics of coffee to produce a personal taste match. With this informative and easy-to-read taste match, coffee drinkers can purchase a coffee that matches their preferences from a wide variety of flavors in their daily life.

Keywords:

coffee, wearable device, taste match, design thinking, conceptual design

Keio University Graduate School of Media Design

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Chapter 1
Introduction

Coffee is regarded as a food of higher quality, and drinking coffee is increasingly associated with pleasure and positive experiences in the consumer's minds. Multiple studies demonstrate that consuming a cup of coffee is related with a moment of personal enjoyment for the user, and therefore coffee is characterized as: pleasure. In addition, numerous research focus on coffee markets today, including consumer purchase behavior and consumption quantification. however, few data relate to coffee consumption motivations, consumer behavior, or assisting consumers in choosing and the best coffee for them. As a coffee lover, I'd like to conduct a study on this issue.

A coffee with a high acidity will have acidity and a crisp aftertaste, while coffee with a lower acidity will be smoother. The flavor of the coffee is influenced in various ways, including by its aroma, its body, and its acidity. If all of these components are precisely combined and suit the palate of the individual, the coffee will be considered a great tasting.

1.1. Background

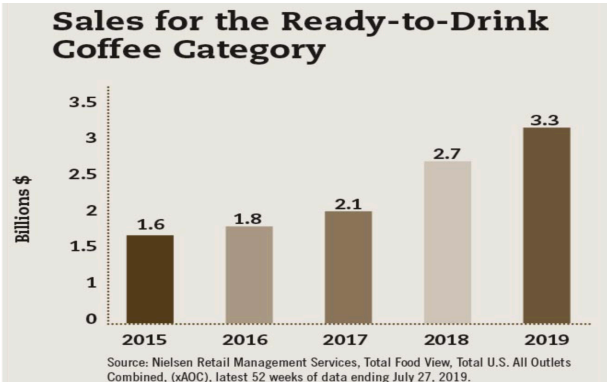
1.1.1 The Consumption of Coffee

Coffee was discovered in the 9th century by Muslims. Later, coffee was transported to Europe and the United States, where its caffeine content, which has a refreshing effect, has led to its widespread consumption and made it a staple in the diets of many people. Even at a variety of meetings and seminars, coffee remains the most popular beverage. Nowadays, the second most widely traded commodity in the world is coffee.The majority of this market is made up of roasted, instant, and ready-to-drink (RTD) coffee. [1] In 2017–2018, the global production of cof-

fee beans from around 60 nations totaled 9513 million tons and was valued at USD 200 billion yearly. [2] According to estimates, 500 billion cups of coffee are drank daily. [3]According to an exclusive consumer poll performed by the National Coffee Association, coffee consumption has reached a 20-year high as Americans adopt new post-COVID behaviors (NCA). Coffee is currently consumed by 66% of Americans every day, more than any other beverage including tap water, and has increased by roughly 14% since January 2021, the greatest growth since NCA began recording statistics. [4] Other research, has also found that coffee consumption increases during Covid-19 quarantine. [5,6] Overall, these surveys and studies indicate that coffee consumption has increased significantly in recent years.

1.1.2 Coffee Products are Constantly Developing New Flavors

As the number of people who consume coffee continues to rise, the range of coffee flavors has expanded to accommodate a variety of consumer preferences. Between August 2018 and March 2019, more than 1,000 new coffee-flavoured products were launched in the US alone. This was 30% more than the same period in the year before. [7]



(Source:https://www.bevindustry.com/ext/resources/issues/2020/March/59-IngredientSpotlight-RTDSalesChart.jpg)

Figure 1.1 Sales for Ready-to-Drink Coffee

In addition, the convenience of ready-to-drink (RTD) coffee options is a key

growth driver, with over 150 new RTD coffee products developed in the past year, an increase of 14% year-over-year. [8]

1.2. Movtivation

These finding demonstrate that both the number of individuals who consume coffee and the diversity of coffee products are on the rise. How to assist these massive numbers of coffee users in selecting the most suitable item for their preferences from among a wide range of coffee types is a challenge worthy of resolution. Therefore, I attempted to design a device to assist daily coffee customers, particularly coffee lovers, in selecting the coffee that best meets their taste. According to a survey I conducted among 167 regular coffee drinkers, 82% of them have purchased coffee that did not satisfy their preferences.

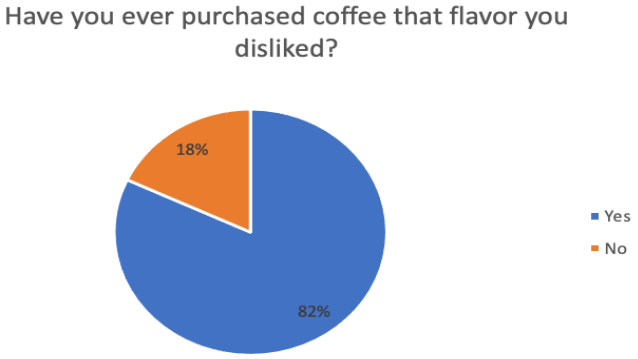


Figure 1.2 Coffee that Doesn't Suit Our taste

When drinking coffee that does not suit their taste, the majority of people are unsatisfied and regret purchasing the flavor; some even wish to get a new one. Only a few individuals do not care about the unsuitable flavor.

In addition, the data from another survey showed that most people are happy and enjoy when they drink coffee that matches their taste, and they would like to drink it again afterward and even want to share this taste of coffee with their friends. Therefore, I decided to make the coffee's flavor and consumer's taste preferences a design breakthrough. If consumers can know the suitability of coffee

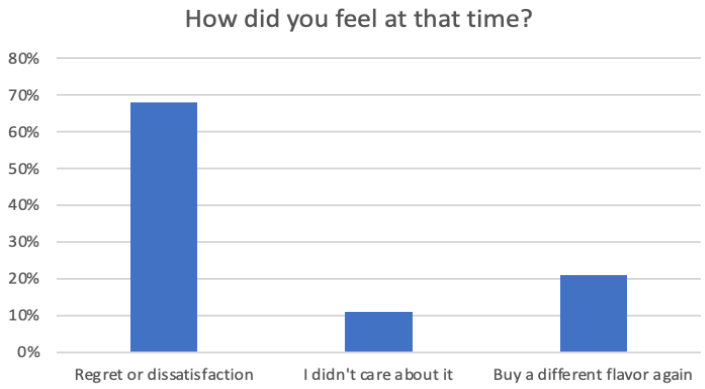


Figure 1.3 How You Feel When You Drink a Coffee that Doesn't Suit Your Taste

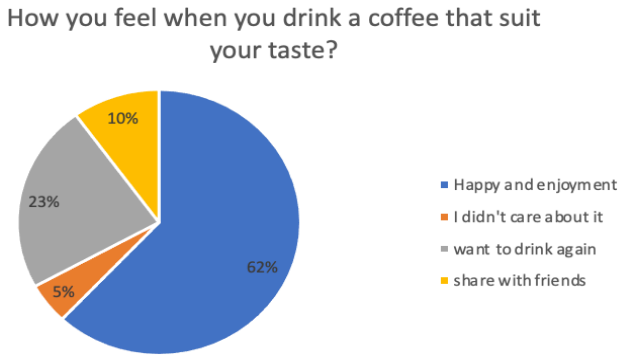


Figure 1.4 Coffee That Suits Your Taste Feeling

to their taste before they buy it, they will be able to choose the right flavor among many different flavors of coffee.

1.3. Research Objectives

The research is about the conceptual design of a wearable device that could be used for choosing coffee during purchasing. And this project aims to explore the possibilities for assisting people in choosing coffee that matches their tastes by using taste matching based on individual sensations. As a result, here are two research objectives that we would like to raise:

research objective1: Determine what design and functionalities would be appropriate for the device.

research objective2: Determine if the design helps the user's selecting of the right coffee for their palate.

1.4. Contribution

Although there are many articles and apps that teach people how to choose a decent coffee, these methods are limited in many ways. The great majority of a person's flavor preferences are acquired through experiential learning and practice. [9]One of the most important reasons is that the analysis is not dependent on individual factors and we are all different and have various tastes. Coffee lovers are the target group for my study. This study is a user-centred design and provide effective reference advice for coffee consumers. This design enables users to determine if the coffee is to their liking before to drinking it, allowing them to obtain the ideal coffee for their tastes.

