The Design Definition and Research of In-Car Digital AI Assistant

Jun Ma1, Xuejing Feng1, *, Zaiyan Gong2 and Qianwen Zhang1

1College of Design and Innovation, Tongji University, Shanghai, China
2School of Automotive Studies, Tongji University, Shanghai, China

*Corresponding author e-mail: 1841839@tongji.edu.cn

Abstract. Nowadays, intelligent assistants, such as Apple's Siri, are becoming integral to our daily lives, and they significantly change the way users interact with systems. Meanwhile, with the development of technologies, people continue to bring the experience of using intelligent products to the car, and the in-car intelligent assistant is also gradually being used. While there have been many studies focused on technologies, there are fewer studies dealing with design issues at the initial stage of the design, the stage prior to system implementation, such as how the personality of intelligent assistant should be, how to design the appearance, and the way of interacting, the designers had to rely on imagination. Therefore, we present a design method to define intelligent assistants, using the MBTI model combined with brand tonality to define the personality of intelligent assistants, then we determined the design direction of the appearance design based on user research and benchmark. Furthermore, the initial design scheme was screened from brand fitting and flexibility, and experts and users were invited to determine the most suitable scheme from the two dimensions of personality and symbolization. This design method allows designers and engineers to explore more precise design solutions and to improve the emotional design and user satisfaction of intelligent assistants before all the complex systems are ready to run.

1. Introduction
People interacting with intelligent assistants on smart devices have nowadays become a common daily behavior, such as Amazon Alexa [1], Microsoft Cortana [2], Google Assistant [3], and Apple Siri [4], allow people to search for various subjects, schedule a meeting, send text messages, or control smart home devices, etc. At the same time, with the progress of the times, people continue to bring the experience of using intelligent products into the car, and the requirements for the interactive experience of the car are increasing, and the demand for automobile intelligence has become the research and development goal of various enterprises. For example, at the Tokyo Motor Show in October 2007, Nissan first launched the PIVO2, a miniature electric concept car equipped with an "Inbuilt robot companion", which preliminarily presented the prototype of in-car intelligent robot. In 2009, MITSENSEable City Lab and Volkswagen jointly developed the AIDA emotional intelligent driving assistant. In 2017, Toyota launched the in-car intelligent robot Kirobo Mini. In 2018, OEM from internet background in China, NIO, has applied the NOMI robot of the in-car AI (artificial
intelligence) system to a mass-produced car for the first time, upgrading from a simple robot to a partner and friend during driving. The transformation of roles at different levels has made the emotional distance between users and cars more closely, and also gives the technology more vitality.

At present, more intelligent assistants are still the results of careful design by engineers and designers with the help of technologies such as machine learning, natural language understanding, natural interaction recognition, and big data analysis [5]. If someone asks Siri and Cortana the same question, "Are you smart?", the result will be very different (Figure 1), and the difference is the result of what the designer intended. Therefore, from the initial stage of intelligent assistant development, we need to solve many design problems. However, while there have been studies on the technical aspects of implementing intelligence assistant and usability evaluation methods for completed systems, but there has not been much research on the design definition and methods of intelligent assistants.

![Figure 1. Different results between Siri and Cortana for the same question, "Are you smart?"]

In the design process, designers often need to define the role of the intelligent assistant, such as the personality and appearance of the virtual assistant that the user will be exposed to, and then map it to interaction details with the user and derive the expected user actions. Furthermore, experiments are needed to verify the usability and satisfaction of the design. In this process, compared with conventional interactive design, it is very difficult to design iteration based on rapid prototyping and testing, which is very important in the design process.

In this paper, we present a design method on how to define the personality and appearance of the intelligent assistant and optimized the appearance design through users and experts participations. Allow designers and engineers to explore possible design problems and solutions through user participation before they are ready to design a complex system, and verify the satisfaction of the design.
2. Method

2.1. Personality definition

2.1.1. General character definition. The definition of the personality of intelligent assistants is essential for human-machine interaction. It refers to the attribution of cognitive, emotional, and social human characteristics to intelligent assistants in order to humanize interactions with consumers. Such humane qualities prompt consumers to have more engaged interactions with intelligent assistants.

