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Design and Development of Intelligent Walking Stick for Blind Individuals

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Abstract: In this high-tech era, technology has made it possible that everyone can live a comfortable life. But somehow the blind humans want to depend upon others of their each day lifestyles which in the long run makes them much less assured in an strange environment. However in recent times the explosion of progressive generation provides many possibilities for them to stay expectantly without feeling as a burden. So, on this paper, we recommend a new concept of an shrewd taking walks stick tool that can be used for protection and navigation to manual them to attain their vacation spot region competently without going through any problems. This system is made with the sensor incorporating the networks that can be implemented within a walking stick, which can provide the group communication between them, in which the navigation information and networks can be provided. It performs some functions such as Real time tracking, Real time monitoring of user, Emergency alert to the guardian, ambulance or police, Obstacle Detection, Voice assistant. It consists of Arduino, Global Positioning System (GPS) along with sensors like Ultrasonic and other supportive sensors and an Android-based Application (APP).

Keywords. Intelligent device, Arduino, Ultrasonic Sensor, GPS.

I. INTRODUCTION

To care for someone who as soon as cared for us is the highest honour. Ageing is an inevitable process. It is inherent to man or women and with old age comes maturity, wisdom and respectability. Blind human beings are the revered participants of our circle of relatives, sensible sages and keeper of traditions, they've lived long they realize life very well. As they grow old, they get weaker and are dependent on others for everything. They even cannot walk on their own they need a support while walking. Everyday objects are transformed into smart objects able to sense, interpret and react to the environment thanks to the combination of Internet and emerging technologies. A smart waking stick for elders can be used to aid walking and assist them to maintain balance and minimize the risk of falling. Because of its versatility, regularly a pair of on foot sticks can be used as a stick to elevate you off the ground, for hiking in choppy terrain or to in reality stability yourself whist strolling. It could aid in strolling usually, whilst taking weight off of a sore, injured or weaker foot, ankle, hip or knee.

The proposed smart walking stick is equipped with different sensors which will alert user about various obstacles coming ahead in his way while walking. This smart walking stick has monitoring features. GPS and GSM modules are geared up in persist with music place of person and send an alert message to every other person. Another crucial function of this walking stick is voice assistant gadget. The user can interact with voice assistant to get some information or finding some route or to share emotions. Those features of clever taking walks stick are beneficial in guiding customers in their mobility and navigation to guide them to reach their destination place thoroughly without dealing with any problems. With the help of this clever on foot stick user can walk freely and without problems in unknown environment without depending on different character. All of the modules of proposed clever stick along with the battery ought to be concealed in the keep on with lessen the threat of damage to the circuit and look fashionable. Indeed, mobility gadgets and private help are strongly preferred to make sure a certain independence of the person.

It performs some functions such as Real time tracking, Real time monitoring of user, Emergency alert to the guardian, ambulance or police, Obstacle Detection, Voice assistant. In Real time tracking we get the exact location of the user and it provides navigation through the Google map. In Real time monitoring the care taker of the user or a guardian can keep a monitor the through a camera. In accordance with the previous we have an emergency alert system which will alert the guardian in case of emergency. In obstacle detection the user will get the alert of the obstacle that arrive in is way. In voice assistant the user can give instructions to the assistant and will respond and act according to the user commands. To work all the different functions, we have components like GSM module, ultrasonic sensor, speaker & mic module.