1.5. Thesis Organization

The remainder of this paper is divided into the 5 chapters listed below:

Chapter 1 An introduction and discusses the thesis's background, objectives, and contributions.

Chapter 2 Related Works include previous related works about coffee taste criteria, flavor identification, flavor preferences, and wearable devices.

Chapter 3 Design Concept, which includes the description of Coffee Radar and the various ideas and decisions that went into the creation of my design project.

Chapter 4 Evaluation, which focuses on describing the user tests I carried out to evaluate my project and proof of concept and design proposals.

Chapter 5 Conclusion, which summarizes the thesis' findings, discusses the extensiblility of the conceptual design, as well as recommendations for future work.

Chapter 2
Related Works

To begin the design process, relevant academic works were studied to establish a solid foundation of knowledge. While research related to finding ways to help consumers choose the suitable coffee for their taste has not been successful, there were components in a number of other areas that may be closely connected with my design project.This part, we focus on coffee taste criteria, flavor identification, flavor preferences, and wearable devices.

2.1. Criteria for Evaluating good taste coffee

A coffee's flavor is a blend of various flavors. If these elements are in perfect balance, we have a good taste of coffee in our hands. Therefore,before choosing a coffee, it is vital to be familiar with the numerous flavor characteristics.

Professionals in the coffee industry still want a standard when discussing and evaluating coffee samples; therefore, they attempt to develop a common vocabulary that will allow them to compare and grasp certain aspects of coffee flavors and aromas. When they were evaluating the consistency of their coffee goods, they came up with the following four basic descriptors that were universally recognized. [10]

1. **Acidity:** This is the most important distinguishing characteristic of coffee. [11]It is defined as a pleasant astringency around the tongue's borders and towards the rear of the palate. Some people might refer to the sensation as dryness. Acidity should not be confused with sourness, as a decent coffee should have some acidity. Acidity gives a coffee its punch, and a lack of it will result in a flavorless, lifeless coffee.

2. **Aroma:** The aroma volatiles produced during the coffee roasting process are the most significant determinant of the coffee's quality. [12, 13] This refers to the sensation received by the nasal passages as a result of interaction with the volatile chemicals and aromatic oils produced during the brewing process. The nose should be extremely close to the coffee, and a thorough inhalation is required to really savor the aroma.

3. **Body:** The viscosity of the coffee can also be interpreted as heaviness on the tongue.The body of the coffee, also known as the mouthfeel, is a tactile sensation felt on the palate when the coffee wraps and swirls around the tongue. Sometimes described as light, medium, or full, the body of the coffee relates to the overall weight, thickness, or viscosity perceived by the tongue. The body of the coffee affects the overall flavor and may induce a sensation of satisfaction. [14]

4. **Flavor:** The flavor is an encompassing term for the essence or overall impression of all the other coffee qualities, including aroma, body, acidity, sweetness, and aftertaste. The best coffees achieve a good balance between all of these characteristics. A coffee's flavor can be complex, comprising numerous distinct flavor components. [15]

2.2. Flavor Identification

Flavor identification is a crucial source of information regarding the foods that are consumed by the mouth. Specifically, the flavors of foods provide us with information about "what they are", which is data that can either directly or indirectly contribute to decisions regarding consumption.

2.2.1 Melon Face Recognition

In the Jinpan Night Market in Haikou, China, there is a melon shop called "AI Melon Shop". This store is distinct from others that sell melons in that the Melon Face Recognition applet is used to verify the sweetness of its melons. In other words, using melon face recognition, it is possible to determine whether or not a

melon is sweet.The melons are differentiated by sweetness level and displayed using technology to meet the different needs of different customers for sweetness on the one hand, making it easy to eat good, healthy, and green fruit, and on the other hand, using artificial intelligence to increase customer knowledge and experience about how to select melon, and making the purchasing process enjoyable.

(Source:https://http://n.sinaimg.cn/hainan/transform/102/w550h352/20181015/_1Qv-hmhafir7508273.jpg)

Figure 2.1 Melon Face Recognition

People can identify melons by scanning them with their mobile devices or by analyzing photos of melons. The designers of the program determined the ripeness of the melons by learning data from over 15,000 images of samples of Yanliang melons at different stages of ripeness and then applying relevant artificial intelligence algorithms, image recognition and other techniques to determine the ripeness of the melons with an accuracy rate of over 90 %.

2.3. Flavor Preferences

Taste plays a significant role in food selection, and a better understanding of the relationships between the tastes of foods is essential. However, the vast majority of one's flavor preferences are the result of experiential learning and hands-on practice. [9] Therefore, the selection of food should get determined by individual

preference.

2.3.1 AI Gastrograph

Analytical Flavor Systems is an artificial intelligence company that uses models of how people sense flavor, aroma, and texture to predict which food and drink products people will like. [16]The Gastrograph from Analytical Flavor Systems was utilized as a data gathering instrument to acquire a deeper insight of user food preferences. Gastrograph can collect data on taste testers, including demographic information, socioeconomic status, previous experience with products, smoking habits, and so on. It also includes information on the surrounding environment, such as temperature, air pressure, and noise levels, as these variables can affect a person's taste experience. The app's central feature is a wheel with 24 metrics, each measuring a sensory experience such as "meatiness," "bitterness," and "mouthfeel." Each criterion has five intensity levels, and taste testers can create a profile of taste perception by mapping these indicators to the quality of the food they detect.

2.3.2 White Coffee

White coffee gives "taste diagnosis" and "taste exploration" of coffee beans to all coffee lovers in order to facilitate clear-headed coffee consumption. [17] It is an app that can identify the type of taste that consumers favor. By purchasing the diagnostic kit, the user receives three varieties of coffee with unlabeled information, which the user then tastes. The diagnosis is performed twice in total, with multiple comparisons to obtain a clear image of the user's taste preferences. Then, six preference investigations are conducted to determine the user's favourite coffee kind. white coffee is a customized coffee preference analysis application that employs AI technology for precise analysis. In addition, it helps users discover coffees that may suit their tastes and encourages them to try them, allowing them to discover more coffees that suit their preferences.

(Source:https://white-coffee.jp/)

Figure 2.2 White Coffee

2.4. Wearable Devices

As the aim of this project is to design a technical wearable that can assist coffee drinkers, we think it would be a good idea to look at the types of wearables available and what wearables are currently available that can identify the taste of food or provide suggestions to the user.

2.4.1 Definition of Wearable Devices

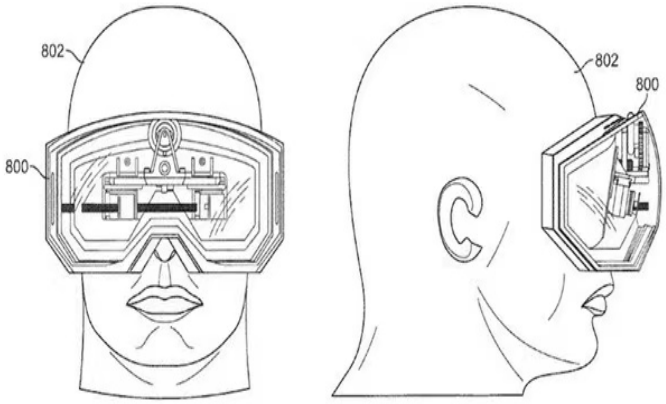
Wearable devices are defined as the intelligent configuration of people's daily attire using Wearable Technology. [18] Various sensors, recognition, connectivity, and cloud services are implanted into people's glasses, watches, bracelets, clothing, shoes, and socks, as well as other daily wear accessories, products, or clothing, thereby enhancing the user's perceptual capabilities. Steve Mann(2001), the famous "father of wearable devices," once stated that "wearable devices are like a wearable intelligent computer; the functions it provides should be continuous, it should always be working, it can be stored, and it should actively provide services that enhance human perception." [19] Additionally, through the device's

appearance and other design elements, the device is made more attractive, fashionable, and comfortable to wear. Consequently, the design of wearable devices can be viewed as a product of cross-disciplinary design involving wearable technology, accessory design, apparel design, product design, interaction design, and numerous other disciplines.

