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SMART SHOPPING CART FOR VISUALLY IMPAIRED INDIVIDUALS

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ABSTRACT

Vision is one of our most important tools to help us survive in the world. Not being able to see well or at all is only the tip of the iceberg that people who are visually impaired have to deal with. Along with that, comes a whole new set of societal challenges, stigma, fears, and beliefs making these groups a minority and not shedding enough light on issues that they face is more common than we realize. While everyone in today's world chases the buzzwords artificial intelligence and robotics to create complex technologies to solve problems like the mundaneness of a task, it would be incorrect to forget about the bigger picture that hints at helping mankind save the rest of it. The visually impaired face a variety of issues right from not being able to navigate along a path to the very basic grocery shopping at a shopping mall. This paper proposes an idea of a smart shopping cart that assists the visually impaired to navigate through various isles of a shopping mart and help them purchase the items they wish to buy with the help of braille assisted buttons and haptic feedback control without feeling the need for any human assistance.

Contribution/Originality: This research focuses on creating a smart shopping trolley that will help a visually impaired person navigate in a marketplace thereby helping them do grocery/essentials shopping without requiring company or assistance by making use of technologies of electronics engineering, knowledge of braille language and voice assisted technologies.

1. INTRODUCTION

The American Foundation for Blind approximates that someone goes blind or visually impaired every 7 minutes in America; about 8 million people in America face visual challenges that makes reading difficult. These blind people confront daily problems, a few of which are as basic as taking the bus or buying food [1]. The visually impaired must heavily use their senses of touch, smell, taste, and sound to go about their daily chores. While some activities can still be done to a great extent, shopping is something that evidently requires a different approach, every item at the shopping mall cannot be recognized from the sense of touch, apart from unpackaged goods which is a very small number of fruits and vegetables, especially in countries like India, the sense of smell is also not of much use. Tasting an item before billing can cause a lot of trouble and if it is not a box of cereal, other items cannot be recognized from the way they sound.

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A market is a place where people get together to buy and sell the goods they need for their daily lives. As buyers, we go to the market at least once a week (if not daily) [2]. Moreover, a lot of people find it fun to go grocery shopping. If asked, visually impaired people would not give the same answer. It is one of the biggest problems that they must deal with. For them going to buy groceries entails finding a person to go with who can help them. The reason for that is not being able to recognize let alone compare items that others easily do. The person they go with or one of the people at the mall itself becomes responsible for reading out items from the shopping list or the ingredients off packets. They are stripped off that feel good factor that comes from shopping alone, that so many people experience. All these problems get magnified during the holiday season, when the whole world is at the shopping center. Navigating from one place to another for those with vision themselves can be difficult, it is impossible to imagine the kind of trouble the visually impaired must face during this time.

In the 21st century, it has been seen through the years that humans have used technology to make lives easier and it has for some. Even if the groups of people who are visually impaired, deaf, and mute are a small percentage, it is important to realize that they are a small percentage of a very big population. Hence, in numbers these people are a group that should have a good amount of research and development allocated from all the science and technology centers that work towards solving the issues that they face. Until recently, efforts to develop technologies to help visually impaired people navigate were bounded by gadgets that assisted them in only avoiding hurdles. After the blind community adopted the cane as the primary method of detecting obstacles, considerable effort was spent to supplement or replace the cane with electronic travel aids such as laser canes and ultrasonic obstacle avoidance systems. However, even with these technologies, visually impaired travelers have difficulty in traveling independently because they still need more information than these devices provide to effectively navigate unfamiliar areas [3]. This solves only the issue of wayfinding, but a very wide range of problems can be solved if small inventions and innovations are used in collaboration. The advances in technology know no bounds and hence, if these problems are talked about more, more people would get started on finding solutions and the world would reach that point much more quickly when the ones with such disabilities can independently get out of their homes to do grocery shopping.

Hence, this paper talks about a smart shopping cart that can be used to assist the visually impaired to help them make the process and the basic activity of grocery shopping much easier.

2. LITERATURE REVIEW

Technology has always tried to make human life comfortable, but there are still groups of disadvantaged people struggling to find innovative ways to facilitate basic daily activities. According to the World Health Organization, about "285 million people are visually impaired worldwide: 39 million have complete vision loss and 246 million have low vision (severe or moderate visual impairment)". Grocery shopping is a necessary part of our daily routine that entails a number of interconnected actions. The design and development of systems that give real-time information to individuals with disabilities and the elderly must be based on user criteria that have been identified [4]. Examples of this behavior include checking the current inventory of the pantry, creating a shopping list based on planned meals, visiting stores, and opportunistic and impulsive purchases according to store signs [5].