In general, as shown in Figure 2, we can define it from the three levels of psychology, perception, and utility, namely "Mate, Assistant, and Tool". From a psychological perspective, "Mate" means that it can help users to discover themselves, but don't impose values. It helps users explore and understand the world, rather than define it directly. Moreover, it helps users strengthen relationships with others and often express positive emotions. From the perspective of perception, the role of "Assistant" is good at removing complexity from life. It can actively interact with users, but it will not disturb them. Besides, its perception of the surrounding environment is extremely keen. From the perspective of utility, the intelligent assistant is more like a "Tool", which can react in real-time, calculate quickly, and give appropriate feedback that fits the context.

There is no doubt that the role of an intelligent mate will become an ideal interaction intermediary between humans and machines. It will transform a car from a travel tool into a travel partner of the user, integrate emotional factors with the physical function, and meet the user's psychological needs. At the same time, the emotional design expands the scope of interaction design, allowing the entire interaction process to present a more three-dimensional structure, and brings more possibilities to the relationship between human-machine.

2.1.2. MBTI model and application. In addition to defining the personality of the intelligent assistant broadly, it is necessary to define it with a personality model in more details. The most popular three personality models are Enneagram, DISC, and MBTI. Enneagram divide humans into nine interrelated non-psychological personality typologies. Each point of the star represents one type of personality, and there are some different connections among those types, representing the "sublimation" and "deterioration" of individuals. DISC is one of the behavioral assessment tools widely used around the world. Human behavior can be divided into four typical modes by their response and their cognitive interaction with the environment. Each of these four modes exists to varying degrees in each individual. MBTI is a theoretical model commonly used in personality or career assessment to measure the laws of people's psychological activities in obtaining information, making decisions, and treating life. Each person's inclination in the four dimensions is determined by their internal personality and external behavior.

While there are lots of similar models, the flexibility and near generic standards of the MBTI system makes it an effective tool [6]. The scale analyses personality into four dimensions: (i) the perspective of whether people tend to focus on the mental energy in the external world or the inner
world, (Extroversion, E) and (Introversion, I), (ii) the perspective of how people acquire information, the personality can be divided into the Sensational type (Sensing, S) and Intuitive type (Intuition, N), (iii) the perspective of how people handle information and make a decision, the personality can be divided into Rationality type (Thinking, T) and Emotion type (Feeling, F) and (iv) the perspective of how people treat the outside world, the personality can be divided into determining personality types (Judging, J) and perception-based (Perceiving, P) [7]. Each personality dimension has two different values, that are combined into 16 personality types. Everyone can be classified into one of the 16 types and the corresponding behavioral characteristics as shown in Table 1 [7].

| Result Type | Role       | Result Type | Role |
|--------------|------------|-------------|------|
| ENTJ         | Commander  | ENFJ        | Protagonist |
| ENTP         | Debater    | ENFP        | Campaigner |
| INTJ         | Architect  | INFJ        | Advocate |
| INTP         | Logician   | INFP        | Mediator |
| ISTJ         | Logician   | ISFP        | Adventurer |
| ESFJ         | Consul     | ESTP        | Entrepreneur |
| ISFJ         | Defender   | ISTP        | Virtuoso |
| ESTJ         | Executive  | ESFP        | Entertainer |

When defining the personality of the intelligent assistant, MBTI is most suitable. Because it can be used to measure the laws of people's psychological activities in obtaining information, making decisions, and treating life. Its assessment criteria are based on behavior, and the results describe both the inherent personality and the external performance. In the process of designing the intelligent assistant, we can make a clear and reliable setting of the personality tendency of the intelligent assistant through dialectical judgments on behavior and personality, and help to outline its behavior framework.

In addition to use the MBTI model defines the personality of intelligent assistant, it is vital to consider the brand's individual demands. Use the brand DNA to unify the human-machine interaction and the visual language of the user interface, and establish a family-oriented interactive experience system. Because of the more interactive experience with strong brand characteristics and family-style, the more identity of values can be generated, allowing users to have more emotional connections with the intelligent assistant.