2.4.2 Wearable Device that Recognizes the Taste of Food

Infrared Sensing System

Recently, international media disclosed Apple's most recent patent for an AR/VR gadget, which reveals that the device will be outfitted with an infrared sensing technology. [20]



(Source:https://ee-paper.com/the-latest-patent-of-apple-ar-vr-device-equipped-with-infrared-sensor-system/)

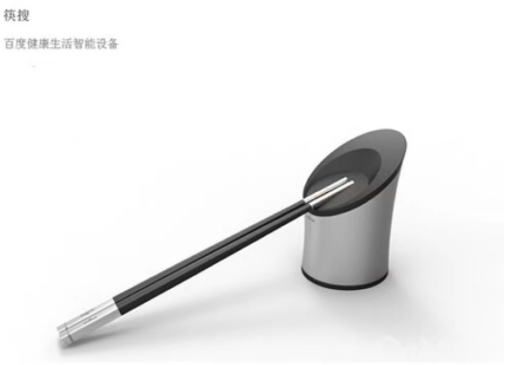
Figure 2.3 Device Equipped with Infrared Sensor System

Using the infrared sensor, the system may collect the spectral information of the target object and synthesize the object data by combining the information from multiple sensors. Moreover, all forms of item information can be displayed in real time by comparing them to database information. This technology can identify all kind of food information in real time, including freshness, sweetness, type of food, sweetness, etc., in order to evaluate the food's flavor. [20]

2.4.3 Intelligent Device that Provides Advice for User

Baidu Chopsticks

"Baidu Chopsticks"are an intelligent product that can intelligently check the PH level of drinks and water, even though that they appear to be normal chopsticks on the outside. If the user is somewhat acidic, it is recommended that they consume drinks that are mildly alkaline, which will be healthier; the device can also assess the sweetness, variety, and origin of fruits. This device combines multiple sensors to provide a variety of physical indications, including water pH (PH), temperature, and salinity data, as well as Bluetooth transmission of measurement data to a mobile device. [21]Based on cloud computing, the collected data are evaluated in real time and translated into a variety of food safety indicators. It intelligently interacts with the user via LED lights at the end of the chopsticks, displaying blue if the test result is acceptable and red if it is inadequate. The chopstick rest, on the other hand, is equipped with an infrared spectrometer for qualitative and quantitative examination of the things being examined.



(Source:https://mr.baidu.com/r/KbtbmO2xJ6?f=cp&u=8791f85dd4d7b89a/)

Figure 2.4 Baidu Chopsticks

Auracle

Auracle uses a microphone placed on the skin to pick up the sounds of mouth-related activity, and by analyzing these sounds, it can identify precisely whether

the wearer is eating or not.

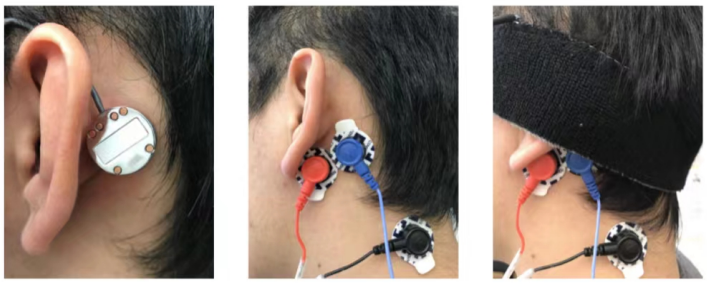


Figure 2.2: Contact microphone

Figure 2.3: EMG electrodes

Figure 2.4: Experiment setup

(Source:`https://auracle-project.org/`)

Figure 2.5 Auracel

This technology focuses on unobtrusive, automatic ways for determining when and for how long a person eats – the foundation for initiating additional sensor activities or inquiring user questions. (For example, a wearable camera may be activated when the eating recognition system detects eating; a digital food log with times and durations of eating as well as photographs of food could be generated and transmitted to nutritionists for examination) [22]Aurabal has the potential to be a wearable product that helps users build healthy eating habits by providing diet guidance, such as consumers who wish to diet or who just wish to monitor their daily eating behavior. Aurabal can connect to the user's phone and automatically delivers messages, such as "are you certain you want to eat again?" when people nibble. [23]

DNA Analysis

This wearable device can recommend healthy foods to users and prevent them from selecting items that are detrimental to their health. [24]The wearable device, similar to a health tracker installed on the wrist bone, conducts a live genomic analysis of the meal selected by the wearer. Using this wearable device, the user

need only scan the barcode of the desired food. On the basis of the DNA analysis, the green light illuminates if the product is suitable for you, while the red light illuminates if it is not. Simultaneously, the DNA analysis will perform a real-time health analysis and suggest an appropriate diet. For instance, if the user spends the most of the week in a low-carb condition, foods that are low in carbohydrates will activate the green light on the wearable, however if the user engages in an intense workout the next week, foods high in carbohydrates will activate the green light.

(Source:http://p.cdn-static.cn/17812_165193293984013.jpg/)

Figure 2.6 DNA Analysis

2.5. Summary of Related Work

Based on the previously mentioned relevant research studies and designs, I am aware of the components that influence the flavor of coffee. When it comes to coffee, flavor is the most influential factor in determining the consumer experience. If someway are capable of providing this information to coffee drinkers, they will have an accurate impression of the coffee's flavor. In order to provide coffee drinkers with useful information on the various characteristics of coffee flavor, it is possible to collect information on the taste of various coffees in advance and compile a comprehensive database. In addition, when advising people on

coffee selection, individual taste preferences should be considered prior to giving recommendations regarding taste compatibility. Due to the fact that individuals have varying tastes, this must be taken into account. This also shows that the two required processes are acquiring information about the coffee's flavor and analyzing the user's preferences. I also discovered that wearable devices have various purposes that can offer a great deal of ease to people's lives and can be incorporated into every part of their lives. In this component of my research, recognition technology can be integrated with data collecting and analysis to provide consumers with trustworthy guidance on their coffee selections. This could permit coffee drinkers and coffee to build a new way of communication and improve their interaction.

Chapter 3
Design Concept

In this section, I will describe the product's concept, the three created prototypes, and the modifications made from the first to the final prototype. As stated in the preceding section, the related work associated with recognizing the sweetness of melons is currently dependent on a mobile phone application for the collecting of information about the flavor of the commodities. However, it would be preferable to develop it as a stand-alone product in order for the user to obtain the desired information during purchasing quickly. To assist consumers in purchasing coffee with which they are satisfied, I aimed to develop a design that is easy to use and help users select coffee during purchasing.

3.1. Coffee Radar

When deciding to purchase something, we look up information about it as reference information. According to research, professional advice provides a more trustworthy and authoritative judgment by eliminating personal bias to a certain extent. [25]

In my design, the Coffee Radar generated taste is a combination of the wearer ' s tastes and the elements that impact the coffee selected. People with varying coffee preferences can use the Coffee Radar to find a coffee that meets their needs. In other words, the Taste Radar visualizes the abstract notion of how well the coffee matches the individual's preferences. So that buyers may determine if a coffee's flavor suits their preferences and make the best purchase decision. The individual's desired coffee sweetness, aroma, body, and acidity must be set as the first step. When a coffee approaches the coffee radar, it will combine the coffee taste criteria with the wearer's personal preferences to create match information

about the coffee's individual preferences.

There is an essential design element in the Coffee Radar: it strengthens the engagement between the user and this design enables consumers to have fun emoji conversations with coffee. Despite the fact that Coffee Radar may be a mobile application, I decided to create it as a physics product. There are numerous apps available with modern technologies that provide product information and purchase advice. Sometimes our lives have become uninteresting as a result of the frequent tapping into the phone.

For the choosing and purchasing of products, it is essential to have timely information about the commodities. It is necessary that Coffee Radar be designed as a standalone personal product for this reason. This will provide a fun and interactive buying experience for consumers who don't know how to select a coffee with a flavor that suits their palate. This design aims to give coffee consumer with taste match that can be used as a reference when purchasing coffee, enabling them to get a coffee that corresponds to their taste preferences.

Coffee Radar includes three main functions.

- [1) Reading user preferences

  Users can inform Coffee Radar of their preferred coffee flavor by inputting their own preference index.

- [2) Communication

  Coffee Radar engages consumers in a playful way through dynamic expressions.

- [3) Providing taste match

  By identifying different coffee taste indications and integrating them with individual preferences, it can quickly present consumers with coffee select-related information.

3.2. Design Process

During the process of researching and thinking design through for the thesis, the above conceptual design for Coffee Radar was built. The design process is

comprised of 5 primary steps, each of which is connected to the others, and the final of the design will be discussed in this chapter.