People spend an average of 1.4 hours a day shopping according to a poll done by the United States Bureau of Labor. If a line is too long, a large number of customers will tend to walk away. The contemporary shopping environment can be divided into two categories: (1) in-person shopping and (2) shopping online. Shopping in absentia is possible through a variety of methods, including online shopping, tele-shopping, and other methods that do not require a shopper to be physically present in the shopping area. Shopping in person is paying a personal visit to the store and picking products based on a variety of variables such as need, convenience, brand, and so on. The suggested smart shopping cart system aims to assist in-person shopping by reducing the amount of time spent shopping and making it easier to find the required product. It also aims to assist store management by providing

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real-time inventory updates [6]. It is important to realize that both of these types of shopping systems have been designed especially for the sighted, since they are the majority of the population, but shopping is never considered to be one of the activities that are, even on a small scale, catered to for visually impaired people as is evident from the ongoing trend in shopping, it entails deciding and travelling to essential department, as well as lugging a carry basket or pulling a cart. Although it may be obscured, this is a time-consuming and physically hard activity for some people.

Traditional mall shopping is a laborious, tedious, and time-intensive experience. The entire billing process at the checkout is exhausting and time consuming. To avoid the long queues, a trolley has been intended to be designed which will be installed with a RFID and an Arduino controller such that the customer would be required to scan the product that they wish to purchase, and this information will be stored, and a bill would be generated [7]. Another challenge with traditional shopping methods is to figure out the organization of the departments in the mall and find the section you need. Not only is this time consuming, but it can also mislead customers as it forces them to navigate through expensive and attractive items which are not required to get to the items you really need. Customers sometimes forget what they needed in the first place, resulting in a waste of time and money on products that aren't required, which is one of the best marketing strategies that have organically been discovered [8]. By definition, a market is a place where people buy and sell goods they need in their daily lives. Most people enter the market weekly (if not daily) as consumers. Developing a better market environment is a vital but underutilized application for realizing smart cities [2].

Interest in research about a solution like this has been reducing, which can be seen from the graphic below in Figure 1(a). The maximum number of publications was in 2019. Most, 69, of which were from India, as can be seen from Figure 1(b). Data from Scopus procured on 4th May 2022. These graphs further show neglect towards an issue that is so important and requires attention. The novel approach discussed in this paper was ideated upon keeping in mind this need.

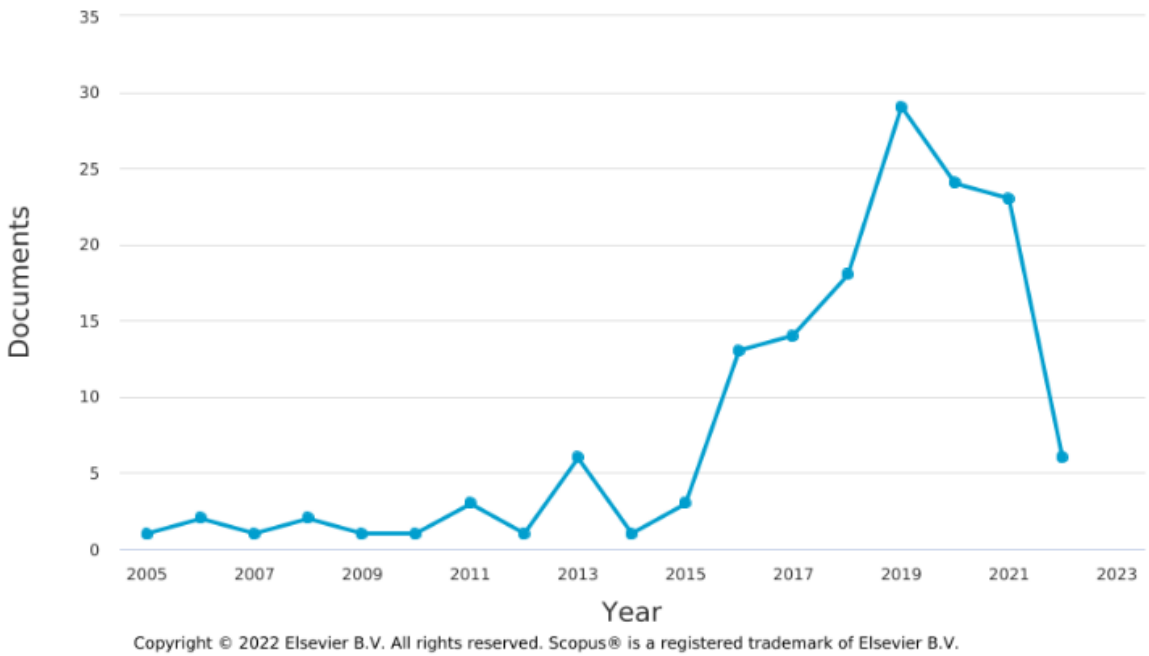

Figure 1(a). Trends of yearly publications.

