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Multi-Utility Walking Assist

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Abstract:- This project involves the development of multi-utility walking assist to aid elderly in order to allow their unrestricted movement and to ensure safety to travel outdoors and peace of mind to family members who can track the movement. Various sensors including Ultrasonic Sensor (HC-SR04), gyroscopic sensor, proximity sensor , ADXL accelerometer, Piezoelectric sensor, LDR/IR(light detection sensor) are incorporated to create a seamless experience for the user providing the person with safety and user experience. Carbon fiber reduces weight by 40% compared aluminum at the same time doubling the strength and improving aesthetic look. In addition to this GSM/GPS module is incorporated to access the location by family members at all times.

Keywords:- *Ultrasonic Sensor, ADXL Accelerometer, Piezoelectric Sensor, LDR/IR(Light Detection Sensor), Carbon Fiber, Aluminum, GSM/GPS Module.*

I. INTRODUCTION

Walking is the most basic and common mode of transportation, and the favorable effects of walking on a variety of physical and psychological outcomes are well-established. For elders in particular, daily walking has significant health benefits and thus prevents disabilities. More established grown-ups today have a more dynamic way of life (for example they travel more) than past ages. However, in contrast to past ages, the current age of older folks have a driving permit and have thus created vehicle pertaining propensities. Many people prefer to go by automobile rather than walking or taking public transportation, according to studies. As a result, they do not profit from walking in the same way that past generations did. (Ketcham et al.2005). Most health committees recommend that elders engage in moderate-intensity physical activity for 150 minutes per week, which can be accomplished by taking a 20-minute stroll every day. (Rao et al.2004).

The problem we are addressing is the movement of elderly people, who are dependent on others to move about one place to another. Elderly people have their own needs and instead of depending on someone, this walking stick helps to make them self-dependent and do their daily chores. The walking stick is energy efficient, lightweight and easy to use, thereby better than a conventional one in all aspects. One added benefit is that the GPS-GSM module helps to keep track of the movements by other family members ensuring them of the current position of elderly people (Thakur et al. 2016).

The proliferation of new and inventive technologies in this modern technological period provides numerous options for everyone to live a more comfortable existence. Some of the new walking sticks have new features but are expensive, but most elderly people don't have the means to afford this, on the other hand less expensive ones don't have the necessary features. So, with the development of the Multiutility walking assist we aim to cure this problem with help of providing advanced technology at an affordable price.

II. OBJECTIVE

With the introduction of the Multi-utility Walking Assist we aspire to maneuver certain difficulties that the elderly citizens face while carrying out their daily essential activities which require them to move from one place to another (Rao et al. 2004). They often tend to look for help so that they can carry out these activities. The Multi-utility Walking Assist glows a system that tries to eradicate this feeling of helplessness and makes them self-dependent to do their daily chores. It is a walking stick, that can be conveniently used by the elderly people. It is completely robotized, simple to keep up with, modest and it is entirely agreeable to utilize. The stick is incorporated with several sensors such as the proximity sensor, ultrasonic sensor, an accelerometer, IR light sensor and also a GPS GSM module (Thakur et al. 2018) . The ultrasonic and proximity sensors are enabled for detecting any hinderance that is nearby. Accelerometers have the potential to save the lives of the elderly and people who have trouble standing (Niu et al. 2018). These delicate accelerometers are utilized in various fall identification gadgets. They sense when somebody has unexpectedly fallen by deciding the adjustment of their speed and toward the path, they are moving. If the device determines that the values for these two variables fall into the danger category, it will automatically send a fall alert and call for help. IR light sensors use a LDR (Light Detective Resistors) which can detect the change in the intensity of light that is incident on them as the resistance of their resistors tends to change accordingly (Jayaraman et al.2020) . The GPS module that is present provides a sense of safety and surety to the family members of the elderly person regarding his indoor and outdoor location at all times (Janwadkar et al.2016). The GMS module on the other hand can send alert messages to the family members related to the elderly person in case of an emergency.(Swapna,P. 2016) The power consumption of the Multi-utility walking assist is significantly low and can be operated easily. Over all the stick is exceptionally financial over the ordinary one.