![Brand tonality and general character definition](image)

**Figure 3.** Use the MBTI model to define the personality with brand tonality and general character definition
Therefore, when using the MBTI model to define the personality of the intelligent assistant, we also combined the brand tonality and general character definition to create a multi-dimensional intelligent partner that meets the expectations of users in the future (see Figure 3). Specifically, we need to define the corresponding qualities in the four dimensions, which are the source of energy, cognitive style, way of judgment, and life-style. For example, at the level of source of energy, we divide Extroversion and Introversion into 4 levels, namely E2, E1, I1, and I2. E2 means that intelligent assistants like to express themselves and share words casually; E1 is good at expressing but depends on occasion and users; I1 means that intelligent assistants prefer to listen rather than express opinions. I2 means that intelligent assistants are closed and restrained without saying a word. Considering the definition of "Mate" of intelligent assistants and the partial tonality of the brand (open, focus on context), E1 is parallel with the dimension of the source of energy. It is good at communicating and listening, and can always maintain a positive and optimistic attitude. It will be active when you need it and bring you wisdom and joy.

Finally, in this way, our personality type is established as ESFP, Performer, and Caregiver. Specifically, in terms of the source of energy, the intelligent assistant is good at communication and listening, and always have an optimistic attitude to convey warmth and vitality. It always shows up quickly, bring wisdom, freshness, and joy with users; in terms of cognitive style, the intelligent assistant is always integrated with the current environment or scene, being keenly aware of users’ emotional changes or new things, and analyzing them with strong cognitive logical thinking. Meanwhile, the intelligent assistant often learns in practice or in interaction with others, and digitalization and intelligence also allow the intelligent assistant to grow with users and keep up with the times. In terms of way of judgment, the intelligent assistant is very confident facing the problem. For users, the intelligent assistant has empathy and is a dependable partner. When making decisions, the intelligent assistant puts the emotion on top priority and tries to maintain a harmonious atmosphere. In terms of lifestyle, the intelligent assistant tends to get pleasure in action rather than spending time on making plans. When given an established plan, the intelligent assistant can always make adjustments according to the new situation. It has good time management skills and ensuring that users have a relaxed experience.

2.2. External appearance design.
In addition to defining the personality of the intelligent assistant through the MBTI model, we also gain insights from user research and benchmark to determine the design direction of external appearance of the intelligent assistant.

2.2.1. User research- Dos and Don'ts definition. In terms of external appearance definition, we had user research to determine the basic direction of the design. The focus of the research is on whether users want in-car digital AI assistant to have a specific image and their preferred form. As shown in Table 2, twenty-four subjects participated in the study, all were in their twenties and thirties. Their car brands are high-end (BMW, Audi, Mercedes-Benz), emerging brands (NIO, Weltmeister, Xiaopeng), local brands (Roewe, Geely, BYD), and mid-range brands (Volkswagen, Toyota, Nissan, Honda).

| Table 2. Basic information of the respondents. |
|-----------------------------------------------|
| Brand                          | Total | Age              |
| High-end brand                  | 6     | 90s×3, 80s×3     |
| The new emerging brand          | 6     | 90s×3, 80s×3     |
| Local brand                     | 6     | 90s×3, 80s×3     |
| Mid-end brand                   | 6     | 90s×3, 80s×3     |

The test results show that 75% of subjects want AI assistant to be human-like or materialized, making cars as their friends and interact with them. 50% of users like the appearance design of Nomi.
In conclusion, while users want to give the intelligent assistant a materialized image, they still want it to be simple and not very complicated.

2.2.2. Insights from benchmark. By investigating the external appearance design of the intelligent assistant in various fields of movies, animation, smart devices and vehicle systems, we summarize the following characteristics: in terms of visual features, the head or face as the main part, eyes and facial feature ratio are very important. In particular, too clear gender or age tendencies might cause more possibility of dislikes; at the brand level, a good design should be accord with the brands' image and personality, and symbolic design could be remembered and propagated easily.

2.2.3. External appearance design—Insights from brand and personality. Based on the above user research and benchmark, we combined with the brand characteristics and personality definition and gave the basic direction of the external appearance design: the intelligent assistant should have a round shape; the primary shape could be overlaid with the secondary shape; simple graphic could express emotions and actions more easily.

