

# When Optic Meet Haptic: Integrating Mid-Air Touch Controller in Online Retail

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## Abstract

Technological developments have penetrated almost all aspects, including the transformation of buying and selling activities. This development is felt to be increasingly significant since the COVID-19 pandemic, which requires everyone to limit direct interactions. This causes the e-commerce platform to become busy and more people use it. However, it is not uncommon for some buyers to feel unsure about the appearance of the product displayed, especially regarding the actual size of a product. This research tries to dig deeper into the influence of 2D and 3D displays combined with mid-air haptic technology on potential consumers' decision interest in purchasing a product. As part of our research, we conducted an experimental study on an e-commerce prototype. Subsequently, we followed up with interviews with the respondents to gather more insights and feedback. The results show that although using a mouse is more comfortable to use, there is a different user experience when using haptic technology in online shopping. The use of haptics also increases potential buyers' confidence in the goods.

**Keywords:** consumers' decision, e-commerce, mid-air haptic, 2D, 3D

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## I. INTRODUCTION

The transformation of traditional markets into online markets has become a significant phenomenon in the digital era. In the past, traditional markets served as the main venue for buying and selling, where buyers met sellers face-to-face to purchase products or services. However, with the advancement of internet technology and the adoption of e-commerce platforms, online markets have revolutionized the way people shop. Now, consumers can access a wide range of products and services from all over the world with just a few clicks. The advantages of online markets include easy accessibility, the convenience of shopping from home, and a wider selection of products. Although traditional markets still play a vital role in daily life, the growth of online markets offers incredible potential to provide more efficient and beneficial shopping experiences for both consumers and sellers [1]. The shift in consumer behavior from offline to online shopping has become a significant trend in the digital era. With the advancement of technology and the convenience of online shopping, consumers are increasingly transitioning from buying products directly in physical stores to using e-commerce platforms to meet their needs. This change is influenced by various factors, such as convenience shopping from home, easier accessibility to a wide range of products, and the ability to quickly compare prices. This phenomenon has significantly impacted the retail industry and has influenced marketing strategies and customer experiences [2], [3].

Several factors drive people to shop online, including performance expectancy, effort expectancy, social influence, habit, facilitation conditions, hedonic motivation, and trust. However, some individuals remain hesitant about online shopping due to concerns such as privacy, switching costs, perceived risks, and technology fear [4]. Online shopping involves inherent risks as consumers cannot physically evaluate the products. The inability to touch products is a fundamental drawback of online shopping because humans typically use the sense of touch to evaluate the functionality of utilitarian products and to experience hedonic sensory pleasures, both instrumental and autotelic needs to capture touch experiences [5]. In Indonesia, uncertainty risks in E-commerce occur due to several factors, such as discrepancies in product descriptions and inaccurate product evaluations from other consumers [6], [7]. These factors lead to consumer scepticism when purchasing products through E-commerce platforms. To address these concerns and enhance the interaction between buyers and online retail platforms, innovative solutions are needed to improve the virtual product experience [8]. Virtual product experience can be defined as an interaction where potential buyers learn about products through touch, swipe, or navigate to find relevant information about the products [9].

To facilitate this, tools are required to help consumers experience, try, or even evaluate products like physical shopping. This need is supported by the growing trend of seamless transactions in online shopping today. The ability to virtually touch products can facilitate consumer evaluations of products in E-commerce. Research conducted using Mid-air Haptic has shown that consumers can be assisted in decision-making and influenced when buying products online [10]. However, previous studies have focused on specific types of products, and there is a research gap regarding the investigation of the effects of touch on the perceived risk of various products in E-commerce [11].

Previous research on product evaluations has not investigated the touch effect on product risk [12]. Such an investigation is necessary because each product may have different risk factors when purchased from an online retail platform. For example, someone buying electronics online may face higher risk factors compared to other products [13].

In this research, we try to answer this research gap to expand insight and additional knowledge about haptic evaluation in sensory marketing experiences. Therefore, we developed the following question: ***What is the effect of implementing Mid-Air Haptic technology and product displays (2D and 3D) on buyers' online shopping decisions for several categories of goods on online retail platforms?*** The limitation of this research is that the online retail platform was developed in the form of a prototype by disguising the brand name of an existing online retail. This aims to avoid bias effects from the respondent's experience. The respondents had an age range of 18-35 years, according to statistical data on online retail users in Indonesia, about 71%. The next limitation is that this research will focus on 2D and 3D product displays in online retail prototypes. Meanwhile, the tool used for Mid-Air Haptic is Ultra Leap Motion.