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III. METHODOLOGY

3.1 Concept Generation:

For a better understanding about the needs and problems of the elderly citizens and what the other members of the family are looking forward to or expect in a product that can be of quintessential standards when catering to the needs of the elderly citizens in the family, we had held an online survey . From the data collected through the online survey, we got a better clarity of the problems the elderly face and then we thus plotted a mind map, empathy map and a journey map. By the help of these methods we were able to arrive at the crux of the problems and were thus able to deduce solutions for them. Going through a few research papers and articles we could gather information regarding the functionality and limitations of these sensors and how we could combine various sensors on a single system. Reverse engineering and brainstorming helped to assess the limitations these sensors had and thus helped to negate those limitations providing a chance to have maximum efficiency.

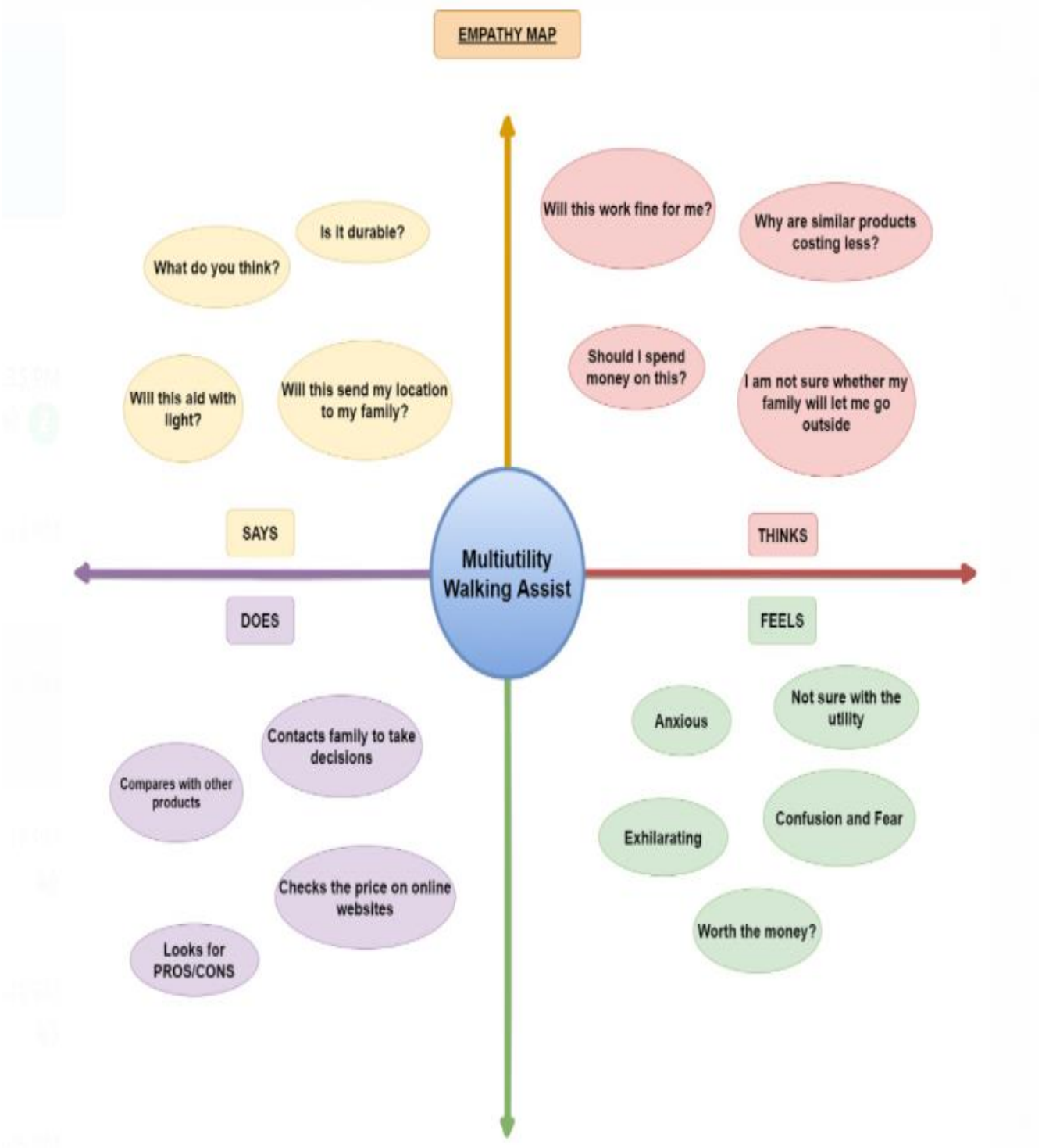

Fig 1: Empathy Map

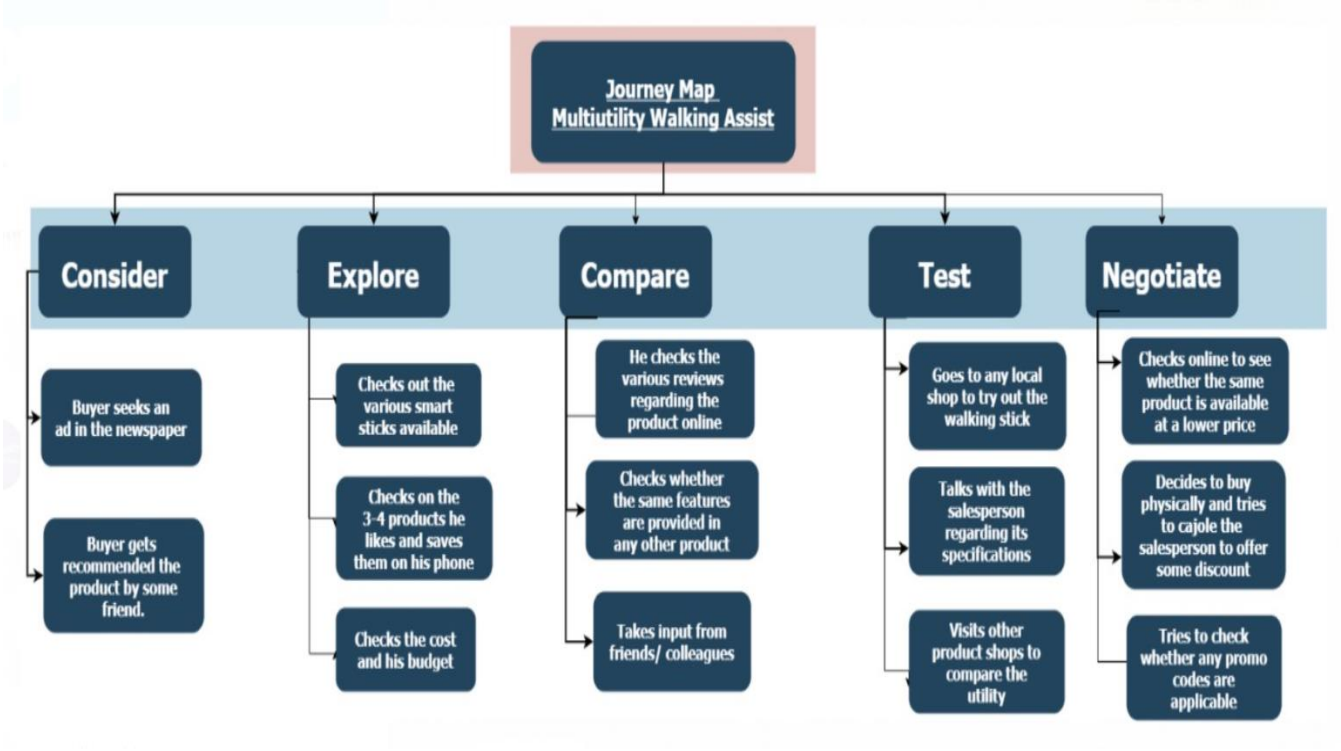

Fig 2: Journey Map

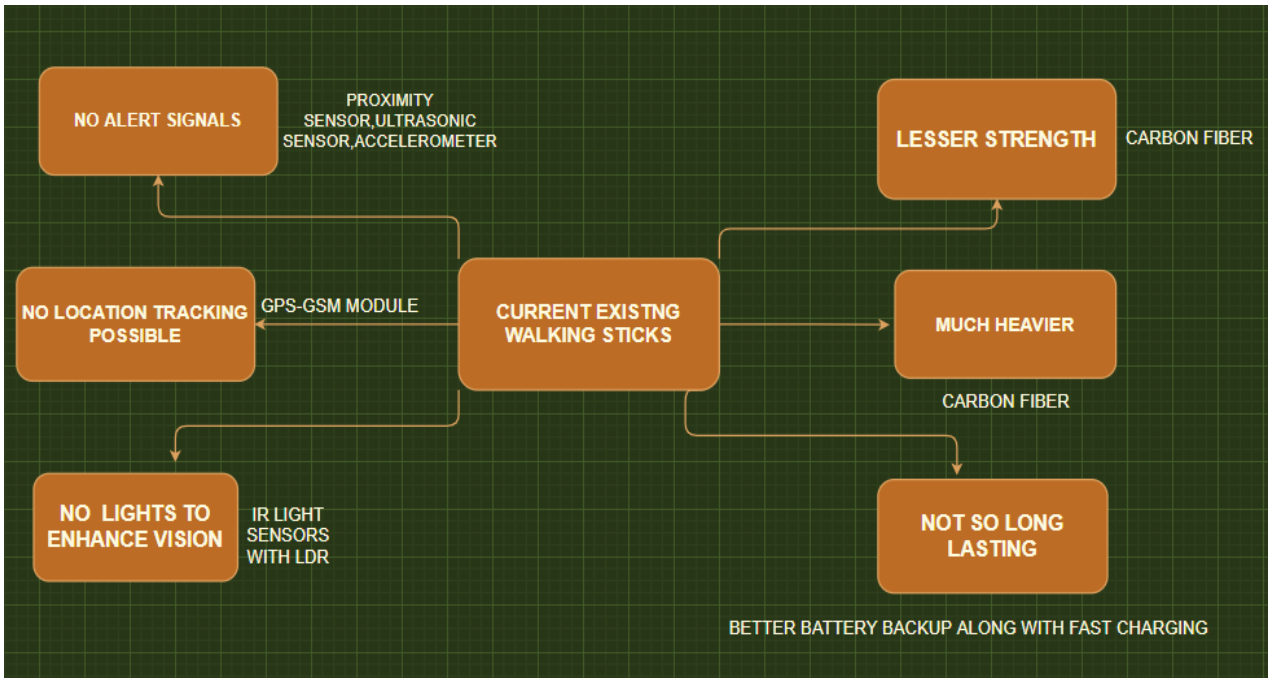

Fig 3: Mind Map