1) Define the pain point problem: My initial research focused on food purchases. People are spending more and more money on food items as the economy develops, but when they buy food items they have never had before, they are likely to purchase goods that do not suit their taste, and they want to better this condition and resolve this issue. Consequently, I pondered creating a design that would identify the flavor of food items. Due to time and technical limits as well as the fact that different foods have varied effects, I focused my research and began to consider my own normal life. My girlfriend and I both enjoy cans of coffee at work, so every time we go shopping, we purchase a portion of coffee to keep at home. Whenever there is a new coffee product, we attempt to purchase it, but if we receive a flavor we don't like, we take a few sips before discard it. Therefore, I had the idea for a research coffee.According to background research, coffee consumption is the second greatest commodity in the world, with a large consumer base worldwide and a large number of new coffee flavors being created each year. And to determine if this was a relevant topic, I used questionnaires to determine that the majority of people had the same difficulty as I had with the number of coffee options and that people are pleased and satisfied when they drink coffee that meets their tastes. As a result, I took a step toward refining my concept for a device that would enable coffee buyers to determine how well their coffee matches their taste before selecting it, thereby assisting them in choosing the best coffee for their taste. Regarding coffee research, I began by examining all sorts of coffee and discovered that it was difficult to examine and collect a great deal of information affecting the taste of brewed coffee and coffee beans. However, I was able to collect accurate taste data from the manufacturers of canned and bottled coffees, therefore the subject of my coffee research was canned coffee and my target user was coffee lovers.

2) Research previous work: I intend to build a new concept design based on existing academic findings about the investigation of factors that influence

the purchase of coffee and the review of commodities. There are two main theories that I used as a foundation for my research.

(1)Coffee Radar generates a taste match based on the user's taste preferences and the coffee taste criteria. The closer an user's taste preference is to the coffee taste criteria, the more suitable the coffee's flavor is for that person.

(2)professional advice provide a more trustworthy and authoritative judgement by eliminating personal bias to a certain extent.

3) Prototyping design : After deciding on the fundamental concept, I created a simple device that satisfy the following two criteria:

1. It can generate a taste match based on the user's taste preferences and coffee taste criteria.

2. The match can be utilized to communicate with the user in an interesting and interactive way, and this taste match can assist the consumer while purchasing coffee.

4) User testing : I would like to test the following hypotheses : (1) If the consumer understands how well the coffee matches their taste preferences, does the design influence their decision to purchase coffee? (2) If users are provided with coffee match information, will they be able to purchase coffee that matches their tastes?

I will endeavor to test users of various nationalities, genders, occupations, and ages in order to reduce inaccuracies in the results.

5) Improvement: Enhance the prototype based on information gathered from user testing

3.3. Criteria

Coffee Radar's system must have important database information regarding the aspects that influence coffee purchase. As a result, a survey was conducted to acquire a deeper understanding of and identify the factors that influence customers to purchase coffee. Internet was used to distribute and gather responses to the

survey. The respondents' ages ranged from 19 to 48 years old, according to the collected data. Of the 170 respondents, 146 were Chinese, 17 were Japanese, 5 were Korean, and 2 were American.

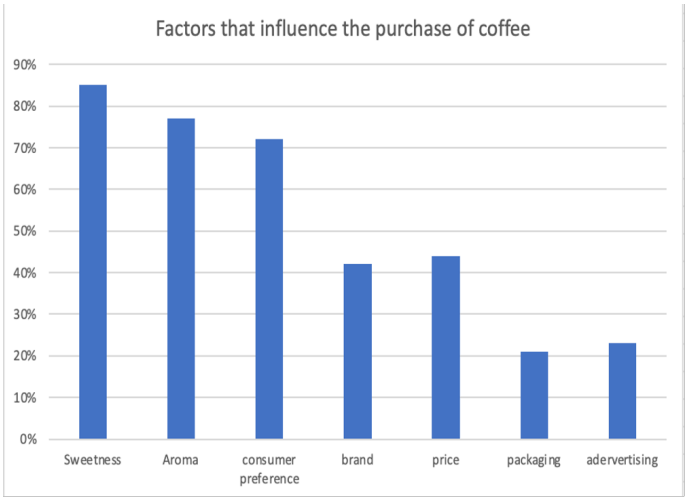


Figure 3.1 Survey Result

According to 170 questionnaire responses, the most influential elements influencing the purchase of coffee were sweetness (85%), aroma (77%) and consumer preference (72%). Price and brand were deemed less significant by the respondents. Packaging and advertising were the least important aspects of purchasing coffee.

Based on the results of a survey on the factors influencing users to purchase coffee, we found that the most important factor that influences users' choice of coffee is the taste. Combined with previous research surveys on the criteria for good coffee. we decided to use the four indicators of sweetness, aroma, body and acidity of coffee as the criteria.

3.4. Taste Criteria Database Source

In order for Coffee Radar to identify the vast majority of coffees on the market, a database of coffee taste criteria was required. I collected valid and accurate

information on the taste criteria of various coffees from the coffee manufacturers. This data can be utilized to build a reliable database for the Coffee Radar system.

(Source:`https://www.suntory.co.jp/softdrink/boss/lineup/index.html`)

Figure 3.2 Sample of Coffee Taste Criteria

3.5. Experiment to Determine the the Generated Taste Match Criteria

For the purpose of determining the generated taste match criteria, 80 users were invited to participate in an experimental survey.

- Experiment time start time: 2022.6.6
- Experimental time end time: 2022.6.10
- Number of experiments: 80 people
- Age range: 20-29 years old
- Number Of Man: 37 people
- Number of Female: 43 people

- Occupation: Student and employee
- Nationality: Chinese(63), Japanese(11), Korean(3), American(2), Australian(1)
- Characteristics of the participants: Average consumption of 4 cans of coffee a week
- Source of participants: KMD's classmates, my friends, some of my students
- Experimental method: On a scale with a range of (0-5) for each criterion, they set their data on each coffee taste preference. Because these input factors can impact the user's preference for the coffee's flavor and the final purchasing choice. The participants were instructed to drink three samples of coffee and choose from these three options (acceptable, unacceptable, and suitable) to indicate how their feel about the coffee's flavor. Finally, the data on personal preference is analyzed in comparison with the corresponding taste of coffee