The structure of this article will be structured as follows, the first will discuss the background of the problem, the second will present literature that is relevant to this case, the third is the research method we apply, the fourth will be the results and discussion and the last will be the conclusions of this research.

## II. LITERATURE REVIEW

### A. Virtual Product Experience

Virtual Product Experience (VPE) enables prospective customers to virtually view, feel, touch, or test products using a computer or other devices [14], [15]. The implementation of VPE can be divided into two components: visual control and functional control. Visual control allows potential buyers to examine products from various angles and distances. Buyers can manipulate product images by zooming in/out and rotating them in all directions using a controller, thus gaining a comprehensive overview of the product they intend to buy. In contrast, functional control allows buyers to explore the functionalities and features of a product. For example, if a buyer is interested in purchasing an electronic product, using the functional control feature will present the item according to its actual functions [15].

Visual and functional control can collectively be referred to as virtual control. However, not all product categories are suitable for this method, such as cereals or products with intricate details. As a result, buyers can assess the suitability of the products they intend to purchase [16].

### B. Interaction Design

Interaction design is an essential component of User Experience (UX) design. In simple terms, it refers to the design of the interaction between users and software products, such as applications or websites. The goal of interaction design is to create products that allow users to achieve their goals in the best possible way.

Below are the 5-dimensional models included in interaction design:

- **1D Words:** Words are commonly encountered components that provide information to users. Words are designed to be as simple and clear as possible, making it easy for users to understand at a glance. Providing too much information can overwhelm users.
- **2D Visual Representation:** Visual representation refers to the use of graphic elements such as icons, images, and typography to enhance user interaction. This dimension often reinforces the information provided through words.
- **3D Physical objects or space:** This dimension focuses more on the methods of user interaction with the product. For example, through a laptop with a touchpad or a mouse, or using a smartphone with touch gestures. It also considers the physical space in which users interact with the product.
- **4D Time:** Time is a consideration to understand how long users interact with the product. Does it take a long time for users to understand the product, or can they grasp its purpose quickly?
- **5D Behavior:** This dimension is related to the emotional responses and reactions of users to the product.

### C. *Mid-Air Haptic and Haptic Perception*

Mid-air haptic technology refers to a form of haptic feedback that allows users to experience tactile sensations and interactions in mid-air without the need for physical contact with an object or device. It utilizes various techniques to create the perception of touch and force feedback in virtual or augmented reality environments [17].

Mid-air haptic technology employs different principles to deliver haptic sensations. One common approach involves the use of ultrasound or acoustic waves to create pressure waves in the air that can be felt by the user's skin [17]. These waves can simulate the sensation of touching a physical object or provide feedback based on user interactions in a virtual environment [18], [19]. Another technique used in Mid-Air Haptic technology is the manipulation of air currents or airflow. By creating localized air disturbances or controlling airflows, it is possible to generate haptic sensations that mimic the sensation of touching or interacting with virtual objects [20].

Mid-air haptic technology has various applications across different fields. Virtual reality can enhance the immersion and realism of virtual experiences by providing haptic feedback during interactions with virtual objects. It has potential applications in gaming, training simulations, remote collaboration, and medical simulations [21]. One advantage of Mid-Air Haptic technology is its non-contact nature, which allows for more freedom of movement and interaction compared to traditional haptic systems that require physical contact. However, there are still challenges to overcome, such as limitations in the precision and accuracy of haptic feedback and the need for further advancements in hardware and software technologies [17], [18].

The aim of this research is to investigate how haptic sensors, which provide feedback and control, affect consumer behaviour when evaluating products in online retail. The study employs the innovative Mid-Air haptic controller illustrated in Fig. 1. Placed beneath the user's hand movements on the table, this controller captures every gesture with greater precision. By utilizing this pioneering technology, users can experience a more lifelike sensation when interacting with desired products, as though they were physically touching and examining them.



