## 2. DESIGN REQUIREMENT SPECIFICATIONS

Ison is designed to improve the lives of users with visual impairments. Ison glasses integrate into the user's life by providing comfort and utility for everyday use while maintaining a discreet appearance. This product features a camera that detects text and speakers that read this text to the user. The camera image data is sent to a connected smartphone which performs the text to speech conversion, and then the audio data is sent to the speakers to be read aloud. This document is divided into three major sections explaining the design requirements, constraints, and standards of the Ison glasses.

### 2.1. Design Requirements

The product adheres to specific marketing and engineering design requirements. These requirements set guidelines for the functionality of the product and its integration within society. The marketing requirements explain the project's goals from the perspective of the user. In contrast, the engineering requirements are the descriptions of the technical specifications needed to implement these marketing requirements.

#### 2.1.1. Marketing Requirements

Ison's marketing requirements outline the project's objectives from the user's standpoint. The list below describes the specific marketing requirements in order from most general to most specific. Figure 2-1 shows a more detailed visual layout of the marketing requirements.

1. Ison is comfortable and discreet.
2. Ison is easy to use.
3. Ison is rechargeable and works for at least eight hours.
4. Ison detects physical text in different fonts and languages.
5. Ison converts text to audio.
6. Ison's companion app allows the user to change the output volume and language.
7. Ison accurately reads text to the user within five seconds.

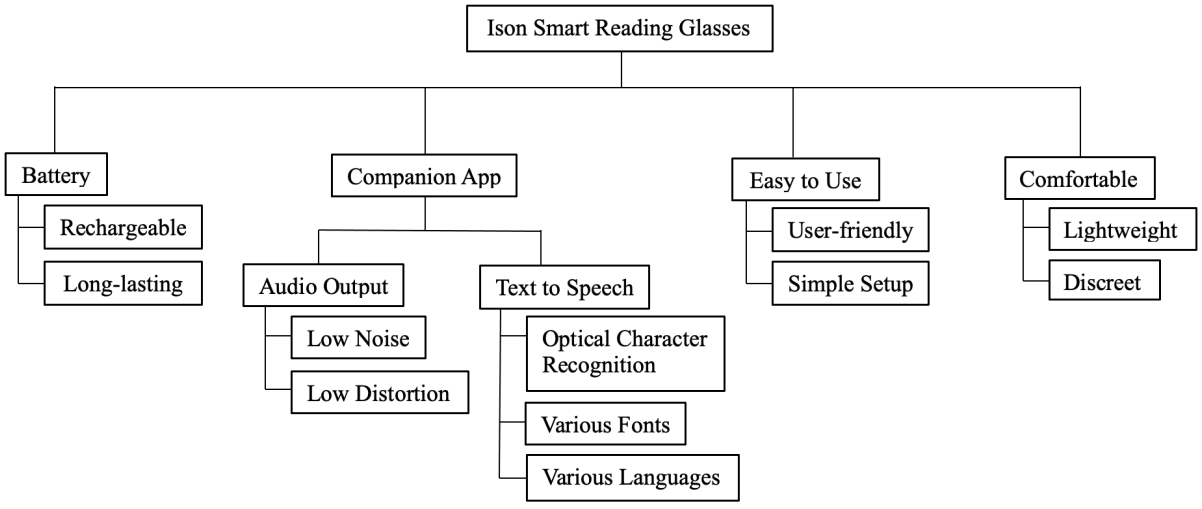


**Figure 2-1. Objective Tree for Ison Glasses**

Figure 2-1 displays Ison's marketing requirements in more detail. These marketing requirements reflect the user's needs which influences the technical design and requirements of Ison.

### 2.1.2. Engineering Requirements

Ison's engineering requirements satisfy the user's needs through the implementation of technical specifications. Table 2-1 shows the engineering design requirements and the marketing requirements that they fulfill as well as justification for each engineering requirement.

**Table 2-1: Engineering Design Requirements**

| Marketing Requirements | Engineering Requirements | Justification |
|---|---|---|
| 1 | Ison weighs less than 100 grams. | Typical glasses weigh approximately 25-50 grams [1], Ison glasses will weigh slightly more to account for the additional technology. |
| 2 | The average set-up time for the companion app is no more than 5 minutes and uses audio to instruct the user through the set-up process. | The companion app must be easy to set up for people with visual impairments. |
| 3 | Ison has a USB-C charging system and a rechargeable battery capable of continuous operation for up to 8 hours. | An 8-hour battery life allows operation for a standard work day. USB-C supports fast charging and shares a cable type with other devices, such as cell phones and wireless headphones. |
| 4, 5 | Ison's camera captures grayscale images in 1920 x 1080 resolution. | Mono cameras are easier to operate, and grayscale images are less complex and easier to process [2]. |
| 5, 7 | Ison recognizes text in various fonts through the smartphone application with at least 95% accuracy. | Artificial intelligence is used in the smartphone application for image processing. It detects text in different fonts and at various angles [3]. |
| 6 | Ison converts text to speech audio to output through the smartphone application to the user within a range of 60 - 90 dB [4]. | Since users with visual disabilities can not read text, Ison reads to users. |

**Marketing Requirements:**

1. Ison is comfortable and discreet.
2. Ison is easy to use.
3. Ison is rechargeable and works for at least eight hours.
4. Ison detects physical text in different fonts and languages.
5. Ison converts text to audio.
6. Ison's companion app allows users to change the output volume and language.
7. Ison accurately reads text to the user within five seconds.