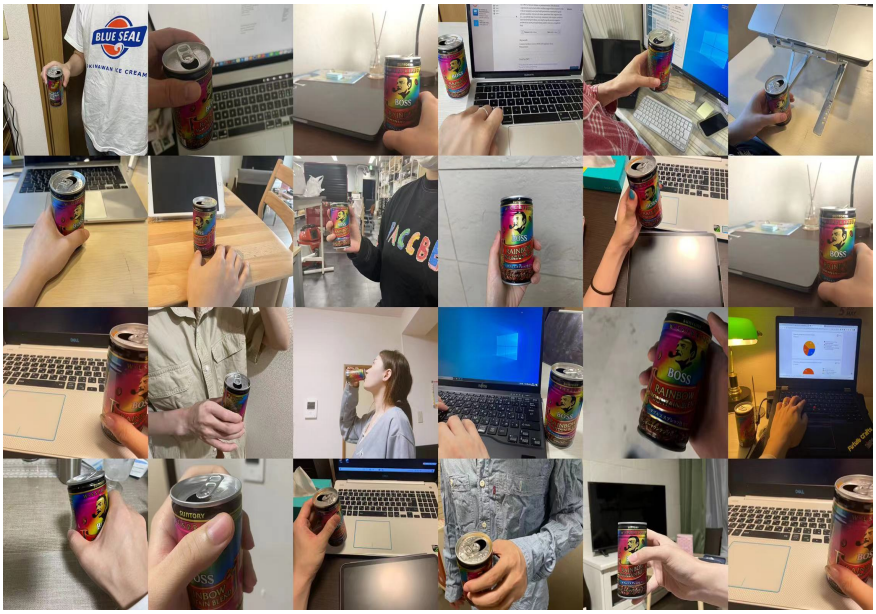


Figure 3.3 Participants tried the coffee

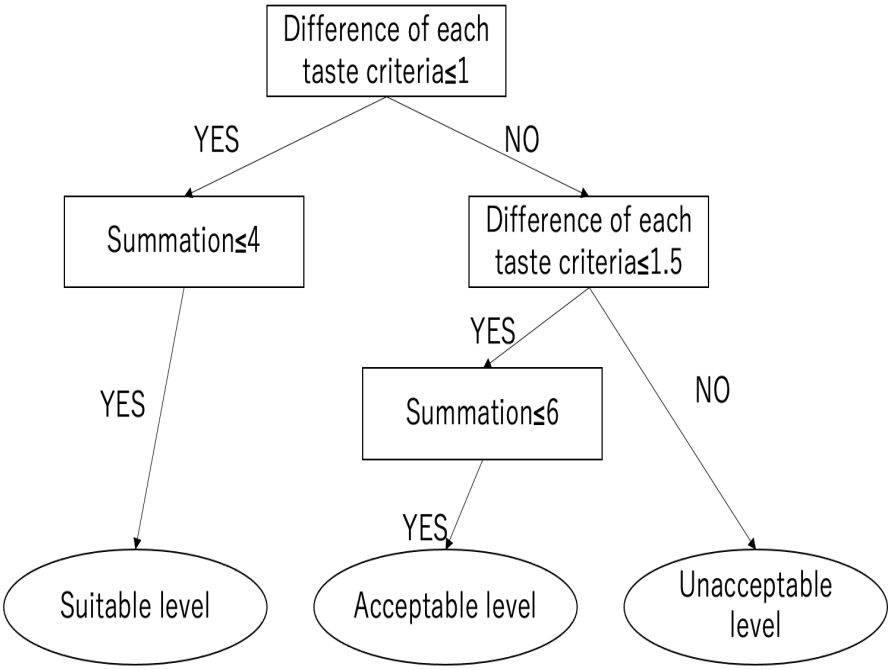


Figure 3.4 Algorithm of Taste Match

Taste match	Difference of each criteria	Summation
Suitable level	0-1	0-4
Acceptable level	1-1.5	0-6
Unacceptable level	1.5-5	0-20

Table 3.1 Experiment results

From the survey, it was found that the difference between the indicators of personal favorite taste and the corresponding taste criteria was in the range of (0-1), and the total difference between the indicators was in the range of (0-4), which is the most suitable degree, and the user is recommended to buy this coffee;The difference of each index is in the range of (1-1.5), and the total difference of each index is in the range of (0-6) is an acceptable degree, which means that most of the taste indicators are suitable for users and can be tried to buy.The difference between the indicators is in the range of (1.5-5), and the total difference between the indicators is in the range of (0-20), which means that the coffee is not suitable for the user to buy.

3.6. The First Prototype

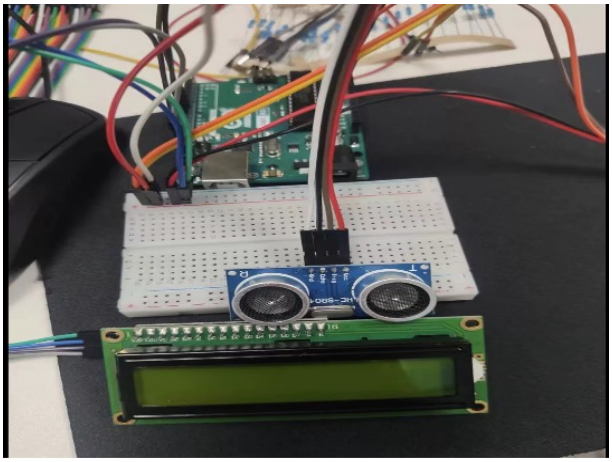


Figure 3.5 The First Prototype of Coffee Radar

The first prototype of the coffee radar is a low-fidelity model comprised of a UNO R3 Micro-controller Board, a LCD 1602 module,an ultrasonic sensor and several female-to-male dupont wires and breadboard jumper wires. At this stage of the prototype, it can only combine the user's sweetness preferences to generate a taste match.

As described in the concept section, to make the design function effective, the coffee taste criteria are entered into the program in advance, while the user is required to set their taste preference information (as this is only the first prototype, it can only set the taste preference for sweetness) as slightly sweet, medium sweet and very sweet. When no coffee is sensed, the display will be in standby mode. To achieve a taste match between the coffee and the individual, the coffee must be held by a person within a specific range that the coffee radar can sense. When the coffee is sensed by the coffee radar, it will combine established personal preference data with a database of coffee taste criteria to produce a taste match. The taste match between the user and the coffee is communicated through text messages.

Figure 3.6 The First Prototype of Taste Match

3.7. How to Sense the Characteristics of Coffee on Coffee Radar

Because of the low fidelity of the prototype's design, this effect was produced using program simulation. We need input the data about user's coffee preferences(acidity, sweetness, body, aroma) and taste criteria into the program. Based on the inputted information, the program will generate the taste match.This is the principle that how the system sense the coffee and the characteristic of coffee.

```python
# function: compare
def compare(coffee, user):
    sweetness_dif = abs(coffee['sweetness'] - user['sweetness'])
    body_dif = abs(coffee['body'] - user['body'])
    acidity_dif = abs(coffee['acidity'] - user['acidity'])
    aroma_dif = abs(coffee['aroma'] - user['aroma'])
    difference_list = [sweetness_dif, body_dif, acidity_dif, aroma_dif]
    # get difference_max and summation
    difference_max = max(difference_list)
    summation = 0
    for dif in difference_list:
        summation += dif
    # compare
    if difference_max <= 1.5:
        if difference_max <= 1:
            if summation <= 4:
                print('Suitable level')
        else:
            if summation <= 6:
                print('Acceptable level')

    else:
        print('Unacceptable level')

# data: coffee and user
coffee = {'sweetness':3, 'body':4, 'acidity':3.5, 'aroma':5}
user = {'sweetness':3, 'body':4, 'acidity':3, 'aroma':5}

compare(coffee, user)
```

Figure 3.7 Coffee Radar System

3.8. How to use prototype 1

In order for the Coffee Radar to detect the coffee, the user has to hold a sample of coffee within a certain range that it can sense. When the user sees the text message "suitable level" on the display, it means that the Coffee Radar is telling

them that the coffee is the most suitable for their taste and that they can feel free to buy. When the user sees the text message “acceptable level” on the coffee radar, it means that the coffee’s taste standard is not too different from the user’s preference and they can try and buy this coffee; but when the coffee radar shows “unacceptable level”, it means that this coffee is not suitable for their taste and they do not have to buy this coffee.

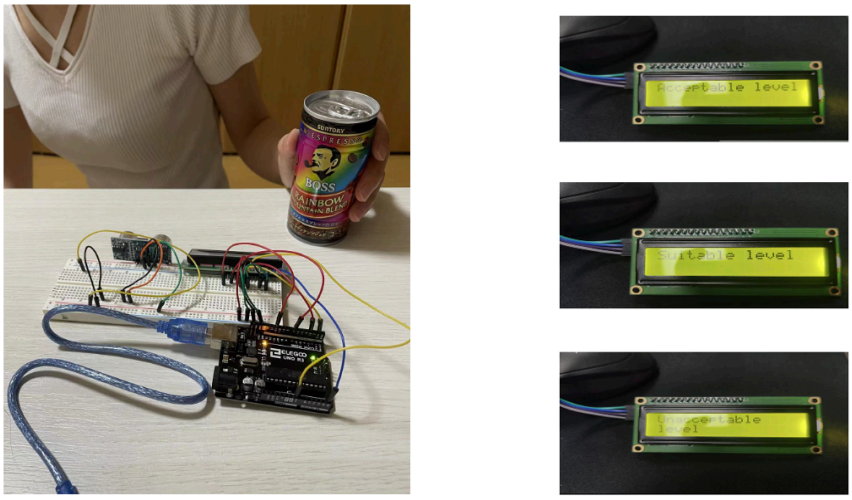


Figure 3.8 How to Use Prototype 1

3.9. New Design of Taste Match

When people describe a coffee flavor, yet the intensity of the flavor is difficult to convey in words. In order to solve this problem, we conducted another survey of related research.From the study we found that Numerous studies have demonstrated that facial expressions, whether innate or acquired, are one of the richest nonverbal communicational catalogs of man, it can convey an individual’s taste appreciation. [26] According to Zeinstra (2009), school-aged children’s facial expressions are a reliable indicator of “dislikes.” [27] Lukas Danner (2014) proved

that “angry,” “repulsed,” “happy,” and “neutral” facial expressions could identify between samples that were liked, neutrally assessed, and disliked in an explicit test. [28] Therefore, we decided altered how we utilize text as the information carrier and the testers were also involved in the creation of the expressions that matched the flavor. By including easy-to-read expressions into the design of the flavor matching information, also it will make the interaction between the user and the taste radar more engaging.

