International Journal of Business Analytics and Intelligence
6 (1) 2018, 25-30
http://publishingindia.com/ijbai/

QFD-Based Smart Cane Design: A Technology to Assist Visually Impaired

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Abstract

This paper reports on a study that helps visually impaired people to steer uncountable confidently. The study hypothesizes that a Wise Cane that alerts visually impaired people about obstacles before might facilitate them in walking with less accident. The white cane, because of its primitive vogue, is unable to produce the blind and visually impaired level of independence that is possible with stylish technology. The aim of the paper is to handle the event work of a cane, which is able to communicate with the users through sound alert, and vibration, that is mentioned as 'Wise/Smart Cane'. The event work involves writing and physical installation. A series of test unit is distributed on the wise cane and the results are mentioned. This study found that the Wise Cane functions well as meaning, in alerting users about the obstacles before.

Keywords: Arduino, Assistive Technology, Ergonomic design, House of Quality, RFID, Ultrasonic Sensor HC-SR04, Visually Impaired

Introduction

The survey of United Nations Agency (World Health Organization) allotted in 2011 tells that in the world regarding one hundred and twenty-fifth of the human population is visually impaired and amongst them regarding 100 percent is blind.

The main drawback with blind folks is quality. This paper proposes a tool for visually impaired people that can offer them navigation. Long white Cane may be an ancient quality tool that will not observe obstacles within the path of a blind man. By modifying this cane with some physical parts and sensors, this can become good cane. Good white cane is specially designed to observe obstacles, which can facilitate the blind to navigate care freely. The vibration feedback and therefore the sound alert can keep the user alert and significantly cut back accidents.

Consumer and medical technology have created vital advancements over the past 60 years. However, the practicality of canes for the visually impaired remains restricted, counting on the user's ability to physically observe objects and forcing the user to be entirely accountable for their safety. This burden may be alleviated with the more security of associate object detector. Additionally, the quality of the white cane has no vary of physical choices. It places an extra burden on the user by forcing an amendment in handle grip betting on however jam-packed the environment is. The white cane is needed by the user to adapt to the cane instead of having a cane, which will adapt to the user.

To address these shortcomings, the good Cane project examines, however, Canes may be technologically equipped to boost their practicality in an exceeding method. This Cane will be conjointly economically accessible. The goal for the Smart Cane project is to eliminate this drawback by planning, building and testing a cane for the blind that utilizes laptop and sensory technology to produce object detection capabilities and freedom of physical variables. Once the project is completed, the cane style is quantitatively and qualitatively examined to see its success as a product.

Bibliography

This section describes applicable connected works on the event of Smart Canes meant for visually impaired people.

The white cane originated in Europe in 1921. Once James Biggs, a creative person of UN agency had lost his vision, began to color his walking Cane white to alert others to his presence. Once veterans of warfare II came to America with vision impairment and sightlessness and they wished to own an equivalent level of independence as that they had before the war. Owing to this, the white walking Cane

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was altered into the long cane type that is still current these days. At present, eighty-two of the world's blind population is at the age of fifty and higher than. More or less ninetieth of the world has visually impaired board-developing nations because of the dearth of care and medical treatments. These figures square measure vital once considering the population that the good Cane is addressing.

According to A. Nurulnadwan, M.R. Nur-Hazwani, and A.M. Ariffin (A. Nurulnadwan, M.R. Nur-Hazwani, and A.M. Ariffin, 2009), technology will facilitate in reducing several barriers that individuals with disabilities face. These sorts of technologies square measure stated as helpful technology (AT).

There square measure many sorts of disabilities, as well as physical disabilities, deaf and visually impaired. AT has been used in helping them. However, developing Associate in Nursing AT is pricey (Herman N. J., 1999) and creating their price high.

According to Mazo and Rodriguez the blind Cane is one amongst the helping tools for the visually-impaired and it's extremely vital. Per (Herman N. J., 1999), one amongst the most issues of the visually impaired, is that almost all of those folks have lost their physical integrity. In addition, they are doing not place confidence in themselves. This statement has been tried by Bouvrie (Bouvrie J. V. 2007), within which Associate in Nursing experiment name "Project Prakash" has been applied. It absolutely was meant at testing the visually impaired to utilize their brain to spot the set of objects. Per Yangtze and Song (Chang C. C. and Song K. T., 2000), this may even be applied to completely different scenario. Once the visually impaired walk into replacement surroundings, they are going to notice it troublesome to con the locations of the thing or obstacles. These examples demonstrate the difficulties of visually impaired folks.