Ison glasses capture images through the camera built into the glasses, and a Bluetooth module sends these images to the smartphone application. The pairing of the bluetooth module and the smartphone is simple and efficient to avoid frustration for the user. The application uses artificial intelligence to extract text from the images, as it can be trained to detect text similar to how humans read. The application then converts the text to audio and uses the Bluetooth module to send the audio data to the built-in speakers on the glasses. The glasses require a built-in rechargeable battery to operate, and USB-C charging systems are becoming more common in electronics [5]. To increase accessibility, USB-C is used as the charging system as many electronics use them today.

### 2.2. Constraints

Ison is designed to assist people who are visually handicapped in their everyday lives, but various factors influence the path to achieving this goal. Ison's design is affected by constraints that are both self-imposed and imposed by others. Self-imposed constraints are put in place by the design team to ensure the final product functions as efficiently as it can. Constraints imposed by others are limitations set by stakeholders, like economic factors that affect the time and cost it takes to design Ison. Table 2-2 shows these constraints in more detail.

**Table 2-2: Constraints**

| Type | Name | Description |
|---|---|---|
| Reliability | Durability | Ison glasses can withstand normal wear and tear over time and drops from 5'8" – the average height in the USA [6]. |
| Reliability | Battery life | Ison holds a charge for at least eight hours. |
| Manufacturability | Weight / Size | Ison glasses have an internal frame width under 125 mm, a temple length of 125 to 130 mm, and weigh less than 100 grams. |
| Economic | Cost | The design team has a budget of $1,000 to build Ison. |
| Economic | Time | The design team has nine months to design and build Ison, with complete subsystems done by April 2024 and a fully integrated system by November 2024. |
| Usability | Wireless Communication | Ison transfers data via Bluetooth to a mobile device. |
| Usability | Application | Ison's companion smartphone application is supported on Android mobile devices. |

One constraint is durability, as the glasses should be able to withstand small drops and normal wear and tear without breaking and requiring replacement. Another constraint is weight and size; the glasses should be light enough and small enough that the user can wear them all day without becoming uncomfortable. A major constraint is battery life. Users likely want to wear the glasses almost all day, so the glasses need to have a battery life that allows them to operate for the majority of the day. An economic constraint is cost, as the total project cost can not exceed one thousand dollars. Another economic constraint is time, as the project must be completed within the designated time frame. Finally, the project utilizes Bluetooth to send data to an application on an Android device. The data processing is done on the app. This allows the

glasses to avoid having processors on them, which means they weigh less. Android devices are used because Android is an open-source operating system, which allows more customization [7].

### 2.3. Standards

Ison adheres to the following Institute of Electrical and Electronics Engineers (IEEE) and Bluetooth Special Interest Group (SIG) standards to ensure safe and optimal operation for consumer use and to maintain interoperability and extensibility.

**Table 2-3: Engineering Standards**

| Specific Standard | Standard Document | Specification / Application |
|---|---|---|
| IEEE 1621-2004 [8] | The device follows the IEEE standard for consumer electronics. | Ison manages the user interface of the power status control to ensure a common interface between different devices. |
| Bluetooth Core Specification v5.3 [9] | The device follows the protocols outlined for Bluetooth communication by the Bluetooth SIG. | Ison properly implements Bluetooth to transmit data to a mobile device for processing and to receive audio data from this device. |
| IEEE 360-2022 [10] | The device follows the IEEE standard for the architecture of wearable devices. | Ison follows safety standards for wearables regarding temperatures, materials, electromagnetic radiation, and environmental factors. |

These standards influence the design methodology for Ison. By adhering to them, the Ison design team ensures interoperability for wireless communication between devices as well as upholding the safest and most reliable practices for handling power in consumer electronic devices.

### 2.4. References


[1] "Ultra-Light Glasses Frames," Glasses.com, https://www.glasses.com/gl-us/ultra-light-glasses-frames [Accessed: March 5, 2024].

[2] “Why to use Grayscale Conversion during Image Processing?,” *www.isahit.com*. https://www.isahit.com/blog/why-to-use-grayscale-conversion-during-image-processing.

[3] M. Akarsu, “Optical Character Recognition,” *GitHub*, Jul. 25, 2023. https://github.com/mftnakrsu/Comparison-of-OCR.

[4] J. Naples, MD, “Healthy headphone use: How loud and how long?,” *Harvard Health Blog*, Jul. 22, 2020. https://www.health.harvard.edu/blog/healthy-headphone-use-how-loud-and-how-long-2020072220565.

[5] "USB-C: More Than Just Data, Fast Charging Too," Mouser Electronics, Available: https://www.mouser.com/blog/usb-c-data-fast-charging [Accessed: March 5, 2024].

[6] CDC, “FastStats - Body Measurements,” *Centers for Disease Control and Prevention*, Sep. 10, 2021. https://www.cdc.gov/nchs/fastats/body-measurements.htm [Accessed: March 18, 2024.

[7] “Android vs iOS App Development: What’s the Major Difference?,” *www.turing.com*. https://www.turing.com/resources/mobile-app-development.

[8] "IEEE Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments," in IEEE Std 1621-2004 , vol., no., pp.1-18, 8 June 2005, doi: 10.1109/IEEESTD.2005.96205.

[9] "Bluetooth Core Specification Version 5.3," *Bluetooth Core Specification*. Bluetooth SIG, 13 July 2021. https://www.bluetooth.com/specifications/specs/core-specification-5-3.

[10] "IEEE Standard for Wearable Consumer Electronic Devices--Overview and Architecture," in IEEE Std 360-2022 , vol., no., pp.1-35, 25 April 2022, doi: 10.1109/IEEESTD.2022.9762855.