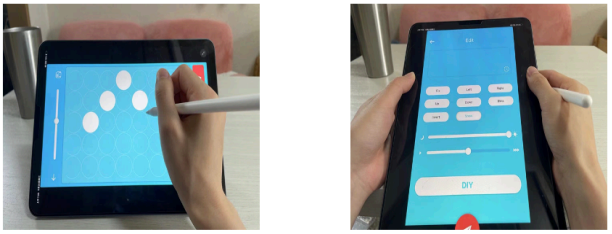


Figure 3.9 Participate in Emoji Taste Match Design

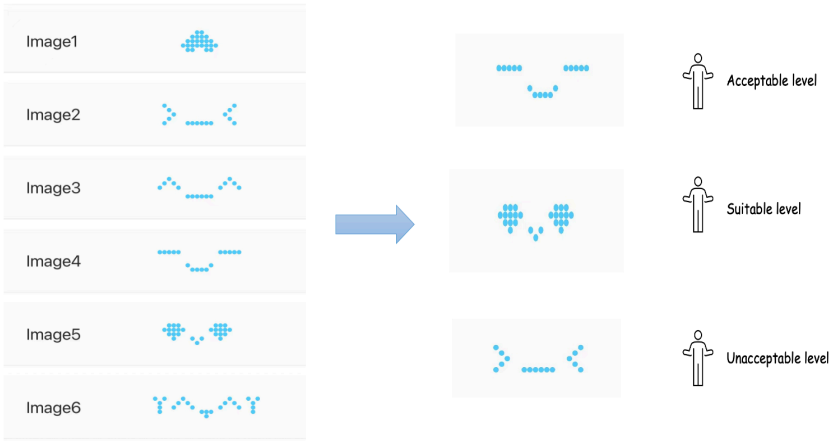


Figure 3.10 Emoji Taste Match

Taste	Emoticon	Dynamic effect
slightly sweet	normal smile	fixed
suitable sweet	love eyes	sliding out
very sweet	unbearable	flashing

Table 3.2 Caste Radar's Emoji design

To identify which facial expressions were associated with preferred intentions and which dynamics may be used to combine facial expressions for a more powerful visual effect. A pilot experiment were conducted using taste-matching emojis created by the participants(10 people).

We decided to use Figure 5 (a pair of flashing loving eyes expressions) as a suitable taste match, Figure 3 (a normal smile without dynamic effects) as an acceptable taste match, and Figure 2 (an upward sliding unacceptable expression) as an unacceptable taste match after combining the feedback of the participants.

3.10. The Second Prototype

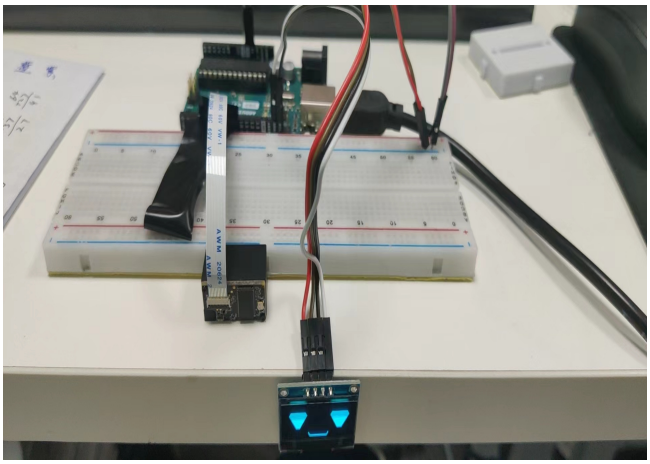


Figure 3.11 The Second prototype Coffee Radar

The second prototype is an improved version of the initial one. To enable the identification of coffee, a barcode recognition module was included. The display

was also replaced with an OLED display module capable of interacting with the user through a variety of matching emotions. In addition to analyzing the sweetness element, the system program of the second prototype may integrate user preferences with the acidity, body, and scent indications of the coffee. This combination of factors provides a matching index that can more effectively assist the user in selecting the ideal coffee for their tastes.

3.11. How to Use Prototype2

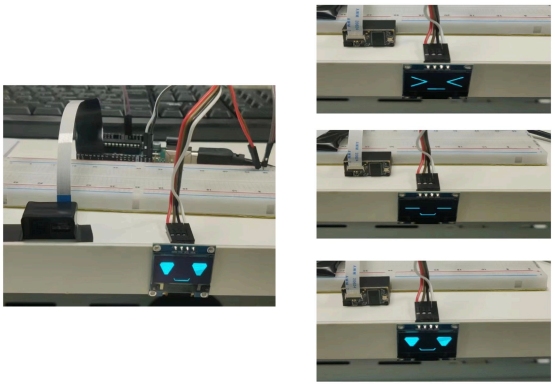


Figure 3.12 How to Use Prototype2

Firstly, users need to set their coffee taste preference information (aroma, body, sweetness, acidity, each preference within 0-5 levels) and input it into Coffee Radar. Through the bar code recognition formation, Coffee Radar can identify the coffee taste information and produce expressions taste match with personal preferences. When the user sees a pair of flashing loving eyes emoji, it means that the taste of this coffee is most suitable for the user; when the user sees a normal smiling emoji, it means that the taste criteria of this coffee are not much different from the user's taste preference, and they can try to buy and experience this taste. When the user sees an unbearable expression, it indicates that there is a large difference between the taste index of this coffee and the user's taste preference, therefore the user does not need to buy this coffee flavor.

3.12. Final Prototype

In this project, a final prototype of a coffee radar was designed using 3D modeling, and we created a concept video.

Figure 3.13 A 3D Rending of Coffee Radar

we designed the appearance of Coffee Radar as a wristband for several reasons. To begin with, people all pick up coffee by hand, which enables the coffee to appear within a set effective range, making it simple to detect and obtain the coffee criteria . Secondly, Coffee Radar targets a young people, and fashion manufacturers and designers are beginning to incorporate wearable devices into their creations. [29]To improve the attractive appearance of Coffee Radar's technology, I designed the screen and the device as a whole so that the screen may display more engaging and interactive information. Third, it has a richer display of interactive features, making the process of communication with the user more interesting through dynamic expression matching information. Fourth, it can be more convenient for users to import their own taste preference settings through the supporting application.

Combined with the previous background section, Coffee Radar is a wearable device that helps users choose coffee; it imports users' taste preference information; by combining and analyzing with the coffee taste database, it can generate taste matches and interact with users in an playful way to help users buy coffee that matches their taste.

3.13. Scenario Design

3.13.1 Persona

Personas are fictional descriptions of users' behavior, goals, and motivations. It includes made-up details to make the persona real and alive. Personas are imaginary, detailed, and concrete representations of target users. [30] A persona is a user model that focuses on the individual's intentions when interacting with an artifact. The model serves a particular function as a device for software and product design. [31]A persona represents a collection of target users with common behavioral characteristics; in other words, it is a hypothetical prototype of a real user. [30] Since their introduction by Cooper (1999), Discover Financial Services, SAP, and FedEx have integrated personas into their design processes. . [32] [33]Therefore, in order to complete the design and to provide others with a better understanding of my concept, I created the persona of "Abel".

Figure 3.14 Abel

Abel, a 22-year-old university student, is a photographer, also a coffee lover. Every morning, he is accompanied by a cup of delicious coffee. Whenever he goes to the supermarket, coffee is one of the items he purchases. When he travels, he also buys local coffee to take home or to give to his friends who like coffee. However, he is often frustrated by the fact that the coffee he buys is not to his liking. Recently, there was a coffee exhibition in Tokyo where 500 new flavors

were on display. As a coffee lover, he decides to go with his best friend to pick up some good-tasting coffee.

3.13.2 Scenario

As soon as Abel steps into the exhibition, he smells the distinctive aroma of coffee. It is the first time he sees so many different flavors of coffee on display in front of him. While he tries to enjoy this coffee exhibition, a receptionist comes up to him and said, "Would you like to try our new product, Coffee Radar? Abel is immediately intrigued, as this is exactly what he had been looking for. After listening to the receptionist's explanation of how to use it, he put the coffee radar on his left hand and set his taste preferences on it.