Next, we made different appearance design based on these design features and combined with the different emphasis of personality characteristics. While designing the appearance, we took into account the visual form of the intelligent assistant in different situations. All schemes are shown in the figure 4.

![Figure 4](image.png)

**Figure 4.** All the design schemes of intelligent assistants

For example, as shown in the Figure 5, when we designed the appearance of one of the intelligent assistants, we give it the symbolic meaning of water, because water is changeable and flexible, and have different forms fitting the context, focusing on different emotional expressions. Therefore, considering the different interaction states of the AI assistant, such as activated, static, and dormant, we combine the different forms of water to design the external appearance with richer emotions.

![Figure 5](image.png)

**Figure 5.** The intelligent assistant with symbolic meaning of water
3. Experiments

3.1. Preliminary evaluation experiment

Based on the above design proposals, we adopted two rounds of test to screen the final design scheme. In the first round of internal experiment, we asked subjects to rate the brand fitting and flexibility of the intelligent assistant on the Likert 5-point scale. The brand fitting measures whether the intelligent assistant meets the brand’s tonality in terms of personality and appearance. The flexibility focus on investigating participants to rate the emotion and action expression, extensibility of accessories, and extent of personalization on the Likert 5-point scale. Detailed evaluation indicators and scoring standards are shown in Table 3.

|                | Brand tonality ([1;5]) | Typical element ([1;5]) | Emotion & action express ([1;5]) | Extensibility of accessories ([1;5]) | Extent of personalization ([1;5]) |
|----------------|------------------------|-------------------------|----------------------------------|-------------------------------------|----------------------------------|
| Participants   | 6 internal designers, mainly are interaction designers, visual designers and user experience designers. |
| Results        | Overall, as shown in Figure 6, the design proposal E had a higher rating with an average of 4.11 points as the final proposal. Firstly, it is composed of basic graphics, with a dividing line in the middle that reflects our brand elements, which is simple and easy to remember and describe. Secondly, the magic ball and eyes on the body can better express expressions and actions, and the magic ball can detect emotions and express emotions based on the situation, allowing users to make personalized customization. As a whole, the intelligent assistant looks lively and not too serious. |

![Figure 6. The average score of each quality of intelligent assistants’ performance in first experiment](image)

3.2. Experts and user test

![Figure 7. The detailed schemes from the selected design](image)
We fine-tuned the details from the selected design, combined the appearance proportions, eye shapes, and accessory styles from different emphasis on personalities to design 6 schemes (see Figure 7). Experts and users were invited to choose the most suitable design. Symbolization and personality fitting were the main factors in this evaluation. In the survey, we measured the subjective perception of personality qualities perceived by users and experts in the source of energy, cognitive style, way of judgment, and life-style. Detailed evaluation indicators and scoring standards are shown in Table 4.

| Evaluation indicators and scoring standards |
|--------------------------------------------|
| **Extroversion/Introversion** (1:5) | **Sensing/Intuition** (1:5) | **Thinking/Feeling** (1:5) | **Judging/Perceiving** (1:5) | **Symbolic** (1:5) |
| 1-5 | 1-5 | 1-5 | 1-5 | 1-5 |

Results related to the experiment are presented (see Figure 8). Scheme A had a higher rating with an average of 4 points and had high compatibility in symbolization and personality. Although these schemes have a similar style, the different facial features, the proportion of dividing lines, and the form of accessories give users different feelings. To some extent, these feelings reflect the culture, region, and mode of thinking of users. However, from a design perspective, it is critical to integrate the personality of the intelligent assistant in appearance design and make it more effective in emotional communication with users. The reflection of brand tonality can also generate a sense of identity with values and produce more emotional sustenance.

![Figure 8](image-url)

**Figure 8.** The average score of each quality of intelligent assistants’ performance in second experiment

4. Conclusion

This research proposes the MBTI model to define the personality of the intelligent assistant, determine the appearance design characteristics through user interviews and surveys, and combine the personality traits to map the appearance of the intelligent assistant and interactive form. This design method allows designers and engineers to explore more precise design solutions and to improve the emotional design and user satisfaction of intelligent assistants before all the complex systems are ready to run.

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