Gambar 1. Mid-Air Haptic Technology

### D. *Mid-Air Haptic and Haptic Perception*

Consumer reaction to a product in e-commerce is a crucial aspect that influences sales success and brand reputation. Consumer reactions can encompass various elements, ranging from product reviews and ratings to social media comments and interactions with the brand [22]. Research shows that product reviews from

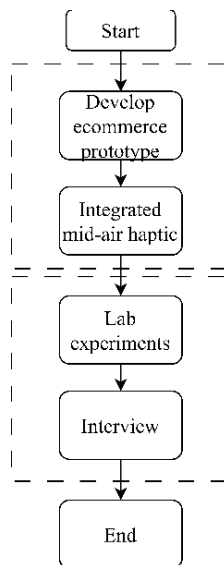
other users have a significant impact on consumer purchase decisions, as many consumers tend to rely on others' experiences before deciding to buy a particular product. Additionally, consumer responses to service quality, product delivery, and the overall shopping experience on the e-commerce platform can also influence the overall impression received by consumers about the brand and the product [23]. Therefore, understanding and appropriately responding to consumer reactions to products in e-commerce are essential for companies to enhance customer satisfaction and build trust in their brands.

### III. RESEARCH METHODOLOGY

In this study, we created a prototype of an e-commerce platform for experimentation by integrating mid-air haptic technology using ultra leap motion. The aim of this study was to assess the extent of the influence of mid-air haptic on the interest and decision-making of potential buyers when purchasing a product. The prototype showcased various items, including laptops, Rubik's cubes, pencils, and soda beverages.

#### A. Experimental Procedure

The experiment was conducted using different methods, namely, trials with 2D and 3D products using a mouse, followed by the replacement of the mouse with ultra-leap motion technology. Subsequently, the researchers interviewed the participants to obtain insights into their experiences and confidence regarding the details of a product they intended to purchase.



Gambar 2. Research Methodology

The experiment will be conducted with a within-subject randomized experiment design illustrated in Fig. 2. The experiment conducted in a lab setting for piloting experiment. The following procedures will be undertaken:

1. Respondents who have registered will be contacted by the research team to schedule data collection.
2. During data collection, respondents will be asked to provide voluntary consent to participate in the research activities.
3. The research team will randomly divide the participants into four treatment groups: (1) 2D and no haptics (control group); (2) 2D and haptics; (3) 3D and no haptics; (4) 3D and haptics.
4. Respondents will be presented with various types of products. The order of product presentation will be randomized to avoid bias caused by the sequence of product display.
5. For each product type, respondents will be asked to perform evaluations. Afterward, they will be given an online questionnaire to complete. To ensure that the questionnaire provided does not confuse participants, the research team will conduct a pretest. Additionally, to ensure that the manipulations used can be understood by participants, the research team will perform a manipulation check.

Furthermore, the research team will also gather other relevant data, including the frequency of online shopping in the last 3 months, the average expenditure for online shopping, and other recent data related to

participants' habits in online shopping. Questions are organized by ease and confidence in using e-commerce [24]. We aim to understand how individuals convince themselves to purchase an item. There are several questions that we will also present in data collection in iterations 1 and 2 as shown in the following table I.

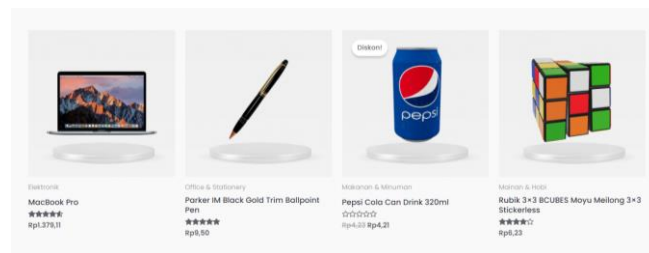
No	Questions
1	Do you feel that 2D images help you make better product choices compared to written descriptions?
2	How confident are you in your decision to purchase a product when it is presented in 2D form?
3	How confident are you in your decision to shop for the product when it is displayed in 3D form?
4	How clear and detailed are the 3D images provided on the e-commerce platform?
5	With the presence of 3D visuals, do you still find written product descriptions necessary for product evaluation?
6	Do you feel that 3D images provide a more satisfying shopping experience compared to e-commerce platforms with 2D images?
7	What is the level of comfort and ease of use of the mouse in navigating through products on the e-commerce site?

#### IV. FINDING AND DISCUSSION

The presentation of results should be simple and straightforward. This section reports the most important findings, including results of statistical analysis as appropriate and comparisons to other research results [7], [9]. Results given in figures should not be repeated in tables. This is where Authors should explain in words what he/she/they discovered in the research. It should be clearly laid out and in a logical sequence. This section should be supported suitable references.