The Guide Cane is intended to assist the visually impaired users navigate safely and quickly among obstacles and different hazards (Borenstein J. and Ulrich I., 2001). Guide Cane is employed just like the wide used white cane, wherever the user holds the Guide Cane ahead of the user whereas walking. The Guide Cane is significantly heavier than the white cane, because of it uses a servomotor. The wheels square measure equipped with encoders to see the relative motion. The servomotor, controlled by the intrinsic pc, will steer the wheels left and right relative to the cane. To find obstacles, the Guide Cane is supplied with 10 unhearable sensors. A mini joystick situated at the handle permits the user to specify a desired direction of motion. Guide Cane is much heavier than the normal white Cane and additionally it is arduous to stay as a result of it cannot be doubled.

Smart Cane is one invention that was originally the creation of a standard blind cane however; it is equipped with a device system. This invention resembles Guide Cane wherever this invention contains a range of unhearable sensors and servomotors. This invention is intended with the aim at serving to the blind in navigating. Inaudible sensors have to compel to sight and avoid obstacles or objects set ahead of the user. Meantime the fuzzy controller is needed to work out the directions, which will be dead as an example to show right, left or stop. Like Guide Cane, this invention additionally encompasses a management button on the handle, and the button has four completely different directions. This invention has equivalent weaknesses because the Guide Cane wherever there will be a retardant to avoid wasting house or to position the sensible cane. Besides that, value is additionally a weakness during this project because it uses inaudible sensors and variety of servo motors. If the price is just too high, users do not seem to be ready to afford for it because of the typical financial gain of the visually impaired folks is comparatively little.

Smart Cane has been designed by students from Central Michigan University wherever this invention uses oftenest Identification (RFID). RFID is used to sight objects or obstacles ahead of the user and detects the RFID tag that has been placed in many areas to navigate the users. This invention is simply sort of a traditional stick however is provided with a bag, worn by the user. The bag provides electricity power to the invention and informs the user through speakers within the bag. For users of United Nations agency does not have the flexibility to listen to, there square measure special gloves, which will vibrate at each finger, during which vibrations in every finger have different meanings. However, this invention has many weaknesses and is just appropriate for tiny areas. This is often as a result of it solely detects the realm with RFID tag otherwise this invention solely works as an everyday blind cane. Additionally, this invention needs a high value if it's utilized in the external atmosphere as a result of the larger space that require to be labeled, the upper value is required.

Mechatronic Blind Stick may be a guiding system, designed to facilitate the daily work among the visually impaired folks. This invention has several similarities with the sensible Blind Cane. During which this invention

uses inaudible sensors and sound vibrations. However, this invention additionally has many weaknesses; it cannot be closed and troublesome to stay. Additionally, this invention is not equipped with sensors to sight the water areas.

METHODOLOGY

Materials and Methods

There were two main elements that were the main target of the good Cane style process: one is changing the fundamental mechanics of the standard white cane and the other one is group action technology as to create it "smart". It had been all over that each would be addressed, initially by creating the cane adjustable by adding a device that may extend the very of the user may observe. The detection of the potential obstacles would then be transmitted to the user through vibrations within the handle.

The Arduino

The sensible Cane's sensors and motors are powered by an Arduino microcontroller. The Arduino could be a programmable electronic platform that permits users to produce prototypes. Together with a board and alternative items of instrumentality equipment, the Arduino is often wont to create varied electronic input, output, and sensory systems. Other than basic electronic hardware, a large variety of advanced devices, as well as sensors, is created to be compatible with the Arduino system. The Arduino artificial language is C based mostly and maybe wont to produce a large type of programs. The Arduino is additionally created a lot of accessible by its low price. Most boards (including the Uno, which the sensible Cane uses) price is $30.