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II. RELATED WORK

After certain age the blind people get retired from their professional life and begin another part of life at home. Blind people are the source of knowledge, wisdom and full life experience. They share wisdom, knowledge and experience to the younger generation and guide them to lead the life. In this fast-moving world, the younger generation doesn't give enough time for the blind people; hence they are dependent on themselves for mobility and navigation. Phi Van Lam and Yasutaka Fujimoto designed A Robotic Cane for Balance Maintenance Assistance [1]. They designed and fabricated the hardware of a robotic cane with an omni directional wheel and a excessive-velocity processing controller for assisted standing and taking walks. The controller estimates the consumer's outside force with the aid of a lam-primarily based linearization gadget with a nonlinear disturbance observer. Romteera khlaikhayai , chavana pavaganun, benja mangalabruks and preecha yupap in proposed an shrewd taking walks stick for aged and blind protection protection [2] that may be used for protection and navigation. This machine consists of the wi-fi sensor incorporating the advert hoc networks that can be carried out inside a on foot stick, that may provide the group communication between them, wherein the navigation information and networks can be furnished. Yeong-hwa chang, nilima sahoo and hung-wei lin proposed an wise taking walks stick for the visually challenged humans[3]. It consists of raspberry pi and percent as the controller, worldwide positioning device (GPS) at the side of ultrasonic and other sensors and an android-based application (App)to manual them to reach their destination region safely without dealing with any problems. A design and implementation of wise on foot stick based totally on one net net of factors development platform become proposed.[4] by Bo Wang, Wei Xiang, Kairen Ma, Yu Quan Mu, Zheng Wu, it uses GPS, GSM, OneNet to estimate the distance of the obstacle and also to send location to the care taker of the user. A GPS and IOT Equipped Smart Walking Stick was implemented [5-10] by Adnan Dabir, Rutuja Solkar, Manish Kumbhar and Geetha Narayanan. It uses Raspberry-Pi, accelerometers, GPS, Internet of things where accelerometers were used to detect the fall of the user and send alert message.A Real-time monitoring of elderly using their connected walking stick was developed [11-18] by Abdel fetteh Lachtar, Abdennaceur Kachouri and Thierry Val. They have developed a novel method for real-time monitoring of disabled people, using their walking cane equipped with an accelerometer and a magnetometer and also implemented an algorithm for calculating the steps number and the distance traveled.

A Smart stick for Elderly was implemented [19-25] by Lakshmi Boppana, Vishal Jain and Ravi Kishore. It consists of GSM, GPS, IR, Pulse rate Sensor, RFID, Strip and Temperature. This walking stick can monitor various health parameters and can also help to reach home safely. It can also be used to control home appliances and to remind the user for taking the medicine on time A Smart Walking Stick was developed [8] by Srinidhi Srinivasan and Rajesh M. using Raspberry Pi Uno board, Force Sensor, Ultrasonic Sensor, Pressure Sensor. It uses ultrasonic sensors to determine the distance of obstacle from the user. Another smart walking stick was developed [26-34] by Oussama Kessentini, Rejane Dalce, Imen Megdiche and Remi Bastide to predict frailty symptoms. The aim of it is to provide the practitioners with robust models trained with the most realistic data. A Microcontroller Based Smart Walking Stick for Visually Impaired People was proposed [35-45] by M. A. Ikbal, F. Rahman and M. H. Kabir. The aim of this stick is to provide a convenient and safe method to frequently move so that the blind may forget about their disabilities. Another smart walking stick was designed

[46-50] with the aid of s. Srinivasan and m. Rajesh. The principle aim was to make a clever stick to avoid leg weak point, stability loss and unsuitable navigation of interior and exterior. Aniot-primarily based on foot stickwas evolved [51-55] through nagarajan, s and dessai sanket, it aims to increase primary infrastructure for IoT based walking stick, on which similarly sensors and analytics may be extended seamlessly. To add intelligence in the strolling stick and taking walks stick will act as an iot device. A clever quadripod walking stick for the resource and security of visually challenged and blind human beings turned into developed 56-60] by using rout amitejash, roy kshaunish, chhatre swapnil, sahu rhythm, and parveen sultana h. The clever quadripod walking stick will pick out obstructions and alerts the user, relying on the ambient lights, the led mild will glow and in case of an emergency situation, the consumer can press the panic button which sends an SMS containing the GPS coordinates of the keep on with unique numbers.

Above are the some of the models of sticks that are either implemented or proposed that already exists. Each of them has certain advantages and certain disadvantages based on its design, construction and materials and equipment's that are used. Some of them have least features like radio, mp3 player, alarm, fall detection, etc., and some don't .During literature survey, we have noticed a variety of walking sticks designed around the world to help blind people for walking some without any assistance and some with very least features. We propose a walking stick which could be carried by the blind people for mobility and navigation [61-65].

III. OVERVIEW OF PROPOSED SYSTEM

To overcome the certain boundaries and drawbacks of current gadgets we have proposed this sensible device. Foremost objective of this is to make a light weight, inexpensive, intelligent but not complicated so that you can be easy to carry through blind people. The proposed device is a machine integration of both software program and

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hardware. Our project has mainly 4 modules included in it. They are object detection module, moisture detection module, GPS module & GSM module along with it we have a buzzer & buttons. The following is the block diagram of our proposed system shown in Fig.1.

