1. PROBLEM STATEMENT

1.1. Need Statement

According to Kela et al., 76% of people prefer to use gestures over speech when controlling their devices [1]. In today's society, smart home devices are prevalent in homes and businesses. As reported by Statista, 43.8% of households in the US have smart home devices and is expected to rise to 75.1% by 2028 [2]. There are a few companies like Amazon and Google that offer control over smart home devices using voice commands, but no company has invented a gesture-based smart home system. Gesture-based smart home systems could be beneficial to many people, including users with speech disabilities, accents, and those who prefer a quiet household.

1.2. Objective Statement

Gestura is the only smart home product that is controlled by gestures. All other smart home systems are controlled by smartphones. Gestura links most smart home devices through a central control module and tracks hand gestures via cameras placed throughout a residential or commercial site. Gestura uses a preloaded gesture library offering a seamless experience for the user.

1.3. Background and Related Work

As smart home systems have developed over the years, voice recognition has become the most widespread smart home control type. In 2019, a study conducted by Amazon reported 70% of the market share was dominated by their Alexa/Echo devices [3]. The Gestura system is the only gesture-based smart home system available on the market today

2. DESIGN REQUIREMENT SPECIFICATIONS

2.1 Requirements

The design team set strict marketing and engineering requirements to ensure ease of use and reliability of the system as a whole. The system accurately tracks gestures and operates efficiently. It is compatible with most smart home devices and suitable for the average home environment.
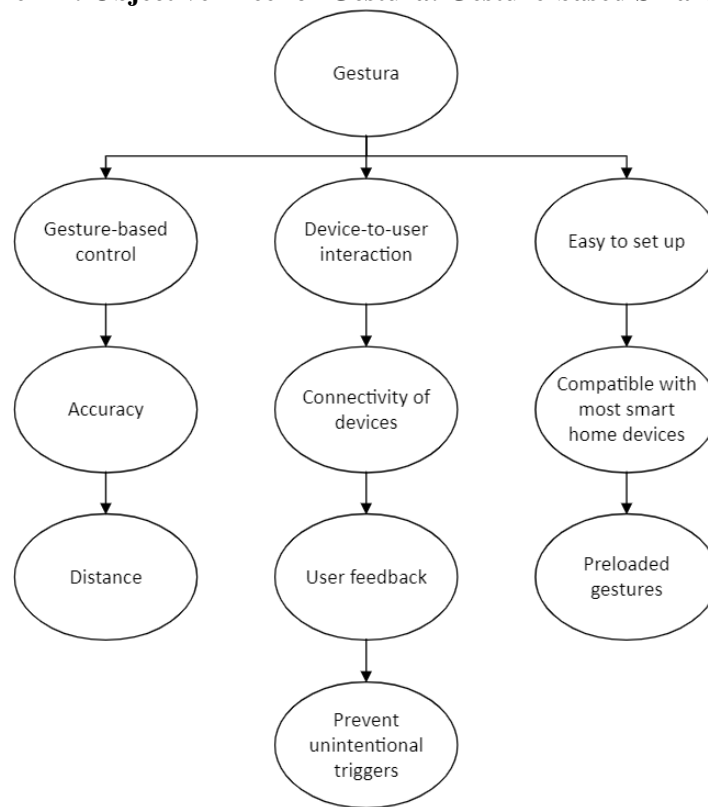
2.1.1 Marketing Requirements

The marketing requirements are as follows:
1. Gestura allows the user to control their smart home devices via hand gestures.
2. Gestura is easy to install.
3. Gestura reads gestures accurately within 10 feet.
4. Gestura is compatible with most smart home devices.
5. Gestura is suitable in any home environment.
6. Gestura provides user feedback, indicating whether a gesture has been recognized or not.
7. Gestura minimizes the chance of unintentional inputs to the smart home device.

Figure 2-1 shows an objective tree that aligns to the listed requirements above.

Figure 2-1: Objective Tree for Gestura: Gesture-based Smart Home

In summary, Gestura is designed to maximize user convenience, providing effortless control of the smart home using hand gestures. These marketing requirements not only highlight its user-friendly design but also form the foundation of the engineering requirements.

2.1.2 Engineering Requirements

Gestura's engineering requirements are set to enhance the marketing requirements providing performance and technical specifications all in one table. Table 2-2 is an in-depth look at the team's requirements and a description of why they are needed.