After the completion of the concept generation stage, we decided to incorporate the following features into the Multi-utility Walking Assist. The features are as follows:

1.) Live location tracker
2.) Alert system
3.) Close-field object detection
4.) Automatic light vision
5.) Rechargeable battery

3.2 Concept Selection:

The concept selection matrix/grid here provides an idea regarding which all components that can be integrated in the system and which all cannot. Each component is given importance on the context of selection criteria. If the component does satisfy the conditions present in the selection criteria, it is then given a score. Based upon the score that each component has acquires the component is allotted a rank. The component that has the highest rank is regarded as the concept of highest regard of importance in the entire system.

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SELECTION CRITERIA	LOCATION TRACKING	VIBRATION SENSOR	LIGHT VISIBILITY	CHARGING	SOUND ALERT
EASE OF HANDLING	+	+	+	+	0
EASE OF USE	+	+	+	+	0
ACCURACY	+	0	+	+	+
DURABILITY	+	+	+	+	+
PORTABILITY	0	0	+	+	0
EASE OF MANUFACTURING	+	+	+	+	+
RELIABILITY OF SETTING	+	+	+	+	+
COUNT	6	5	7	7	4
RANK	3	4	2	1	5
SELECTED OR NOT	YES	YES	YES	YES	YES

Fig 4: Concept screening matrix/grid

From the Concept Screening matrix it is explicit that all of the concepts are of almost equal importance and hence all of the concepts can be added.

Hence going by the results that have been inferred from the matrix above and assessment of the needs and desires of the customers that have been collected through online surveys, it can be concluded that customers are anticipating for the following features:

- **Long battery life** and **fast charging** for the device battery, so that the elderly who usually tend to charge the battery can still use it without any low battery issue.
- **Location Tracker** is necessary so that the other members will constantly have an idea about the indoor and outdoor location of the elderly member in the family.
- The **Light Visibility** is highly required as most of the senior citizens, tend to have the cataract problem due to their old age. This light visibility feature will prove to be a huge asset for the senior citizen as it will enable them to see better and more clearly when there is low light.
- The **Vibration** and the **sound alert** features that are employed go hand in hand, as they will allow the elderly citizen to move in a right direction in case any obstacle is present near his vicinity and is causing any hindrance in the path that the person is moving on.