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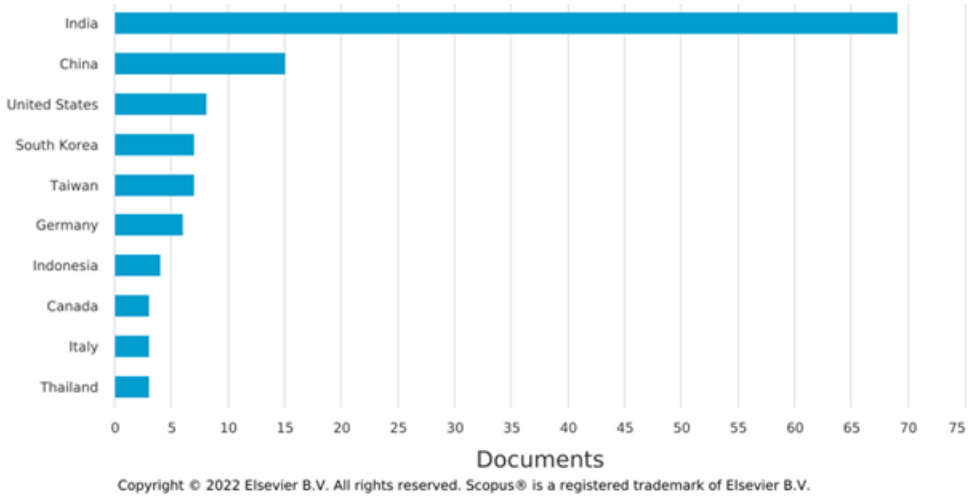

Figure 1(b). Trends of yearly publications.

Dating back to the dawn of time, humans have always developed technology to meet their requirements. Regardless of the domain, the primary goal of technological advancement has been to simplify processes and make routine tasks easier and faster [6]. Technology has a significant impact on people's lives. During the previous decade, the rise of e-commerce has changed the patterns and styles of consumers. The Internet and e-business are intrinsically linked. The World Wide Web, as well as advertising and promotion, have made online purchasing possible. Online shopping has become more popular as the emergence of specialist sites such as Amazon, Julie Chic, and Integra, etc. The presence of ecommerce, on the other hand, has not stifled the growth of traditional markets [9].

Over the last decade, the advent of low power, low cost processing and communication technologies has spawned numerous Smart Everything applications. With the Internet of Things boom, these research efforts are now being developed as a business, making a normal manual workstation "smarter" than ever. The success of many application areas has sparked the desire to create smarter and more intelligent market surroundings that are closely related to our daily lives [2]. Several technologies have been developed to assist the visually handicapped, including automatic text readers, Braille note producers, and navigation assistance canes but these innovations have been generic. Something to help with assistance of the visually impaired is rather specific. It is not a popularly pursued topic as many things need to be considered from the basics of the design to the computational concept to the economics of the innovation.

A navigation process is proposed made up of five general processes to account for the wide range of directional activities and the numerous causes of errors that can arise. The first navigation process is sensing which indicates possession of information regarding automation or landmarks, for instance, vision, audio, etc. The second process, which depends on loss of memory and non-cognitive distortion, is about generating a map that outlines a series of adjoining segments and turns. The third process is initiating a survey description of the layout or configuration of the spatial specifications. The fourth process computes and evaluates desired routes determined from the survey description or the map of the route and the fifth process is implementing those routes [10]. Distractions are unavoidable while navigating in a real-world environment. Distractions such as ambient noise can be perceptual, but other distractions are said to be cognitive in nature. For example, travelers are expected to remember directions, participate in conversations, and search for landmarks. These activities require a high degree of cognitive ability. Spatial cues in hearing have been found to be very helpful in directing visual attention. Voice-based cues have proven to be useful and may be indistinguishable from spatial perceptual cues in some situations [11]. Perceptual depictions of our environment are created using information from sight, listening, sensation, and speech.

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Such perceptions are the source of both temporal spatial portrayal in working memory that endure long after the input has stopped and permanent perceptions in long-term memory [12].

While researching the strategies of blind and visually impaired individuals to explore unfamiliar environments, a survey was conducted that revealed the best performers made use of search patterns and strategies in such a way that finding objects rapidly was efficacious and this enabled the progress of object-to-object associations [13]. Many of the typical modifiers incorporated into labels and identifiers that provide names distinctiveness and originality may be a foreign concept to those who are visually impaired. For instance, the difference between "a yellow book" and a "black book" may have no sensible explanation for this subgroup [14]. It has also been noted that walkers with vision impairments prefer to stroll in close proximity to sighted pedestrians, and so walk at a regular pace, however when walking alone, they tend to slow down. It has also been claimed that as the route's difficulty increases, so does the efficiency of their movement, and vice versa [15]. People who can roam around and position themselves in the surroundings securely and responsibly are more likely to feel safe and self-reliant both of which are necessary for their inclusion in a diverse society. From both an empirical and academic standpoint, research is being performed to understand how visually impaired individuals develop cognitive maps of their surroundings, as well as the most effective approaches for teaching them about space [16].

The way a user interacts with technology is one of the most significant parts of it. An intuitive, straightforward, and functional user interface makes the difference between a widely used successful product and an unsuccessful product. When attempting to assist someone with a disability, the interface design becomes critical. Not only must the interface be user-friendly, but it must also be adaptable to various contexts [5]. This paper proposes a smart shopping cart that provides a wide range of features making a visually impaired individual to need nothing but the cart to successfully navigate through the cart and get the items on the shopping list in the least amount of time. It is a product of interest to but not limited to visually impaired individuals.