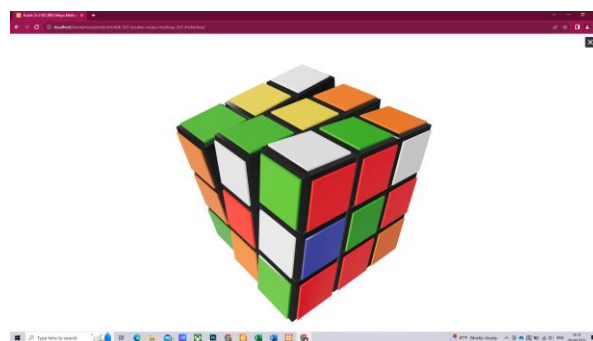
##### A. E-commerce Prototype

We have created an e-commerce display prototype that displays several items such as ballpoints, laptops, canned beverage products, and rubric games (figure 3). These products consist of different segments, from the luxury segment to daily necessities. With these products, we want to know how confident people are in buying goods in certain segments through e-commerce and who influences this. Product displays are divided into 2 categories, namely in 2D and 3D. The aim of the difference in appearance is to find out how much influence it has on potential consumers' decision making in purchasing an item.



Gambar 3. Prototype E-commerce

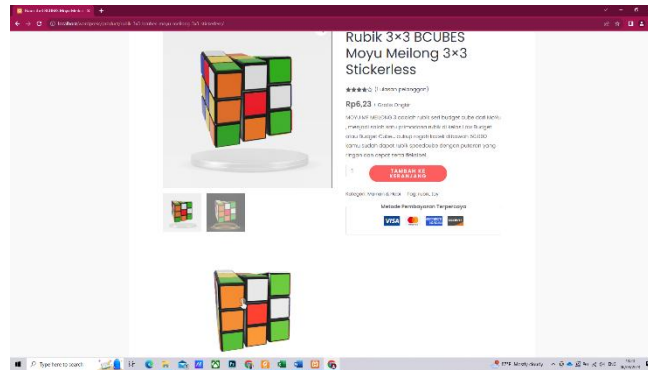
The display in Figure 3 is also in 2D form, whereas to see the 3D display you can enter first by selecting one of the products.



Gambar 4. Product in 3D model

Figure 4 exemplifies one of the 3D displays for rubric game items. Prospective buyers can zoom in, zoom out, rotate 360° so they can feel as if they are holding the product. The 3D image is located below the 2D

image so that potential buyers can choose to see product details in both 2D, and 3D form. Both 2D and 3D displays can be viewed in detail using a touchpad, mouse, or mid-air haptic device.



Gambar 5. 2D and 3D options

### B. Collecting Respondent Data

Data collection was conducted four times, using the four scenarios previously described. The treatment was administered randomly to three participants, each with different academic backgrounds, selected from among students.

As an experiment, we took 3 respondents (R1, R2, R3) with different backgrounds. The respondents are familiar with using e-commerce to carry out goods purchasing transactions. R1 said that it was quite rare to use e-commerce, around once every 2-3 months. However, R2 and R3 are quite frequent with an intensity of  $\leq 3$  times a week. R1 and R3 said they liked shopping using e-commerce because it was more complete, had a wide variety of choices of goods, and lots of promotions, making goods cheaper. However, slightly different from the other 2 respondents, R2 said that they prefer to shop offline, especially for items that can be found every day. The use of e-commerce by respondent R2 is used to look for items that are really needed but are not available online.

Next, we dig deeper to find out and see the habits of respondents in making purchase transactions in e-commerce. Before starting the experiment, we asked questions like: "What do you do when you are going to buy an item from an online market?"

R1 replied that before deciding to buy, usually look at the reviews first. When buying an item, I will look at the product in more detail by paying attention to the description, rating, price, and reviews. Almost the same expression was also made by R2 and R3. According to respondents, having detailed product images will help potential buyers imagine a real product image when they receive the goods later.

### C. Experimental with Touchpad and/or Mouse

In the first experiment, carry out a scenario of buying goods in an e-commerce using 2D images without haptics (using a mouse and/or touchpad). In this experiment, respondents purchased goods on an e-commerce prototype. The scenario for buying an item is to start by looking at the item in e-commerce and then carrying out the "add to cart" activity.