Sensors that have been incorporated in the product:

- **Ultrasonic sensor**: The ultrasonic sensor is used so that the user who is using the stick will gain a better insight regarding the obstacles present ahead and around him.
- **Light sensor**: The light sensor which is automatic, will immediately light up when it detects darkness thus providing a better vision to the elderly person. This feature is heavily helpful when the elderly person has problems with respect to his vision that is quite prevalent among the elderly citizens such as glaucoma, cataracts, etc.
- **Vibration motor(with a buzzer)** : The vibration motor will vibrate in case any vehicle or lateral movement is detected in front of the user. This motor will receive an input signal from one of the 3 ultrasonic sensors which offer a 360◦ range of detection and thereby thus gets actuated and starts vibrating and buzzing providing an message to the elderly citizen to move out of the way or change the direction of his path.
- **GPS-GSM module**: The GPS-GSM module will always be providing the live location of the elderly citizen which will allow the family members to have a constant knowledge at all times regarding the whereabouts of the senior citizen.
- **Gyroscope sensor**: This sensor would be added into the system with the sensitivity adjusted to such a limit such that incase there is any light shift in the calibration with regard to the balance of the stick, then immediately an alert signal would be sent to the members of the household implicating that maybe the senior citizen has fallen down or is at urgent emergency situation.

Model of the product:

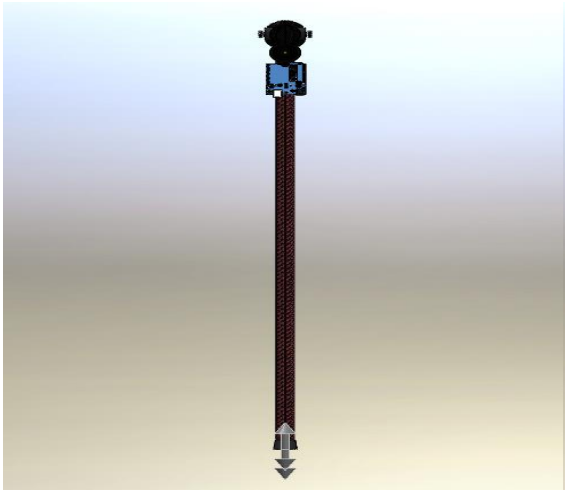


Fig 5: Front View

Fig 6: Left view

Fig 7: Right view

Fig 8: Back view

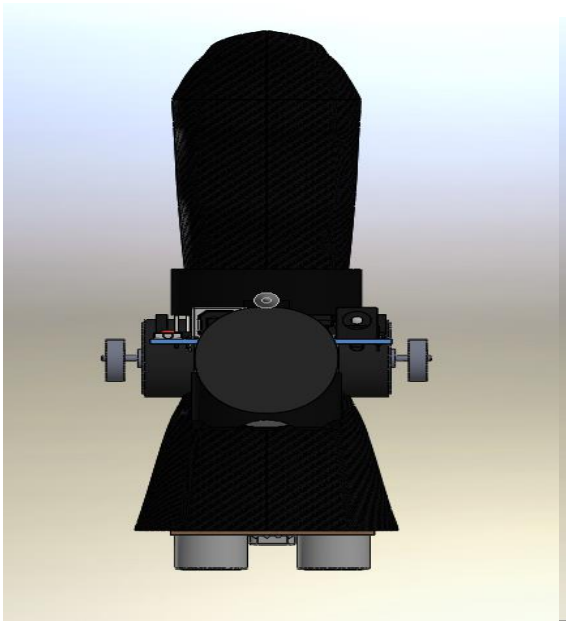


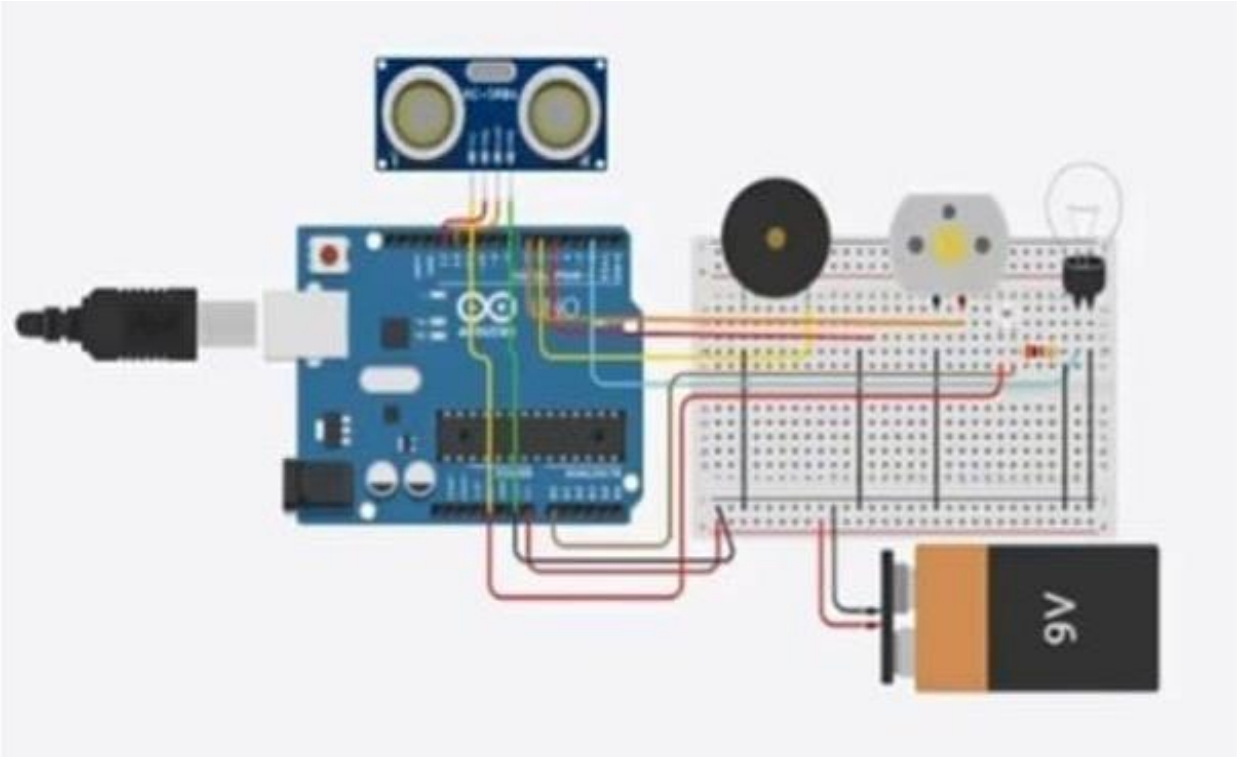
Fig 9: Bottom view

Fig 10: Isometric view

Fig 11: Dimetric view

Fig 12: Trimetric view

Model of the circuit in TinkerCAD:



The model was built in TinkerCad open source software. The basic circuit consists of the microcontroller Arduino Uno, HC-SR-04 Ultrasonic sensor, Buzzer, Vibration motor, Light source, Ambient light sensor, breadboard and a 9V rechargeable battery. Whenever the ultrasonic sensor senses an obstacle in its proximity, it sends the output signal to Arduino Uno which thereby activates the warning mechanism to the user. In the alert mechanism, the buzzer sound is activated and vibration motor is rotated to indicate the user about incoming obstacle. The ambient light sensor senses the wavelength of the light around its environment. If the environment is dark and dim, it automatically sends the signal to Arduino to switch on the light source. The opposite happens when the environment is bright and shiny.

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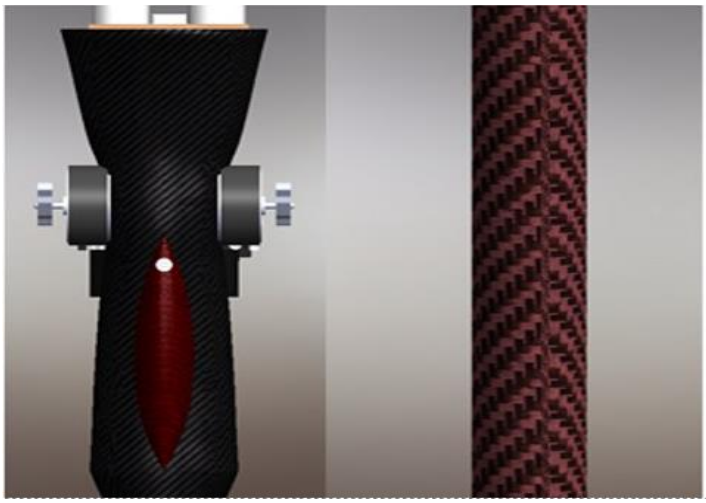
Product Description:

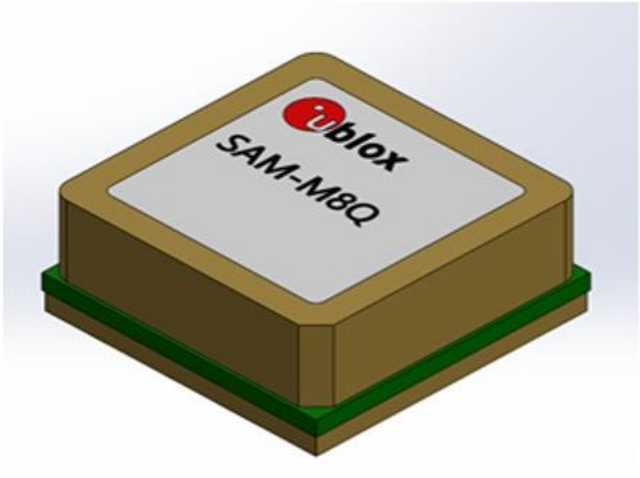
Easy movement

Better ergonomic capability than the traditional walking stick



Reduced weight

Carbon fiber, which is durable and 5 times lighter than steel and 42% lighter than aluminium



24 x 7 location tracking

GPS-GSM module helps to track live location accurately

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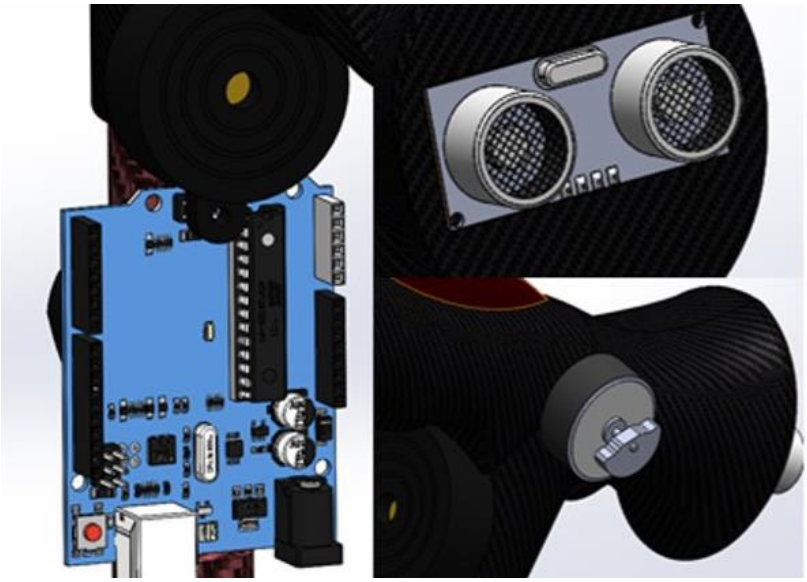

The Multi-Utility Walking Assist or the MUWA is the best companion to the elderly, light and ergonomic in nature but at the same time durability is the best in class, there's nothing to worry about your safety. With the GPS-GSM module and the multiple sensors present the children can enjoy peace of mind and not worry about their aged parents. With the sensors dependent on the environment orientation, the user has the seamless experience and can once again walk about carefree without the help of others.

Rendered Image of the product:

Rendering assists with making a photorealistic perception of an item as it is being developed. Early ideas can show materials, tones, look and feel. It assists with selling a thought, speeds up idea endorsement and recognizes any plan issues all through the improvement cycle before it takes on an actual structure.

Therefore, a fine rendering with all the material specified was done on our product. We gave it a carbon fiber finish material which would help it in its durability and sustainability. The product has been smoothened and given a better surface finish.

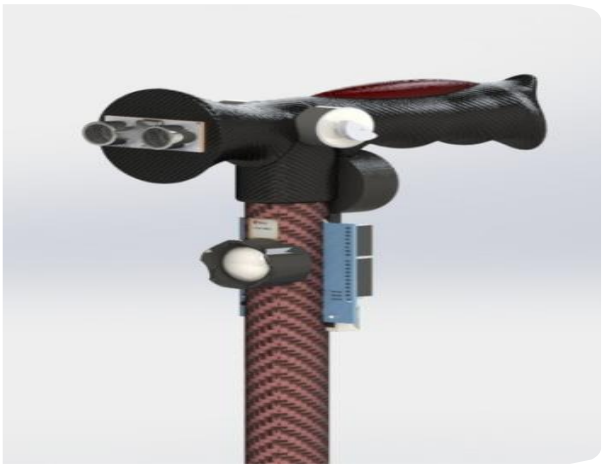

Fig 13: Rendered Image

Sustainability Analysis/Assessment of the product:

The sustainability analysis for the product was carried out on SolidWorks using the Sustainability feature that is used for evaluation of the product.

Model Name:	Walking Stick
Material:	Zoltek Panex 33
Recycled content:	0.00 %
Weight:	1359.44 g
Manufacturing process:	Custom
Surface Area:	1.10E+5 mm²
Built to last:	10 year
Duration of use:	10 year

Manufacturing Region
The choice of manufacturing region determines the energy sources and technologies used in the modeled material creation and manufacturing steps of the product's life cycle.