Table 2-2: Engineering Requirements

Marketing Requirements	Engineering Requirements	Description
1, 3, 6, 7	The camera is high resolution.	To be able recognize a hand gesture at 10 ft the video needs to be high quality.
2, 5	The device is USB-C powered.	The device is not complicated to plug in and needs enough power.
2, 4	The device takes less than 2 minutes to set up.	Competitors demonstrate that 2 minutes to power and connect to WI-FI is a reasonable time [4].
1, 2, 4, 6	The device is Bluetooth and Wi-Fi compatible to control the main brands of smart homes.	Most smart home devices connect through Bluetooth and Wi-Fi.
2, 5	The dimensions of the device are less than 5in x 4in x 4in	The device is compact, thus ensuring that it is easy to set up and place.

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The design team's engineering requirements prioritize ensuring ease of use and reliability. This device will run smoothly and easily connect to other devices (lights, thermostats, TVs, and so forth).

The device will be USB-C powered, which guarantees an easy plug-in and a reliable power supply. This ensures a set up time of less than 2 minutes. The small footprint of the device allows for easy setting and minimal footprint. The devices WI-FI and Bluetooth capabilities allow for seamless communication between the cameras placed throughout a household. The high-resolution cameras with its 10-foot range make certain that 72% of the average living room is covered and able to accurately recognize gestures [5].

2.2 Constraints
The constraints outline the requirements for Gestura. The constraints are the limitations for the design of the product. These constraints include economics, safety, hardware, and accuracy. Gestura meets all the constraints shown in table 2.2.

Table 2.2: Constraints

Type	Name	Description
Economic	Cost	The budget for the project is $1000 provided by the Electrical and Computer Engineering Department at Mississippi State University.
Economics	Time	The prototype is functional within two semesters.
Safety	Parental Controls	Parental controls ensure that children cannot control the device without parent's consent.
Hardware	Power	A USB C-port cable is used to power the device from a standard 120V wall outlet. Many smart home devices are powered via USB-C.
Accuracy	Distance	The device accurately recognizes the gestures within the dimensions of an average sized U.S. home.

The budget for the Gestura product is $1000. The product also needs to be affordable to customers. Gestura needs to be completed and functionally working within two semesters. Parental controls are paramount for the safe use of the device, which is an expectation of the customer. Using a C-port cable to power the device is ideal as it is the primary power cord of many electronic devices. Accuracy ensures that the user can perform gestures within most of the room where a camera is positioned. Ideally, gestures are recognized within 10 feet of the device.

2.3 Standards
The design team ensures that the standards below are followed for this product. The standards will protect the consumer and help the product run more reliably.

Table 2.3: Engineering Standards

Specific Standard	Standard document	Specification / application
USB 3.0	Universal Serial Bus Revision 3.0 specification	This is the standard that defines the capabilities and characteristics of the USB advanced technology. This is used to power the control module.
Bluetooth 5.0	Bluetooth Core Specification Version 5.0	This is a series of standards used to define the capabilities and features of wireless communication. It is used for wireless connectivity between the control module and the cameras to transfer data.
802.11ac Wireless	Institute of Electrical and Electronics Engineers (IEEE) standard for WI-FI	This standard builds upon the foundation of the original WI-FI standards. It provides faster and more reliable communication. This is used for the control module to communicate with smart home devices.
2802	Underwriters Laboratories (UL)	Standard for testing the performance of a camera's image quality by performing various tests and giving a performance score to different cameras.
29119-3	International Organization for Standardization (ISO)/International Electrotechnical Commision (IEC)/IEEE	Software test documentation standard for software testing by keeping various documents to track progress and results while performing tests.

The above table describes the various standards that are utilized for documenting, testing, and the components used in manufacturing the product and the manufacturing process.

2.4 References

[1] J. Kela et al., "Accelerometer-based gesture control for a design environment - personal and ubiquitous computing," SpringerLink, https://link.springer.com/article/10.1007/s00779-005-0033-8#citeas (accessed Sep. 29, 2023).

[2] "Smart home - United States: Statista market forecast," Statista, https://www.statista.com/outlook/dmo/smart-home/united-states (accessed Sep. 29, 2023).

[3] "Intriguing Amazon Alexa Statistics You Need to Know in 2023," Safeatlast, https://safeatlast.co/blog/amazon-alexa-statistics/#gref (accessed Sep. 29, 2023).

[4] "Set up Alexa in a Few Easy Steps," Amazon, https://www.amazon.com/alexa-setup-guide/b?ie=UTF8&node=17978645011#:~:text=In%20about%20a%20minute%2C%20the,and%20Alexa%20will%20greet%20you (accessed Sep. 29, 2023).

[5] "Average Living Room Size And How To Make Yours Look Larger," Homedit, https://www.homedit.com/average-living-room-size/#:~:text=A%2012%20x%2018%20ft,need%20a%20larger%20living%20room (accessed Sep. 29, 2023)