Developing a fully assistive system with several interfaces involves a number of problems, not all of which are immediately apparent. The hurdles while shopping include localization, grocery shopping issues avoiding obstacles and staff. Other issues are user-focused that include adjusting the frequency of instructions and direction to the speed of a person, adjusting the viewpoints of different cameras to provide accurate guidance, and sufficient computer capacity to maintain the system and to respond in real time [5]. This shopping cart aids retail management by automatically updating inventory after each item purchase. The Smart Shopping Cart has the ability to make the shopper's shopping experience more enjoyable and efficient, while also making inventory monitoring easier for store managers. Applicable solutions for phones and smart shopping trolleys are an important aspect of the architecture and communicate with each other in a smart Internet of Things environment. The above services aim to improve the quality of life of the visually impaired by using the proposed architecture to increase mobility in daily life [17].

One such concept already introduced as some technologists have been working on, is by using spectacles powered by Artificial Intelligence, Machine Learning, and Computer Vision, wherein a customer simply needs to put those glasses on and walk towards an aisle, attempting to screen the items by pointing or getting directly in the line of sight of the item on a rack, and the information about the item would simply come up, read out aloud. It could also detect misplaced objects, such as those placed in a trolley or a rack where they do not belong. It might also detect and assist in navigating through crowds in a retail mall. Each of these activities should consider not only the computer vision part of the problem, but also the actual implementation of a complex system that spans wearables, and cloud computing platforms. This requires the issue of real useful consumer items to be addressed. The device uses smart glasses to provide head view, network connectivity, and voice feedback. Eyeglasses are primarily used in assistive systems to guide the aisle in front of planned or desired merchandise. The commands offer the appropriate direction, such as either side, ahead, and backwards [5].

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The market is a physical area where a vendor and a buyer can exchange resources and sell items. There are numerous types of trolleys that are utilized in various forms such as "mobile grocery carts", "infant strollers", and the traditional "shopping" carts, where the emergence of "entrepreneurial thinking" often leads to an increase in trade transfers based on the selling and buying. When buyers understand their expenditure, they're more inclined to assess the worth of the product to avoid spending unnecessarily. While the moves of the retail mall are strategic, customer satisfaction is just as important if not more so and it was observed that people who received this information departed from the store happier than those who didn't. While merchants and customers are increasingly more interested in the "smart" aspect of shopping trolleys, many are concerned about how the said "real-time expenditure feedback" may alter purchasing behavior. As they receive real-time purchase feedback, budget buyers are encouraged to invest more. High-budget customers, on the other hand, pay less because of this input. Moreover, smart shopping carts increase low budget customer intentions while keeping high budget consumer intents. These findings suggest that there are major differences between low- and high-budget customers that need further explanation. They have far-reaching implications for infrastructure, online shops, and software developers [9].

Similar studies have been conducted and a number of innovations have made shopping easier for everyone in general. A smart wearable band is one such suggestion that was introduced. The band has an application that can provide customers the exact location of things they need when shopping, as well as the fastest method to get there. Additional features or options for adding products to the basket include scanning the barcodes of the items and retaining them in the cart. It directs the user to the items one by one, following the most direct path. This app also displays all of the store's current promotions. This necessitates the use of personal devices rather than a specific gadget from the store. If the consumer does not have such an electronic device, he or she won't be able to avail themselves of this service. If the store's layout is modified and outdated, it will result in chaos and a lot of wasted time trying to find things. Working employees may replace the goods and it may not be placed in the same spot, making shopping more difficult for the customer. The consumer may pay anywhere in the store, and an electronic receipt will be created and distributed through SMS or email. After the payment has been made, the smart bands will be verified for successful payments at the departure points before departing. Payment could be done via both the online and the offline modes. Many display screens would be put up to display all the final items and payment choices after scanning the temporary QR code with the smart band. Only cash payments may be made at the cash counter in the end. This decreases the time spent in long lines and boosts the supermarket's sales. This is the basic technique for adding and removing items from the smart cart. To examine the final cart items, there is no need to download any sort of mobile application because this can be configured at the exit point when an individual customer's cart will be presented on the screen before the final ask of choice of "mode" of payment. "Ultrasonic" sensors will also be deployed in digital racks in supermarkets to monitor routine product stock management. When a product's supply is nearly depleted, a notification of fresh stock ordering would be issued to store management immediately [8]. The most important thing to realize here is that this technology is made keeping in mind that a sighted person would be able to use the application to make the most out of the features that it offers. It would be of no use to a visually impaired person. A lot of research has gone into developing smart solutions that employ mobile devices to help people with vision problems do things like go shopping. The creation of a solution that provides a decent quality of life for persons with vision impairment is one of the most difficult jobs for researchers. It's also critical to create solutions that enable persons with vision impairments to engage in social activities so that they feel included [18].

