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# Bridge — Remedy for the Visual Impairers

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**Abstract**

The increasing prevalence of visual impairment globally is a pressing public health issue that requires immediate action. Research has shown that there is already a tremendous amount of visual impaired around the world. As many as 1.1 billion people were thought to have vision impairment in 2020. This figure is the sum of 510 million people who had near vision loss, 258 million people with mild vision loss, 295 people with moderate to severe vision loss and 43 million people living with blindness. (Fleck, Anna, 2024) In addition to the current disturbing situation, the future trend isn't any better. Vision loss is predicted to increase by as much as 55 percent in the next 30 years, impacting some 600 million new people, according to the 'Vision Atlas' report by the International Agency for the Prevention of Blindness (IAPB). By 2050, the overall figure is predicted to have risen to some 1.8 billion people, with a breakdown of 866 million people living with near vision loss, 360 million people with mild vision loss, 474 people with moderate to severe vision loss and 61 million cases of blindness (Fleck, Anna, 2024). The aging population is a primary driver; as people live longer, conditions such as cataracts, age-related macular degeneration, and glaucoma become more prevalent. The International Agency for the Prevention of Blindness (IAPB) emphasizes that "the number of persons aged 80 years or over is projected to triple from 140 million in 2019 to 420 million by 2050," (The International Agency for the Prevention of Blindness, 2022) highlighting a demographic shift that will exacerbate the burden of vision loss. Facing the urgent situation, insurances for visual impairers' welfare would be essential for social well-being and sustainability.

**Keywords:** bridge card, health, visual impaired, object detection, AI model

## 1. Social Interaction — Key Toward Welfare

Social skills are defined as the abilities necessary for effective communication and interaction with others. For individuals with visual impairments, these skills are essential not only for personal relationships but also for professional success. As noted in a study, "Effective social skills are crucial for blind individuals, offering them numerous benefits" (Tariq, Fouzia, 2023). Clear communication and empathy can enhance abilities to build connections and navigate diverse social environments. However, the visual impairment can complicate social interactions. The lack of visual cue, such as facial expressions and gestures, makes it hard for visually impaired individuals develop alternative strategies to engage with others, building further social estrangement.

The psychological consequences of inadequate social interaction can be profound. Studies have shown that visually impaired individuals are at a higher risk for anxiety and depression due to their challenges in social interaction. The inability to engage effectively in social situations can lead to withdrawal from activities that promote well-being. As a review discussing low visioned group social function points out, "Blindness may make it more difficult to effectively engage in social interactions," which contributes significantly to reduced quality of life (Klauke, Susanne, et al., 2022). These nonnegligible disadvantages emphasized the dare need for visual impaired to socialize.

## 2. Challenges

A primary difficulty for visually impaired individuals is the reliance on non-verbal communication cues, or visual implications, which are crucial in social interactions. Much of human communication is conveyed through body language, facial expressions, and gestures. Visually impaired individuals often miss these cues, leading to misunderstandings and a lack of engagement in conversations. Difficulties with recognizing and interpreting the body language, gestures and facial expressions of the person with whom they are communicating can result in misunderstandings and make social nuances difficult, or in certain instances, impossible to interpret (Bhargava, Dolly, n.d.). This absence of visual feedback can hinder their ability to understand others.

Secondly, Self-confidence plays a crucial role in social interactions. Many visually impaired individuals may feel anxious or hesitant when engaging with others, especially if they have experienced misunderstandings. This anxiety can lead to an unhealthy cycle of isolation — the fear of negative experiences prevents them from seeking social connections. Additionally, societal stereotypes about blindness can sometimes result in discrimination from common people. An online volunteer website suggested that the perception that visually impaired individuals are less capable can lead to awkward behavior from other (Society, Blind Welfare, n.d.). Finding a proper method for visual impairers to socialize would therefore be essential. Bridge can be the perfect tool.