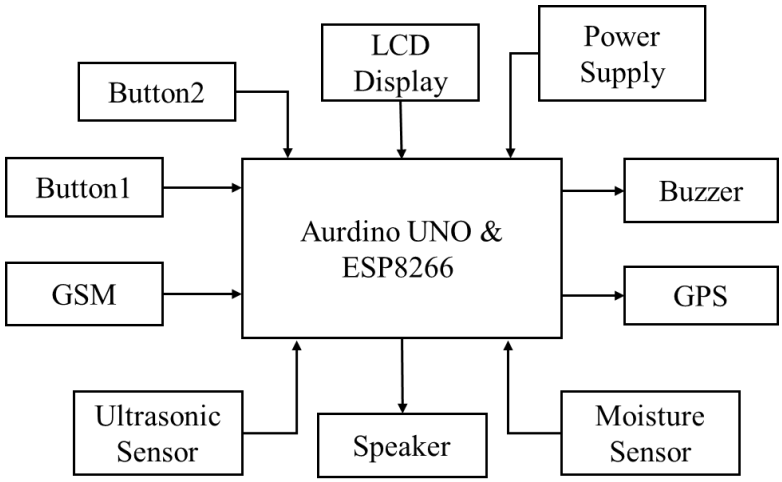

Fig. 1 System block diagram

As we can see from the block diagram, we have used an Ultrasonic Sensor, Moisture Sensor, GPS and GSM module, Buzzer, LCD display and two buttons. Ultrasonic Sensor detects the obstacle and sends the data to the Arduino to calculate the distance of the obstacle is the obstacle is in range specified, it'll send data to LCD display and a buzzer will alert the user. Moisture sensor detects the water or any slippery area surrounding the user and send data to the Arduino intern it sends message on LCD display and a buzzer will alert the user. In the block diagram, it is shown that the sensors and modules (i.e., the input and the output units) are interfaced with the Arduino UNO & ESP8266.
The sensors are related to arduino uno & esp8266 as the enter gadgets and the output gadgets are GSM module and the buzzer. The SIM Slot is connected to ESP8266 and is use to tracking purpose and user's physical device can be connected to a network, Internet or intranet communication and networking capabilities. The Google Assistance is connected to ESP8266 and is quick response to a user(i.e., user ask to questions starting point to the destination point).

In this simulation, Arduino board, GSM, moisture sensor, ultrasonic sensors are present. The moisture sensor is connected to the Arduino pin (pc0) and this sensor is used to sense the water. If there is any water content present in the water sensor it will give the input signal to the Arduino controller and through Arduino board, we can get the output via buzzer or vibration motor. In Real time tracking we get the exact location of the user and it provides navigation through the Google map. In Real time monitoring the care taker of the user or a guardian can keep a monitor the through a camera. In accordance with the previous we have an emergency alert system which will alert the guardian in case of emergency. In obstacle detection the user will get the alert of the obstacle that arrive in is way. To work all the different functions, we have components like GSM module, ultrasonic sensor, speaker & mic module.

Arduino Uno: Arduino UNO is a microcontroller board based on ATmega328p. It has 20pins out of which 16 virtual enter and output pins and 6 analog enter pins, 16mhz quartz crystal, power jack, ICSP header and reset button. Its miles very easy to carry out with Arduino considering that it is person pleasant, the operation voltage is 5v, we will immediately connect it to PC with USB cable, power it with ac-dc adapter or battery. Ultrasonic sensor: hc-src04 ultrasonic sensor has four pins-ground, VCC, cause and echo. It ranging from 2cm to 500cm (5m). Especially it has two beginning –one is transmitter that is used to transmit the signal and some other one is receiver that's used to get hold of the signal. It sends ultrasound waves at high frequency and acquire back the signal.

Moisture sensor: the water indicator circuit operates by using triggering the bottom of the switching transistor. While the stick steps on water, the metallic strips are short-circuited with the aid of the water triggering a pulse at the base of the transistor. As the transistor is induced, the VCC at the collector pin is shorted to the floor thru emitter pin and a low good judgment is surpassed on the pin 3 of the Arduino.