The smart shopping cart proposed in this paper caters for the visually impaired by allowing the shoppers to be able to navigate through the aisles of a shopping center by firstly recognizing the current location of the cart and then taking the list of items one by one and directing the person towards the rack with that item. Additionally, it will also help the person detect obstacles on that path. This shopping cart will have buttons that would have braille

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scrip written on them depicting the name of the button as if it is written in plain text; all buttons would feel the same way to a visually impaired person. These buttons would help the user further tackle complex problems of checking whether an item is in the inventory, and the location of the item. Furthermore, it would also have a camera sensor along with a scanner which would give the price and other information such as the manufacturing company of the item, the ingredients and further cooking recipes if asked for by the shopper. Many foods, such as fruits and vegetables, may be identified just by touching them. For visually impaired people, distinguishing between containers that feel the same but hold different contents is a common issue. This is especially severe when the items are harmful, such as distinguishing between a glue stick for example, and a stick of lip balm [1]. More often than not, there are huge lines at the store that take up the majority of our time. Consumers confront several issues while shopping, such as worrying that the amount of money brought is insufficient and not having enough knowledge about the products [19]. So, the audio output of the cart with the help of the scanner can enable a comparison of two items that are scanned by listing out pros and cons of each of those items to help the consumer make an informed decision. This cart would be able to solve the problem of the time-consuming process of researching which product to purchase. It would also allow the shopper to check these items out by making an online payment or if the shopper is a frequent visitor, until a certain amount he could also have the items added to their account which can be paid for later or at the end of the month. On top of all this, many visually impaired people don't shop solo and rely on friends, family, volunteers, and store personnel to assist them with basic grocery purchases. When these people are unavailable, consumers have to reschedule or postpone their journey to the mall. They spend their time waiting for store staff to assist them if they make it to the store, and they frequently experience an inordinate level of delay. Many of the obstacles that spatial processing brings to the visually impaired can be reduced when compensating non-visual information about the environment is supplied [20]. This might also lead to a shopper settling for a distant substitute because they could not find the item they were looking for Vladimir and Aliasgar [21]. With all of the technical developments being updated and quickly becoming obsolete, ongoing innovation is required in all aspects of life. Shopping is an activity that hasn't seen any technology breakthroughs in a long time [8]. IoT aims to connect the physical and virtual worlds by using the "world wide web" as an intermediary to communicate and exchange data without human intervention [22]. It is high time issues of those with disabilities of vision loss and deafness are resolved by providing technological solutions.

3. PROPOSED METHODOLOGY

Before designing a model, it is essential to consider the different types of challenges that are encountered by the visually impaired. The location or shelf where a product is placed in a shopping mall is repeatedly changed according to the supply and demand of the item. For those of us who can see, searching for anything in such an environment becomes a time-consuming process, so we can empathize and appreciate how difficult it would be for those who can't. They require assistance for nearly all tasks, from navigating through the store to searching the shelves and checking the product's details to reaching the billing counter for checkout. The entire process is stressful and, to top that, the limited support from the shop assistants adds to their difficulties.

We are proposing a system that will help ease these problems and model a better shopping experience for those struggling with it by designing a shopping cart that enables the visually impaired to explore stores independently using auditory and haptic feedback technology, rather than relying on others for assistance. This product/idea would reduce the dependence of the blind and visually impaired on others, moreover, helping them gain more confidence.

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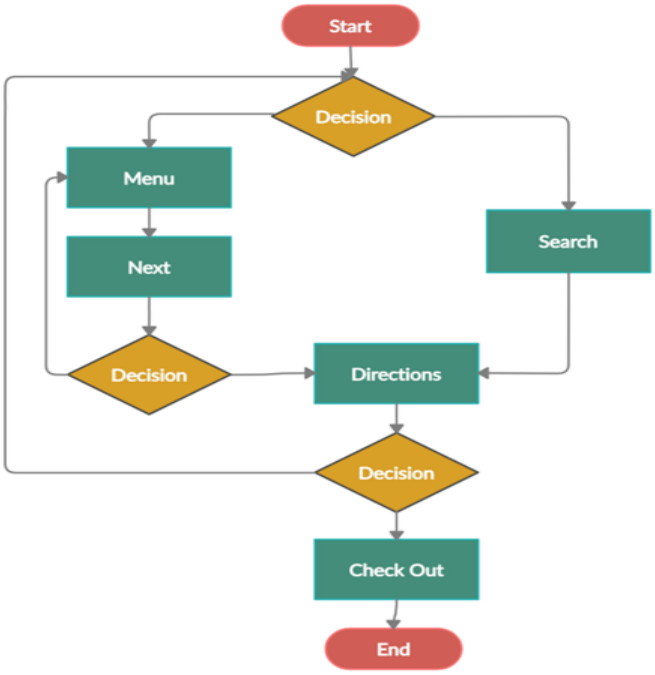

Figure 2. A flowchart of the buttons of the proposed model.