## 3. Bridge Card Connection

Bridge is traditionally played by four players divided into two partnerships, which inherently encourages interaction. As noted in an analysis of the game on a blog, Bridge provides an excellent platform for socializing, as players must communicate and cooperate with their partners to achieve a common goal — winning the game (FasterCapital, 2024). This necessity for collaboration not only enhances strategic thinking but also cultivates communicational skills. Players must articulate their strategies clearly and interpret their partners' signals accurately. This dynamic helps individuals develop essential communication skills that extend beyond the game. Players need to understand and interpret verbal and non-verbal cues from their opponents (FasterCapital, 2024). By engaging in these interactions regularly, players would be able to convey thoughts and emotions effectively.

Continuing, Bridge emphasizes teamwork — a critical component of social interaction. Players must work together to strategize and make decisions that benefit him and his partner as a group. This collaborative spirit encourages players to support one another. According to an online blog, Teamwork and cooperation are other valuable social skills that card games can promote (Senior Helpers, 2023). By participating in such cooperative activities, individuals learn to appreciate different perspectives and develop a sense of belonging within a group.

Last but not least, Participation in bridge club provides precious opportunities to meet new people from diverse backgrounds. This special setting creates a friendly atmosphere, easy to initiate conversations and form connections. The game acts as a social equalizer; regardless of age or background, players come together over a shared interest. As mentioned in an online social blog, Bridge provides an excellent opportunity to meet new people and expand your social circle (FasterCapital, 2024). This expansion of social networks can ease the feelings of loneliness and isolation, particularly for the visual impairers.

In conclusion, playing bridge significantly enhances individuals' socializing abilities through its emphasis on communication, teamwork, and relationship-building. The game's structure encourages meaningful interactions that foster friendships while also providing logical thinking practice healthy for their cognitive system. By embracing this timeless card game, visual impairers can participate in social interaction while enjoying the intellectual challenges it brings. Still questions remained: how can visual impaired participate in bridge card?

## 4. Background and Related Work

For individuals with visual impairments, participating in bridge presents significant challenges due to the physical limitations imposed by their condition. The loss of sight can be particularly detrimental for a bridge player, as the game relies heavily on visual information. Several key disadvantages emerge for visually impaired players. First, they may struggle to process in-game information, especially regarding the dummy cards, which must be visible to all players at the table. Second, tracking the progression of each round is inherently difficult without visual cues. Finally, the act of playing out dummy cards becomes nearly impossible without vision. Despite these difficulties, providing an opportunity for visually impaired individuals to participate in bridge is crucial. Such participation could offer a valuable social interaction experience, requiring minimal physical movement and thus reducing the risk of injury. The challenges faced by visually impaired bridge players represent a tangible problem. For instance, in a Google Forum post, a user named Laura sought advice on how to enable her visually impaired father to play bridge, highlighting the need for a solution such as a Blind Bridge Detection Device.

Through research, several potential solutions have been identified to facilitate bridge play for the visually impaired. First, the use of Braille cards can help players access the information on their own hands. Currently, most visually impaired players rely on assistants to read the cards aloud (Johnson, Gabriella M., & Shaun K.

Kane, 2020). Second, radio frequency identification (RFID) technology is being explored to transmit card data to players via antennae, offering a potentially convenient method, though still in the experimental stage (DeJordy, Allison, 2012). Lastly, speech recognition applications, such as those provided by the online bridge platform Bridge Base Online (BBO), can assist visually impaired players in navigating the game (Posea, Vlad, Mihaela Balint, Alexandru Dimitriu & Alexandru Iosup, 2010).

## 5. Methodology

Although several solutions have been proposed, their practicality and actual benefits remain questionable. Thus, I propose an alternative approach that may offer greater advantages. My solution involves using a camera to process the visual information and an ear microphone to transmit this information to the players (Di Cagno, A., E. Iuliano, G. Aquino, G. Fiorilli, C. Battaglia, Arrigo Giombini & Giuseppe Calcagno, 2013). Specifically, after players receive their cards, they would first use Braille cards to identify their own hands. They would then place their cards on the table in front of them, within designated areas marked by black tape. A camera, positioned above the table, would process the cards using computer vision.