Buzzer: A buzzer is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

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GSM and GPS module: In this module through GPS and GSM the longitude and latitude of the stick is tracked which is dispatched to the emergency contact in emergency conditions. The latitude and longitude of the stick is dispatched as a text message. A GSM modem is a tool which may be either a cell smartphone or a modem tool which can be used to make a computer or every other processor talk over a community. A GSM modem calls for a sim card to be operated and operates over a community range subscribed with the aid of the network operator. It could be related to a pc thru serial, USB or Bluetooth connection. Liquid crystal display 16*2 display: a 16*2 LCD is a fundamental module wherein 2 represents lines and sixteen represents characters in which every man or woman is displayed in five*7-pixel matrix. This LCD has registers namely command and statistics. The command register is used for storing command commands given to the liquid crystal display to do predefined duties like clearing and controlling the display, initializing and so forth.

IV. METHODOLOGY IDENTIFIED

Some of walking-resource robots were design which was useful for blind human beings to navigate from one location to some other and also to roam outside and indoor. All robots had been designed mainly to detect the obstacles which are found in the front the consumer on the time of journeying however these devices only stumble on items that are at the ground or the ones which are not touching the ground. Such assistant devices may solve on part of problem but they face problem at other level. So, the devices should have solution considering in all perceptive which may help them when they walking outside or inside at least at the flat surface. Some of the devices are also implemented to detect fall of the persons which may help both blind and blind people and prevent them from dangerous fall. The devices that are design are not accurate and complex or in some battery life is less. The exiting devices have some drawbacks that may motivate to make efficient and simpler device by overcoming the limitations.

Here we are using Arduino UNO as the controller. So, the input and output units are interfaced with the Arduino controller. The ultrasonic sensor is interfaced with Arduino as the input and the output for the ultrasonic sensor are in the form of sound through buzzer. The GPS and GSM are interfaced with Arduino controller through transmitter and receiver methodology.

The feature of the GPS to find and the reason of GSM is to proportion the area to the precise cell wide variety. The Arduino is coded using Arduino IDE software. Based totally at the function of the Arduino this system turned into logically coded within the Arduino ide software and checked for the errors. If there may be any blunders it will likely be displayed inside the message box. After doing away with the errors, the sketch may be compiled and run correctly. Sooner or later, the cartoon is uploaded into the Arduino controller via USB serial interface.

The major consideration in the development of a walking stick is including the following steps:
The handle of the stick will have a “Disable” button which will be used by the carrier to disable the stick while not being used. A Panic button on the stick will further helps the carrier in connecting with his/her family in times of distress, and any be used by the person to further validate the fall by notifying the family member. The alert notification will be accompanied by the GPS location of the person carrying the stick as derived from the GSM-GPS model. This methodology has the appropriate phases to facilitate the smooth development of the software system.

In addition, system requirements including the hardware and software requirements used in developing this system are described.

1. GSM Module – For sending emergency alert

International machine for cell verbal exchange (GSM) is essentially a GSM modem used for transmitting mobile voice and data offerings operates on the 850mhz, 900mhz, 1800mhz and 1900mhz frequency bands. The GSM module sends the message to the numbers targeted within the program one at a time after the positive put off.

2. GPS Module – For tacking the user and stick

The GPS receiver or GPS module can read the geographical coordinates of a place with the help of at least four GPS satellites. The GPS module continuously provides the data about position of current location on the earth surface in terms of Latitude and Longitude. The information provided by GPS module is sent to the user through an APP.

3. GSM & GPS Module algorithm

Input: Button Event
Output: Sending the alert message
Steps 1: START

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Steps 2: When the system starts then the GPS module is turned on.
Steps 3: GPS module is configured to send only latitude, longitude, timestamp and velocity parameters using NEMA protocol.
Steps 4: WAIT till you get valid latitude and longitude.
Steps 5: Configure SIM800 module in text mode followed by mobile number and SMS containing valid parameters.
Steps 6: STOP

Object Detection Module – For obstacle detection

The ultrasonic sensor module continuously emits the ultrasonic waves & reads the distance travelled by the waves. If the distance is less than the set threshold value it informs the user about the obstacle ahead with a speech.

Object Detection Module algorithm
Input: Returned ultrasonic wave
Output: Distance of obstacle from the stick
Steps 1: START
Steps 2: When the system starts then the ultrasonic module is turned on and emits ultrasonic waves.
Step 3: The reflected waves are recorded and the timestamp between the waves is recorded.
Step 4:The distance of obstacle is calculated using the formula Distance = (Time x Speed of Sound) / 2.
Step 5: Buzzer is activated if the distance is less than pre-defined distance.
Step 6: STOP

Moisture Detection Module – For detecting any wet surface or slippery place
The Moisture sensor detects small puddles or moist surface on the walking path and informs the user about the wet or slippery area ahead with a speech.