The working of this model is also shown in the form of a flowchart in Figure 2 and is designed in such a way that the blind and visually impaired need not call for assistance very often and can manage their shopping by themselves. This model of the shopping cart is designed using Tinker CAD and demonstrated in Figure 4, Figure 5 and Figure 6. As soon as the customer enters the shopping center, they must decide whether they wish to go through the pre-existing shopping cart menu or to search for specific things that they want to purchase. If they select the pre-existing menu, the shopping cart's audio system will play a list of all the categories. They can then select a category, click next using the buttons that have braille script engraved on them or instruct next as a voice command, and choose a product, following which they must decide whether to add more things from the menu or get instructions or details of the products they have chosen, for instance, the expiry date or date of manufacture. The dots that we see on the bar in Figure 3 are the braille translation of what the buttons represent. If they begin by selecting the search option, they will be directed to the product that they have searched for with the help of voice commands. After that, they can either choose to check out or continue shopping for more items.

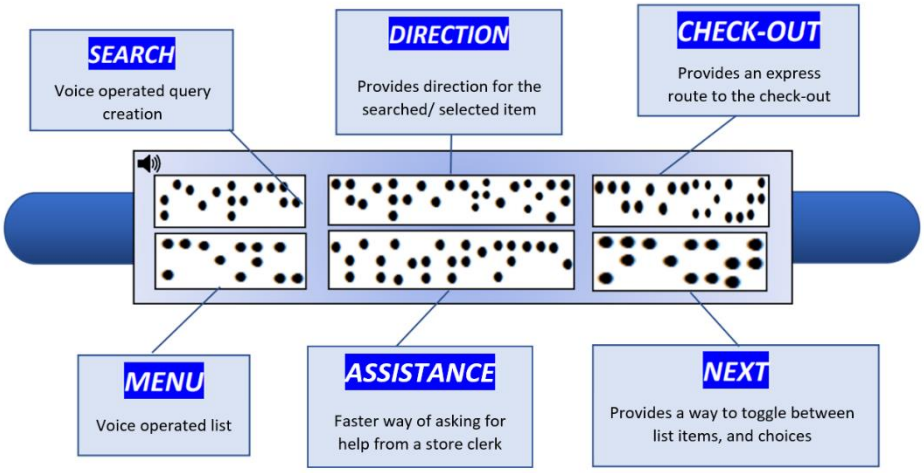

Figure 3. Handle of the smart shopping cart with buttons in braille

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The proposed system comprises eight buttons, shown in Figure 4, the functionality of six of which are explained below:

1. Menu: This button provides voice-operated list creation functionality. It eases the experience of the user creating a continuous route, without the need to create a search query between each shopping item. Once this button is pressed, the voice command is activated and the customer can hear an automated voice, through a set of headphones provided to them, listing out the items that are available in the alley that they are in.

2. Search: This button provides voice-operated query creation functionality; it eases the experience of the user to tell where a specific product is and guides the user to the specified product. Once this search operation is activated, it acts as a virtual assistant to the customer. The user can talk to the virtual assistant to search for the desired product and get directions to navigate through the store and find the product.

3. Next: This button provides a way to toggle between list items and choices. It allows users to make quick decisions and navigate through some actions.

4. Direction: This button provides direction for the searched or selected item in the store and helps the user to find their way out. After the search button confirms that the item the user is looking for is in stock, the direction button comes into play. Every trolley will have a chip embedded as will different sections in the mall. When an item is chosen by the customer, it is marked as the destination and the location at which the trolley is currently present is marked as the starting point. Using AI and ML the server finds the route with the least traffic (this is possible because all the trolleys have a chip that is read in real-time) and guides the user that way. The trolley also has a sensor, in the front, to caution the user when there's an obstacle ahead.

5. Check-out: This button provides an express route to the check-out counters. This improves the experience of the user, by finding the shortest distance to the check-out area, instead of having to rely on a worker/helper for the way. Once the customer is done with their shopping, he or she will press the checkout button after which they will receive directions to get to the nearest cashier or checkout counter where they can finish the billing procedure.

6. Assistance: This button provides a faster way of asking for help from a store clerk. This button exists for those trolley users who need more assistance than the trolley can provide. Once the assistance button is pressed, the app (used by the entire staff) sends a notification of "help needed" and the location of the user in need of help, once someone from the sales staff confirms that they will tend to the user the notification goes away.