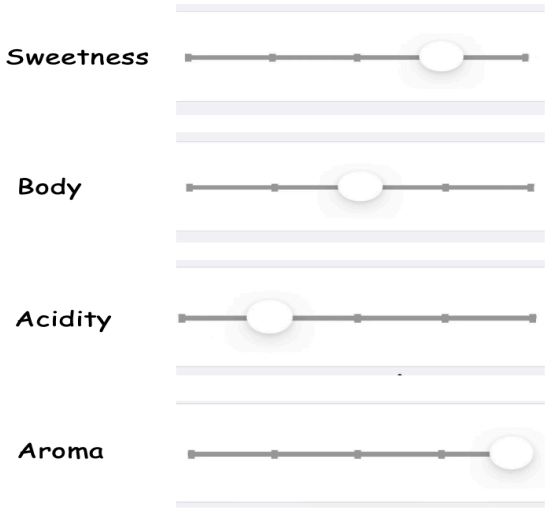


Figure 3.15 Set the Taste Preferences

He first walks towards the Boss Coffee booth, where he casually picks up a can of black coffee, at which point the coffee radar displays an unbearable expression. Having listened to the explanation of the function, he realizes that the flavor of this coffee taste is not for him. But he wants to confirm whether the function of this coffee radar is so powerful, then he asks the boss coffee exhibitor for a tasting sample. Although the aroma of this coffee is particularly pleasing to him, the acidity of coffee is overly and not his usual preferred taste. He picks up

another bottle of micro-sugar coffee, at this time, the coffee radar displays a normal smile and he understands that the coffee in hand is not the most suitable one although some taste criteria are close enough to his tastes. After he tries it, he also finds the body and the acidity are acceptable to him, but the sweetness aspect is still a little different from his preferred taste. After picking it out for a while, he suddenly sees a flashing loving eyes expression on the coffee radar and he immediately understands that the coffee on hand is the perfect one for his taste. After tasting it, the pleasure of drinking his favorite coffee every morning is overwhelming. After a 2-hour visit to the exhibition, Abel satisfies that he had picked out more than 20 coffees to suit his taste with the help of the coffee radar.

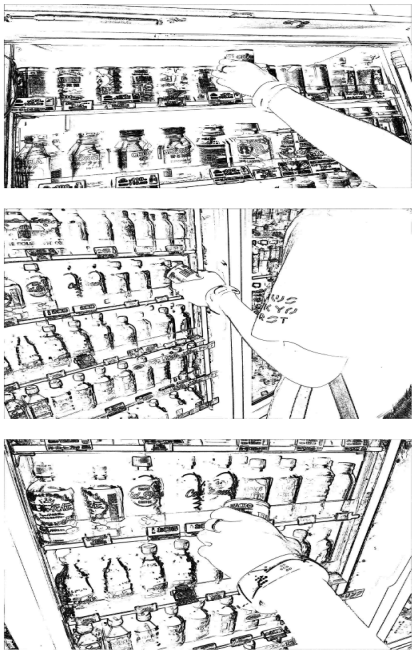


Figure 3.16 User scenario

Chapter 4
Evaluation

Based on an investigation of current consumer pain point difficulties in coffee selection, the concept of coffee radar was discussed in the previous chapters. Methodology, participants, experimental design, and conclusions are included in this chapter. A variety of experiments were conducted to determine the effectiveness of coffee radar.

4.1. Methodology

To evaluate this design, a qualitative evaluation is conducted on how the Coffee Radar is effective in helping users to choose suited taste coffee.Since no measurement scales have been devised for such situations, it is especially valuable for gauging reactions and impressions of new ideas. [34] In addition, qualitative research can help understand users' needs, feelings, values, and perceptions that underlie and influence behavior on a deeper level than close-ended quantitative measurements. [35]The evaluation experiment consists of two parts: 3 experiments and interview. The experiments are described in detail in the Experimental Setup section. Each experiment is followed by a semi-structured interview with each experimenter. Some basic questions were asked, which were predetermined beforehand, including "What are your positive feelings about using this design or what is not enough about it?" and "Do you think the design helps you to get the right coffee for your taste", with other questions based on user responses.

4.2. Experiment Setup

4.2.1 User Validation

Participants in Experiment 1

The 10 participants consist of my classmates and friends. Their age ranges between 20 and 28 years. The mean age for participants is 24.8, and the average education level is a master's degree. An average number of coffee purchases per week among the participants is approximately eight, and their characteristic is a sweet coffee lover.

Experiment 1

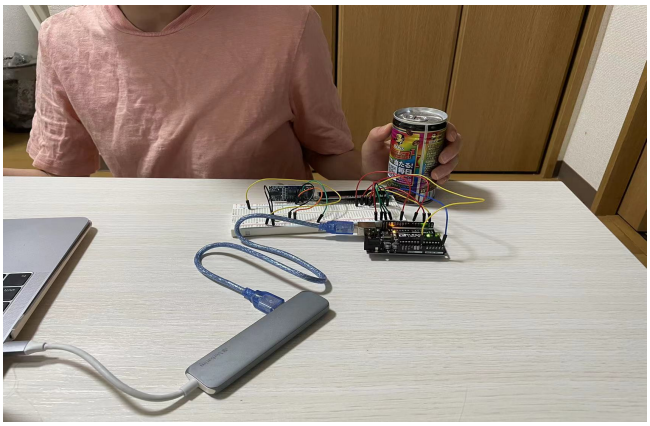


Figure 4.1 Prototype 1 User Testing

In the first experiment, 10 users were asked to test the first prototype. In the first prototype, only the sweetness of the coffee could be combined to generate the matching information. So the 10 participants only set their sweetness preferences in advance on the taste radar. A medium sweet RTD coffee was used as a sample for user testing. After obtaining the sweetness matching information from Coffee Radar, they tasted the coffee to verify the accuracy of the matching information.

Results and Perceptions of the First Prototype Experiment

The first experiment was conducted by the participants using the first prototype. From the interview results, although the accuracy of the generated coffee sweetness matches reached 70 percent. the participants did not like the design. First of all, they thought that the coffee radar function was a bit simple, that there was more than just sweetness that influenced the taste of coffee, and that presenting the match information through text was boring to them.The function of distance sensing is not required for coffee radar. But more important is what timing the user has to get the taste match.

4.2.2 Participants in Experiment 2

Participants are 4 people who where my classmates and friends. Their ages ranged from 22 to 27 years old. They are all coffee lovers and on average drink at least one can of coffee a day; coffee is one of their daily necessities.

- User 1: He is Japanese and works in a company. He likes the taste of coffee to be slightly sweet
- User 2: She is an international student at Waseda University and buys a can of microsugar coffee every day at the school's convenience store
- User 3: She is my KMD classmate and likes to drink cafe au lait
- User 4: He is a Chinese who studied in Japan. He likes the acidity of coffee because the taste keeps his mind sharp during the study.

Experiment 2

Four people participated in the second experiment with the second prototype. Users need to set their taste preferences on Coffee Radar including: sweetness, body, aroma, acidity. The taste match is presented with expressions. To improve the credibility of the experiment's results, they were asked to shop for coffee using coffee radar for a week. (At least once every day, and each purchase requires a new taste) At the end of the experiment, statistics were collected regarding the

number of times participants purchased the desired coffee taste, and participants were interviewed.

Results and Perceptions of the Second Prototype

During the second testing, the new generation of coffee radars left the participants with a good impression.

- (1)Provide effective suggestions: Based on participant interview feedback, this study found that Coffee Radar's primary model is to provide effective suggestions. In other words, the taste match is useful when the user is unsure whether or not to purchase a particular coffee flavor. Four users enjoy this feature.For user 1, his job requires him to go out to meet customers, so he buys coffee at a different convenience store each time. If the nearby convenience store doesn't have the flavor he always buys, he has to try other flavors. With the help of Coffee Radar, he can quickly find a coffee that suits his taste. User 2 said that although many coffees are labeled as mildly sweet, some of them are still sweet to her. Coffee Radar is able to distinguish the difference between these micro-sugar coffees. User 3 likes to drink coffee au lait because she likes medium sweet coffee and does not like too bitter coffee. With coffee radar she found a lot of coffees that suit her taste for sweetness. User 4 likes the acidity of coffee, so he used to buy black coffee, and with the recommendation of Coffee Radar, he found several coffees that suit his taste.

- (2)Preferred extension: Coffee Radar not only helps users to choose the right coffee for their taste but also has a mode to recommend users to try other flavors of coffee to expand their liking. Because it can identify that the majority of coffee flavor criteria are similar to customers' taste preferences. Sometimes, there are some flavors that consumers may enjoy after tasting this coffee flavor. User 2 stated that he had never drunk a café au lait, and his stereotype was that the sweetness of the coffee must be unacceptable to him. Once he picked up a can of cafe au lait and the coffee radar showed a smiley face, he was curious to try and buy the can of coffee and after drinking it, he felt that he liked this flavor of coffee and said he would choose this

flavor again. User 3 also enjoyed a lot of coffee she hadn't drunk before because of this feature.