Throughout the game, the camera would track the cards played by each participant, and the information would be transmitted to all players via an ear microphone. To further enhance the system, the camera would also detect potential mistakes made by players and provide real-time feedback, addressing the remaining challenges of ensuring accurate gameplay.

In order to compare my solution with the other current ones, I created an evaluating matrix based on cards availability, setup difficulty, convenience in understanding, conformity to bridge, and error rate.

1) Cards availability — 3*x

The need for an easily accessible card set would be essential in order to provide real convenience for the blind players, giving the weight of 3.

2) Setup difficulty — 2*x

It is somewhat important to have a portable and carriable device. However, device setting would always be, I believe, an unsolvable problem if the blinds want to set up themselves. I would now give the assumption that there would be someone helping to provide the environment, so giving the weight of 2.

3) Convenience in understanding — 4*x

It is important for the blinds to easily interpret the massage the device is trying to given. They need understand properly and with ease to actually manage to enjoy card game rather than suffering during the process.

4) Conformity to bridge — 5*x

Considering the project we are currently doing; this is the most important factor to be considered. The conformity of the plan with bridge

5) Error rate — 5*x

It is definitely, another important factor to be considered. If error constantly appears, how can you play cards?

| | Cards availability | Setup difficulty | Convenience understanding | Conformity to bridge | Error rate estimate |
|---|---|---|---|---|---|
| RFID | 2*3 | 3*2 | 5*2 | 3*5 | 4*5 |
| AI app | 5*3 | 5*2 | 5*2 | 1*5 | 3*5 |
| camera | 5*3 | 2*2 | 5*2 | 5*5 | 4*5 |
| tactile guidance | 5*3 | 2*2 | 3*2 | 1*5 | 4*5 |

* x = [0,5], determined by their unique advantage (for error rate, bigger is better).

Num = weight*x

RFID = 57

AI App = 55

Camera = 74

Tactile guidance = 50

In comparison, Camera would be the best alternative that we should consider other than the other current solution.

**6. Detection Model and Results**

After deciding to use a camera in our device development, I conducted research on models capable of detecting and identifying playing cards. Several criteria needed to be met: the model must accurately identify multiple cards simultaneously while maintaining optimal accuracy. I narrowed the options to the Rain Man model (https://hackaday.io/project/27639-rain-man-20-blackjack-robot) and Roboflow (https://universe.roboflow.com/0lauk0/playing-cards-muou8/model/10). Both models perform well in card recognition, but I selected Roboflow in combination with YOLOv8 (Wang, Gang, Yanfei Chen, Pei An, Hanyu Hong, Jinghu Hu & Tiange Huang, 2023; https://github.com/geaxgx/playing-card-detection) for its additional advantages, particularly in scenarios that are highly beneficial to our use case. Once the model was chosen, we applied it to our practical setup. Initially, I implemented a loop to have the model scan the table five times, each iteration focusing on a different block of cards. However, despite achieving high accuracy, this process proved to be time-consuming. To address this, we made several modifications: first, we divided the images and applied grayscale, simplifying and reducing the data the program needed to process. Additionally, we disabled unnecessary output functions, such as print statements. Finally, upon reviewing the model, we discovered that jokers were not included in the detection. After implementing these optimizations, the processing time was reduced from 26 seconds to 3 seconds, making it feasible for future use. We now have a model capable of accurately identifying the cards on the table with near-perfect precision.

**7. Conclusion and Limitation**

Now, having this model, we can develop the real usage of this to benefit the blinds. After the model gets the information, it would analyze and later help to find mistakes in between the players' actions. It would identify basic violation of bridge's rule to help the game keep going. Further, the connection of earpiece and the program should also be built, and finally, presenting a device with the ability to help the blind play bridge.

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