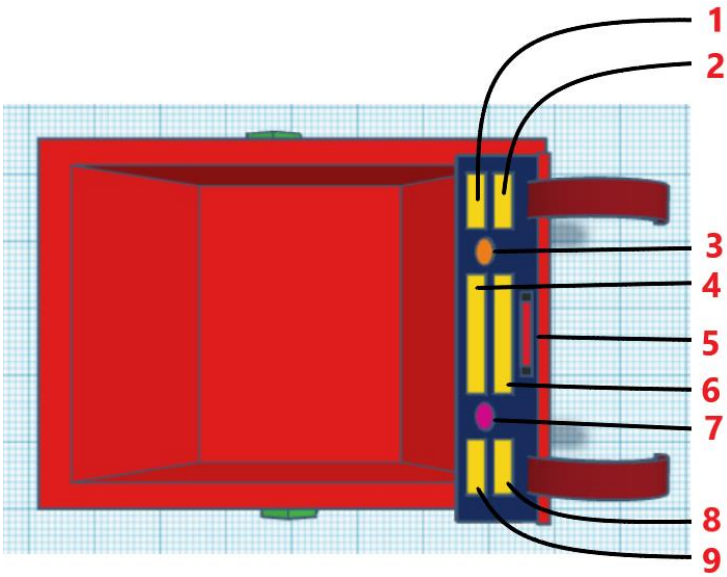

Figure 4. Marking and types of buttons.

These six buttons have their functionality name engraved as braille script for the people to understand. The use of uncontracted braille script would be beneficial to both children as well as adults. The uncontracted braille script

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is a basic and standard system in which every letter of every word is expressed in braille. Braille is a pattern of raised dots that people that are visually impaired may read with their fingertips. It is not considered as a language; rather it is thought of as a code which is implemented to get an understanding of other languages for a vast population of people who are visually impaired.

The IoT refers to a system of interconnected machines that may receive as well as transmit data over a wireless network without human interaction. The functionality of the navigation, assistance and check-out buttons is largely based on this notion. IoT, is a computational concept that explains the idea of ordinary physical items being connected to the internet and being able to identify themselves to other devices, allows all trolleys to communicate with each other. The IoT provides the ability to monitor and track objects, which supports trolley navigation and direction. In fact, in one of the most recent attempts at making a trolley like this, a STM32 microcontroller was used, the STM32 basic system can be used as the control kernel to build an indoor Ultra-Wideband infinite placement area consisting of three base stations and two tags. The TOF (Time of Flight) double-sided two-way ranging technique can be used to automatically position tags. As a result, the tracking system where passive tags are placed can track and provide data for active tags automatically. [23]. In this IoT-based shopping trolley, the significant use of sensors that transfer data to a computer or software, allowing them to execute crucial activities, assists the customer in detecting, scanning, and improving their shopping experience. The floor plan and layouts of the shopping space is stored in the database which can be accessed, at any time, to help the customer with directions.

Another aspect of the design is voice command. Since a visually impaired individual may not be able to communicate by means of reading and writing, the alternative is to give commands to the machine by talking to it. A voice-user interface (VUI) allows people to communicate with computers by using speech recognition to interpret commands and respond to queries. VUIs have been integrated into a variety of devices and are the most common way to engage with virtual assistants on smartphones and smart speakers. A VUI is the user interface for any speech application in which we are managing a machine by just speaking to it. The widespread adoption of these types of interfaces was aided by technological advancements. VUIs are becoming increasingly prevalent, and users are reaping the benefits of these hands-free, eyes-free interfaces in a variety of circumstances.

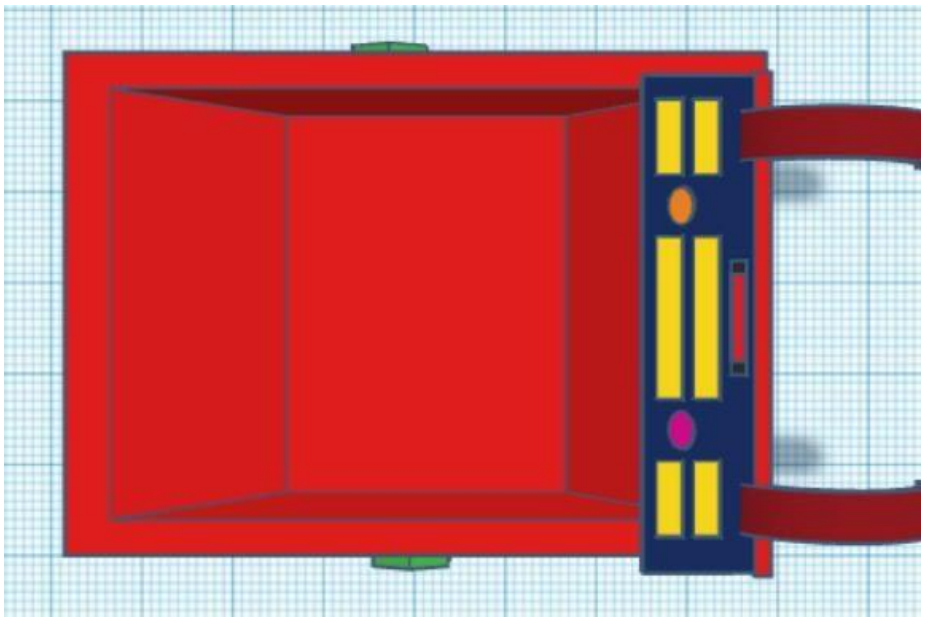

Figure 5. Top view of the smart shopping cart.