- (3)Playful interaction: The participants found it interesting to communicate with the users through emojis. One participant thought that the process of getting a Taste match from Coffee Radar was similar to the process of looking up information about a product online. But the end result is that we don't need to read a big text, we can get the exact information we want through a funny and easy-to-read emoji. And in the process of selection, timely advice will allow him to quickly make an accurate judgment.

- (4)Personalized advice: Another favorite attribute of Coffee Radar is that it generates taste matches based on personal preferences. User 3 said that her friends would recommend some good taste coffee to her, and sometimes she tried the coffee recommended by her friends and felt that it didn't suit her taste. But Coffee Radar is different, she only needs to set her taste preference, and Coffee Radar will help her find the right coffee for her taste.

Limitations

Based on user experience testing, this research indicated that Coffee Radar can effectively assist users in choosing the right coffee for their tastes. Still, the results of the interview survey also revealed some design shortcomings. First, Coffee Radar requires the barcode of the coffee to be scanned in order to identify the coffee. If the barcode is not aligned, it does not immediately produce a match. One participant recalled that because she was not familiar with the use of the coffee radar at the beginning, it did not work well in obtaining taste matches. Secondly, it was also noted that although the match information was highly valid, there was sometimes a gap between what the coffee radar thought was the most suitable flavor and what they liked. In addition, the final design of Coffee Radar should be a wearable device, and due to technological limitations, the final outcome could not be realized on prototype 2, which had some impact on the user experience.

4.2.3 Concept Validation

Experimennt 3

The research has conducted a concept validation with visitors to the PLAY Project lab's exhibition at Keio University's Graduate School of Media Design. Even though some of the participants were not coffee lovers, this research used the Coffee Radar prototype as a trigger to obtain feedback on the design concept.

Figure 4.2 Concept Validation in PLAY EXHIBITION 2022

The participants were first given an introduction of the Coffee Radar, and after an introduction to the purpose of the Coffee Radar, they were invited to watch a concept video. Then, they were invited to participate in an interview survey about Coffee Radar. It also required each respondent to sign a consent form stating that his/her participation in the test and survey was of his/her own free will and that he/she agreed to be able to record and photograph the experiments and use their survey data for this study. The interview questions addressed three main questions.

- (1) If you were unsure of which coffee to choose, to what extent do you think this design would help you?
- (2)Do you hope there will be any designs like this in the future?
- (3)What are your positive feelings about using this design or what is not enough about it ?

22 individuals participated in the conception validation test and, on average, spent 15 minutes comprehending and assessing Coffee Radar. After collecting the initial data and doing an initial analysis, all samples were validated and used for further investigation.

4.2.4 Results and Perceptions of concept validation

According to the results of the interview survey, 85% of respondents felt that a coffee radar can be a useful tool when selecting a coffee. Even if some survey respondents are not coffee lovers, they would also like to have one of these devices. One user explained that her boyfriend enjoys coffee, so she can set the Coffee Radar to his taste preferences and purchase coffee that matches his likes. The surveys also collected a lot of participant comments on how to enhance the present design and generate ideas for future projects. First, participants want richer form factor for the Coffee Radar in terms of its appearance. Specifically, one participant, a fashion designer, asked if the coffee radar could be designed as a ring. The interaction with the user could become a vibration mode, and different frequencies could represent different matches. Another respondent suggested that the matching expression of the coffee radar could be defined by the user. Because young people are pursuing fashion and being unique, he desires his coffee radar to be distinct from that of others. Another group of respondents wanted the coffee radar to identify not only the taste of RTD coffee but also the taste of brewed coffee or coffee beans. These comments can be used in future design work.

4.3. Overall Evaluation

In terms of overall, the Coffee Radar is welcomed by testers. They believe that obtaining taste-matching information when selecting a coffee would help them in purchasing the suitable flavor. The majority of testers feel that Coffee Radar provided an effective taste match and that its interaction with the user through emojis was fascinating. Although getting a taste match by recognizing the bar-code was less sensitive sometimes, it was still able to identify information about the coffee quickly after adjusting the angle. Users are looking forward to more interactive functions in the future, as well as other appearance designs.

Chapter 5
Conclusion

5.1. Summarize

Today, coffee is the most popular drinks in the world and the second most traded commodity. Each year, coffee makers offer a wide variety of different tastes to satisfy consumer preferences. Coffee lovers have more options because of the wide variety of tastes, but how to finding a suitable flavor among the various options is a frequent problem they encounter. This is the primary motivation for developing Taste Radar. This research demonstrates the design rationale and concept development behind Coffee Radar, which targets the needs of coffee lovers and coffee consumers that are not adequately addressed effectively. Coffee Radar is a physical technology that helps users to buy the right coffee for their taste. By analyzing the pain point problem of coffee selection and purchase, I proposed the design concept of obtaining a taste match and designed two prototypes. From identifying the various taste factors that influence the coffee selection, followed by defining the criteria for the match, and finally the design of the program. A prototype of a coffee radar that can implement the function of generating taste matches was created in a continuous improvement process. Through user experience experiments and proof-of-concept experiments, the effectiveness of the coffee radar was verified and some effective suggestions were obtained that can be used for future designs.

5.2. Limitation

Coffee Radar is intended to help customers in choosing coffee that suit their preferences. As with many other studies, there are limitations to these design investigations.

- (1)Sample of participating user testing:

  Most of the people who participated in my user test are my classmates, and they are very receptive to innovative design. They also valued the futuristic aspect of the design over the practical aspect of the current product. Their feedback may be biased because of the futuristic features of Coffee Radar that were demonstrated in the interview survey with them. This research did not investigate different types of users is one limitation of the survey process.

- (2)Lack of prior studies on taste match:

  Due to the lack of relevant studies,the current metric of taste match may be inaccurate.

- (3)Low-fidelity prototype:

  While the conceptual video was effective in terms of making the design understandable to people, the low-fidelity prototype had an impact on the user's experience. This also contributed to some bias in the results.

5.3. Future Work

Based on the results of the user study, this research also summarises the following points to further improve the coffee radar design.

- (1) More sensitive identification:

  According to feedback from user testing experiments, sometimes coffee radar can quickly identify coffee to generate a taste match, but sometimes it fails to achieve the desired identification. Therefore, the future design should consider the improvement of sensing and recognition system. For example, a module for image recognition could be placed on the coffee radar. By recognizing the appearance of the coffee, the taste match can be produced quickly.

- (2)To increase recognizable coffee types:

Participants who participated in the user test noted that while the current coffee radar helped them purchase RTD coffee that suited their tastes, it was unable of identifying other coffee items, such as coffee beans. For coffee lovers and coffee consumers, also enjoy brewed coffee. Future work could be done to improve how to select good-tasting coffee beans or to identify brewed coffee flavors.

- (3)Diversified interaction: Currently, Coffee Radar communicates with users by using expressions. In the user test, participants said they had to recognize the coffee again if they didn't look at the screen. In the future, we can increase the interaction mechanism between Coffee Radar and users, for example, by using different frequency vibration patterns to communicate with users.

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Appendices

A. Questionnaire

A survey of consumers
purchasing and selecting coffee

1. where are you from?

*2. What's your gender?

- Male
- Female
- Prefer not to say

3. What's your age?

*4. What's your highest educational level?

- Less than High School diploma
- High School
- Bachelor Degree
- Master Degree
- Phd

*5. Do you like coffee?

- Yes
- No
- Not bad

*6. Have you ever purchased coffee that flavor you disliked?

- ◯ Yes
- ◯ No

*7. How did you feel at that time?

- ◯ Regret or dissatisfaction
- ◯ I don't care about it
- ◯ Buy a different flavor again

*8. How you feel when you drink a coffee that suit your taste?

- ◯ Happy and enjoyment
- ◯ I don't care about it
- ◯ Want to drink again
- ◯ Share with friends

*9. When you buy coffee, you usually take ( ) into consideration: 【多选题】

- ☐ Price
- ☐ Brand
- ☐ Packaging
- ☐ Advertisement
- ☐ Habits
- ☐ Sweetness
- ☐ Aroma