Pulse Width Modulation

The Arduino permits for input and output by plugging wires into 'pins'. Input pins scan information (such as info from a sensor) and square measure capable of taking in a very continuous varies of values. Thus, through sensors, the Arduino may be incessantly updated with info regarding the surroundings around it. The output pins send a current to any device connected to them, like a motor or a lightweight bulb. Not like the input pins, there square measure solely two prospects for the voltage: 5V or 0V. Bit by bit dynamical the speed of the motor needs never-ending amendment in voltage that is not potential with the output pins. However, the Arduino will leave (and has special output pins dedicated to) Pulse Width Modulation (abbreviated as PWM). Rather than go over several voltages, the voltage apace changes from 0V to 5V. PWM simulates a gradual amendment from one voltage to a different, providing something connected to the pin to vary at a time. As an example, if 5V square measure being outputted one-fifth of the time, this can be called a two hundredth duty cycle, and the simulated voltage is one-fifth of 5V, i.e. 1V.

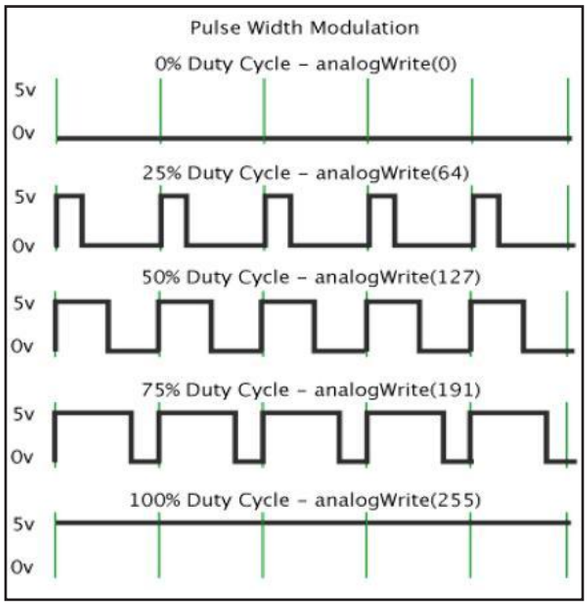


Fig. 1: This Diagram Shows how the Number of Pulses Sent Changes Depending on the Analog Write Value

A operate designed into the Arduino, analog Write (), permits a program to create use of the PWM operate just by plugging in a very price starting from zero to 255, with the latter being the utmost double voltage (a continuous output of 5V).

The Ultrasonic Sensor

The detector employed in the sensible Cane is that the HC-SR04. It emits associate ultrasound at 40,000 cycles that travels through the air associated. If there is an object or obstacle on its path, it will recover to the module. Considering the period and therefore the speed of the sound one will calculate the gap. The HC-SR04 inaudible Module has four pins- Ground, VCC, Trig, and Echo. The bottom and therefore the VCC pins of the module must be

connected to the bottom and therefore the five volts pins on the Arduino board severally and therefore the trig and echo pins to any Digital I/O pin on the Arduino board. So as to come up with the ultrasound one must set the Trig on a High State for 10 µs. which will send associate eight cycles sonic burst which is able to travel at the speed sound and it'll be received within the Echo pin. The Echo pin can output the time in microseconds the acoustic wave traveled. For instance, if the article is 10 cm aloof from the detector, and therefore the speed of the sound is 340 m/s or 0.034 cm/µs the acoustic wave can get to travel concerning 294 ? However, what we may get from the Echo pin are double that variety because of the acoustic wave must travel forward and bounce backward. thus so as to induce the gap in cm we'd like to multiply the received period of time price from the echo pin by 0.034 and divide it by 2.

Creating the Ergonomic Design

Besides the sensory system itself, the most innovative and important aspect of the Smart Cane is the ergonomic design. The design began with preliminary measurements and sketches. Then, the cane was designed and modeled in 3-D using Autodesk AutoCAD software.

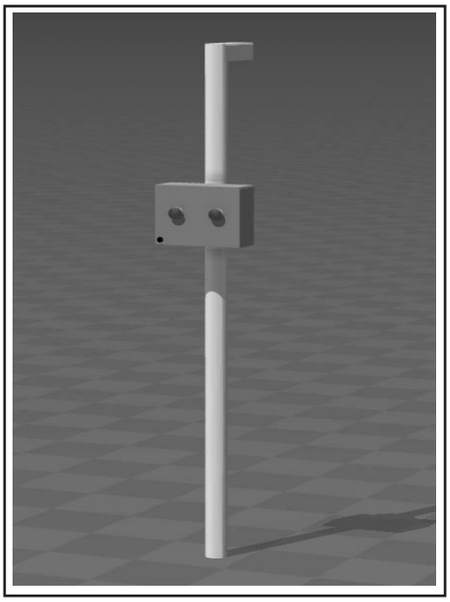


Fig. 2: Design of the Smart Cane

This allowed for the Arduino, ultrasonic sensor, breadboard, vibration motor, battery and the on-off switch to be placed inside a box attached to the cane.