Use Region
The use region is used to determine the energy sources consumed during the product's use phase (if applicable) and the destination for the product at its end-of-life. Together with the manufacturing region, the use region is also used to estimate the environmental impacts associated with transporting the product from its manufacturing location to its use location.

Model Name:	Walking Stick	Material:	Zoltek Panex 33	Weight:	1359.44 g	Manufacturing process:
				Surface Area:	1.10E+5 mm²	Custom
		Recycled content:	0.00 %	Built to last:	10 year	
				Duration of use:	10 year	

Material Zoltek Panex 33 0.00 %

Material Unit Cost Not Defined

Manufacturing

Region:	India
Process:	Custom
Electricity consumption:	0.766 kWh/lbs
Natural gas consumption:	410 BTU/lbs
Scrap rate:	5.0 %
Built to last:	10 year
Part is painted:	Yes (Water-based Paint)

Use

Region:	India
Duration of use:	10 year

Transportation

Truck distance:	1600 km
Train distance:	0.00 km
Ship distance:	0.00 km
Airplane Distance:	0.00 km

End of Life

Recycled:	8.0 %
Incinerated:	20 %
Landfill:	73 %

Environmental Impact (calculated using CML impact assessment methodology)

Carbon Footprint

34 kg CO_2e

Material:	31 kg CO_2e
Manufacturing:	1.8 kg CO_2e
Transportation:	0.109 kg CO_2e
End of Life:	1.0 kg CO_2e

Total Energy Consumed

580 MJ

Material:	560 MJ
Manufacturing:	21 MJ
Transportation:	1.5 MJ
End of Life:	0.765 MJ

Air Acidification

0.082 kg SO_2e

Material:	0.062 kg SO_2e
Manufacturing:	0.019 kg SO_2e
Transportation:	5.3E-4 kg SO_2e
End of Life:	5.4E-4 kg SO_2e

Water Eutrophication

0.010 kg PO_4e

Material:	7.9E-3 kg PO_4e
Manufacturing:	9.8E-4 kg PO_4e
Transportation:	1.1E-4 kg PO_4e
End of Life:	1.3E-3 kg PO_4e

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Cost Analysis:

The cost analysis for the product was carried out on SolidWorks using the Costing feature that is used for evaluation of the product.

SOLIDWORKS Costing Report

Assembly Name:	MUWA
Date and time of report:	05-Jun-21 9:22:14 PM
Total weight:	3.08647 lb
Total stock weight:	5.62611 lb

Quantity to Produce

Total number of assemblies:	1
Lot size:	1

Estimated cost per assembly: 65.67 USD

Component Cost Impact

Top Ten Components Contributing Most to Assembly Cost

Component	Configuration	Material Cost (USD/Assembly)	Manufacturing Cost (USD/Assembly)	Total Cost (USD/Assembly)
Walking Stick	Pre-Determined	23.67	8.01	31.68
GPS-GSM Module	Default	16.21	5.66	21.87
Arduino (Uno)	Default	4.47	1.21	5.68
Light Source	Default	3.83	0.41	4.24
Ultrasonic Sensor	Default	2.00	0.20	2.20
Total		50.18	15.49	65.67

Cost Breakdown for Each Part

Calculated Parts	Method	Quantity	Part Cost (USD/Assembly)	Total Cost (USD / Assembly)
Arduino (Uno)	Multibody	1	5.47	5.47
Light Source	Multibody	1	3.83	3.83
GPS-GSM Module	Multibody	1	21.87	21.87
Ultrasonic sensor	Multibody	2	1.03	2.06
Vibration motor with buzzer	Multibody	1	0.41	0.41
Total				33.64

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IV. CONCLUSION

The Multi Utility Walking Assist is designed and the circuitry is also made which involve the ultrasonic sensor, GPS-GSM module, Vibration motor(with a buzzer) ,Gyroscope sensor and Light sensor. All these sensors are working together covering all the facets, that would allow the user to be completely independent and at the same time provides the user with an assured feeling of safety. The Multi Utility Walking Stick is economic and it has also been designed using components and materials that are sustainable in the environment. The features that have been incorporated into the stick based on the uses propounded along with the economic price and sustainability aspect of the product would seem very appealing and congenial to the target customers, thereby allowing the elderly citizens to be a beneficiary of the product and thus eliminating the daily problems they usually face.

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