The next process is to conduct interviews with respondents, using questions 1 and 2 in Table I. During the interviews, all respondents expressed that they were initially drawn to an item due to its visual appearance before they read its detailed description. However, since the 2D image shown does not provide enough detail from multiple angles, respondents require a thorough reading of reviews and descriptions to make a purchase decision.

During the second experiment, a purchasing scenario was carried out by utilizing 3D images in conjunction with a mousepad and/or touchpad. While the scenario itself remained unchanged, supplementary 3D images were introduced.

Following the experiment, R1 conveyed that R1 felt more confident when inspecting products, particularly those of a higher value. This could be attributed to the fact that the 3D images afforded a more comprehensive look at the items. Additionally, the ability to manipulate the images according to their preference cultivated a sense of inquisitiveness and contentment. R3 has added haptic feedback, making it feel like objects can be touched even when using a mousepad or touchpad.

All respondents indicated that they prefer to use a mouse instead of a touchpad when conducting experiments. Interaction is faster and easier, especially when experimenting with 3D images.

#### D. Experimental with Touchpad and/or Mouse

The next step in the process involves integrating a prototype e-commerce website with Mid Air Haptic, which allows for the display of both 2D and 3D images. Prior to gathering data using Mid Air Haptic, a simulation is conducted to familiarize users with the tool. Most respondents were new to using Mid Air Haptic, and although they faced some difficulties due to lack of familiarity, they exhibited enthusiasm towards the new technology.

Some of the challenges experienced by respondents included (1) the tool's lack of sensitivity and occasional misses, (2) difficulty in clicking on small buttons or icons, and (3) difficulty in reaching buttons located in the corners.

In sharing their experiences and opinions while using haptics, respondents had the following to say:

R1: "It can be overwhelming, as clicking on one item can become complicated."

R2: "It's great for scrolling or viewing 3D images, as it creates a more realistic experience. The hand movements make it feel like you're holding it in real life."

R3: "Using haptics is enjoyable and makes the experience feel more modern."

#### E. Experimental Result

Based on this data in Table II, using Mid-Air Haptic tends to take longer because respondents are not used to using a touchpad or mouse. The use of haptic technology is usually used in the simulation sector and arts [25], [26]. However, the responses given by respondents were very interesting regarding the application of Mid-Air Haptic in the online market. The three respondents stated that when using a touchpad or mouse, they were used to it and had no difficulties at all. They tend to prefer using the mouse directly because it is very easy to operate and place the cursor on the object precisely. However, using a mouse or touchpad does not provide a different experience.

R	Time		
	Touchpad	Mouse	Mid-Air Haptic
R1	10'29"	3'57"	11'58"
R2	3'26"	3'20"	6'53"
R3	6'58"	9'3"	20'52"

This paper discusses a pilot experiment conducted in a lab setting. It is important to note that the results cannot be generalized. The experiment aimed to test the integration of Mid Air Haptic with an e-commerce platform. Feedback from respondents during interviews and observations led to slight changes in the application prototype. For instance, the buttons were made larger as respondents had difficulty accessing them due to their small size.

#### F. 2D and 3D Products Display in Online Market

The use of product displays in 2D has become commonplace in online markets. The purpose of the product display is so that buyers get an idea of the product they are going to buy. The 2D shape that is common in online markets does not add to the user's experience when shopping and does not give a special impression of the item. This is one of the causes of potential buyers being unsure about the original form of the goods [6], [8].

Referring to research conducted by [27], [28] regarding the use of the 3D concept in online retail, we tried to combine it with the free touch concept by using Mid-Air Haptic technology. The 3D appearance of the image gives the buyer a more realistic perception of the item, as they can see the shape from all sides in a 360-degree environment.

## V. CONCLUSION

This research delves into the efficacy of implementing Mid Air Haptic technology in online retail. The technology supplants traditional mouse or touchpad navigation for purchasing items on an e-commerce platform. In the pilot experiment, indicate that although the use of a mouse is more comfortable, there is a different user experience when employing haptic technology for online shopping. The study is centered around gauging a person's purchasing inclination when using various methods: mouse, touchpad, and Mid Air Haptic. The findings indicate that e-commerce businesses can increase customer engagement by presenting 3D renderings of their products. Mid Air Haptic technology offers an unparalleled shopping

experience by emulating the tactile sensation of interacting with a product. Future research can focus on finding solutions to the challenges that arise with integrating haptic technology into e-commerce design.

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