Along with theses six buttons, there are two additional circular buttons and a barcode scanner incorporated into the panel as can be seen in Figure 5, which depicts the top view of the Smart Shopping Cart. These two circular

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buttons, engraved with braille code, perform two supplementary functions. The pink button is designed to be used for comparison of two products. If the customer wishes to make a comparison between two or more products, they can make use of this button and they will be briefed about the differences between the products, so that they can decide which is best for them. The orange button is utilized as a command for the weighing scale. If the customer places an item in the tray (marked as 11 in Figure 6) and presses the orange button (marked as 3 in Figure 4), they will be informed about the weight of the product. This would prove to be most essential when the customer is buying fruits, vegetables, or groceries. The last functionality on the panel is the barcode scanner. When the customer finalizes the product, they will scan the barcode of the product, which will initiate the billing system, adding the product to the customer's final bill. By doing this, the tedious process of standing in line and waiting for the store assistant to scan everything and then generate a bill could be avoided. Once all the items are scanned, a bill is automatically generated and the customer can pay directly at the checkout counter after they have been directed towards it, using the checkout button.

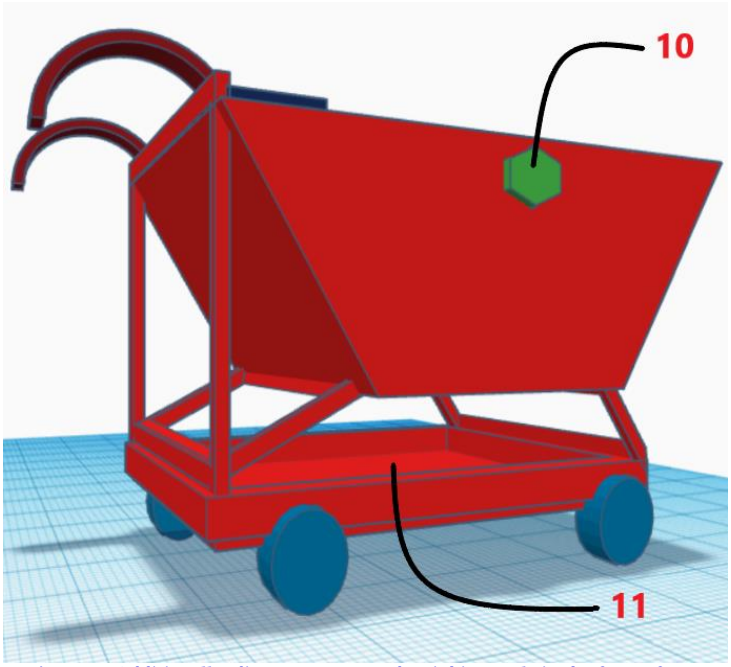

Figure 6. Additionally, distance sensor and weighing scale in the form of tray.

The advantage of the distance sensor as can be seen in Figure 6, (marked as 10), is that it will help the customer smoothly navigate through the store by avoiding collision with any obstacle. Without needing to touch the obstacle, the distance sensor can detect obstructions and compute the distance between the sensor and the obstacle. The weighing scale in the form of a tray is used to help the customer with the weight of a product that they wish to buy, and its cost according to the weight.

4. RESULTS & DISCUSSION

This smart shopping cart could be a customizable product cum service that caters for every single service that a visually impaired shopper would require. It would be dynamic and would be able to be installed in any type of shopping environment/marketplace. According to the layout of the place, these carts can be made to be well-versed with that area and hence, would be perfect to help someone navigate and find the items they wish to purchase. This is a novel approach towards using existing technologies from the fields of electronics & robotics engineering to solve a problem as socially relevant as this.

Once this smart shopping trolley is ready, it is expected that it would help a visually impaired user navigate within a marketplace by processing the item that the shopper is looking for and letting him know whether that

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particular item is in stock or not, and if yes, where it is located, the trolley would then give instructions on how it needs to be moved to land in front of the aisle containing the said item. If the shopper still needs assistance, a separate button, if pushed, notifies the staff that some sort of help is required, and it would also send the location of the cart so the store personnel would know where they are needed. All these functionalities when put together in one single cart will prove to be a novel product that could change the face of shopping for the visually impaired.

5. CONCLUSION

Today, businesses are motivated by IoT and AI and prospects of reducing human labor and operating costs thereby increasing profits IoT based shopping trolley system utilizes voice commands and distinct buttons that make shopping and navigation through the shopping area an easier process for visually impaired customers and as well as anyone else who require assistance. This shopping cart digitizes the process of shopping while solving social problems of dependency of a person with a disability on either a friend, family member or the shopping center staff. Each of these trolleys can be specially designed for the designated shopping center while also customizing them as for the kind of store it is used in and the inventory list. The scope of improvement for this project could be implementing vigorous AI algorithms to tell the difference between two or more types of items such as fruits, vegetables, or any other perishable categories of items. Artificial Intelligence can help us understand and identify and overcome the limitation to the current problem.

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