Result Analysis

Few details had been obtained when analyzing the customer review as Quality Function Deployment (QFD) listed below:

- Increase of the working range of the cane
- Durability
- Recharge ability of the power source
- Water proof covering for the electronic parts
- Light weight
- Low price

The research work was done focusing on those criteria obtained from the customer reviews and the smart cane is able to detect the obstacle in path such as chair, pole, human, wall, and door up to 2-meter efficiently.

Discussion

Key Findings of the research work is listed below:

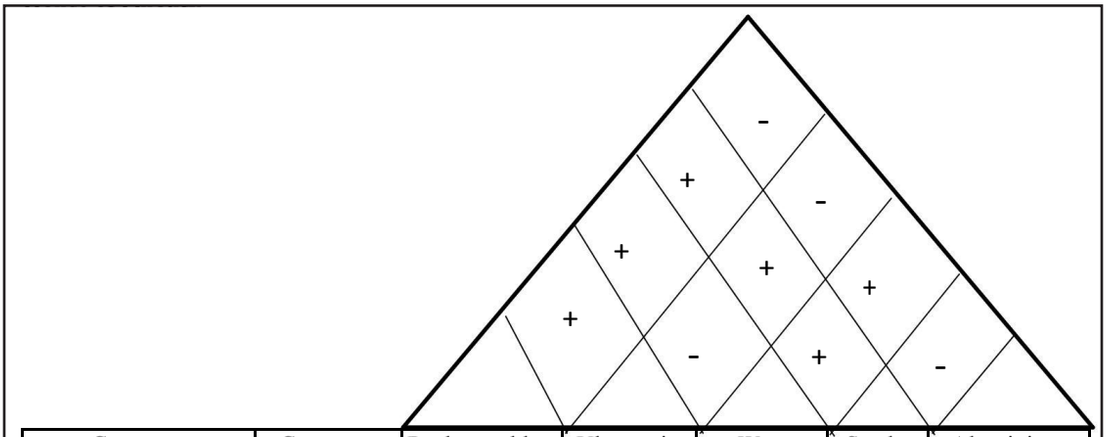
- The device increases the confidence of the users due to which travel time for majority of the users is reduced.
- During the study, users suggested various modifications such as reduced weight, reliability in detection of obstacles and improved path finding abilities.
- Training is very critical for the acceptance and use of this device.

Every customer had his or her own unique reviews about the Smart Cane. However, some criteria were common in every case and by following the process of QFD, the final specifications for the smart cane were found and focusing on those specifications, the cane has produced. Moreover, the findings were discovered from the reviews of the final product known as the Smart Cane.

Conclusion

The main purpose of this study is to supply an image, which will notice objects or obstacles in front of users and feeds warning back, within the styles of sound and vibration, to users. From the tests dole out on its functions reveal that the developed image that is known as Sensible Cane has achieved its objectives.

Table 1: House of Quality of Smart Cane



Customer Requirements	Customer Importance	Rechargeable battery	Ultrasonic Sensor	Water Proof Covering	Steel Parts	Aluminium Parts
Increase the working range of the cane	40	7	10	10	7	10
Reliable	20	7	7	3	10	7
Rechargeable power source	20	10	7	7	3	3
Light weight	10	3	7	3	7	10
Low price	10	7	7	7	7	10
Target values		720	820	700	680	800
Ranking		3	1	4	5	2

Relation, Symbol & Rating (0 – 10):
Strong Relationship = 10,
Moderate Relationship = 7,
Weak Relationship = 3,
Positive Relation= +,
Negative Relation= –

This study would suggest that an influence provide meter reading will be put in to watch its power standing. The inaudible sensor's operating vary may be variable by the user. GSM hunter may be wont to acknowledge the user regarding his/her position. This Smart and Sensible Cane technology will be used widely among visually impaired personals and create them a little more well-off in their life and also the Sensible Cane in-built this project is additionally low cost and approachable for pretty much each user.

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