Moisture Detection Module algorithm
Input: Any water surface
Output: Presence of water surface
Steps 1: START
Steps 2: When the system starts then the moisture module is turned on.
Steps 3: Continuously checks for the water, if detected alert is sent.
Steps 4: Buzzer is activated if the water is detected.
Steps 5: STOP

V. HARDWARE REQUIREMENTS

5.1 Arduino Uno

Arduino Uno is a microcontroller board based on atmega328p. It has 20pins out of which 16 digital enter and output pins and six analog input pins, 16mhz quartz crystal, energy jack, ICSP header and reset button evaluate to percent microcontroller, it's miles very clean to carry out with Arduino because it's miles person friendly, the operation voltage is 5V, you may immediately join it to pc with USB cable, power it with ac-dc adapter or battery.

Fig. 2. Arduino UNO

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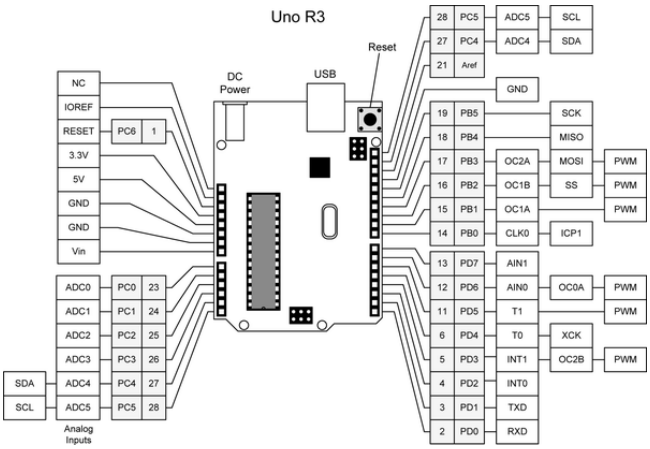

Fig. 3. Arduino UNO Pin Diagram

5.2 Ultrasonic Sensor

Ultrasonic sensor is used to detect the item in front of the character. Hc-src04 ultrasonic sensor has four pins-ground, VCC, cause and echo. It ranging from 2cm to 400cm. In particular it has establishing –one is transmitter which is used to transmit the sign and any other one is receiver that is used to obtain the signal. It sends ultrasound waves at excessive frequency and get hold of returned the sign.

Fig. 4. Ultrasonic sensor

This sensor comes with a range among 2cm to 400cm and is utilized in a huge range of applications inclusive of speed and direction size, wireless charging, humidifiers, clinical ultrasonography, sonar, burglar alarms, and non-unfavorable trying out. It measures correct distance using a non-contact era –a era that includes no physical contact between sensor and item. Transmitter and receiver are two main elements of the sensor in which former converts an electrical sign to ultrasonic waves even as later converts that ultrasonic signals back to electrical signals. It offers precise size info and comes with accuracy (decision) around 3mm, terming there is probably a slight difference inside the calculated distance from the object and the actual distance. Hc-sr04 incorporates four pins in overall.

5.3 ESP8266-12E Module

ESP-12e is a low energy intake of the UART-WIFI module, with very competitive prices within the industry and ultra-low energy consumption generation, designed mainly for cell devices and iot programs, consumer's bodily device can be linked to a wireless community, net or intranet communiqué and networking capabilities. Esp-07 using small ceramic antenna package deal can assist IPEX interface. Users have a variety of set up alternatives.

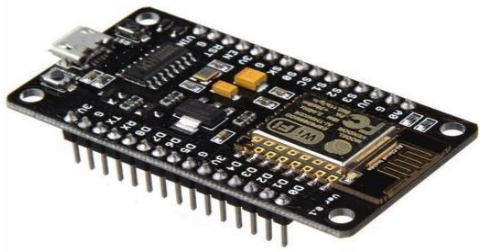

Fig. 5. ESP8266 Microcontroller

5.4 GSM Module

World wide gadget for cell verbal exchange (GSM) is essentially a GSM modem used for transmitting mobile voice and records services operates on the 850mhz, 900mhz, 1800mhz and 1900mhz frequency bands. The GSM module

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selected for these paintings is sim 900a which operates at 900 mhz. This device may be used to make any controller talk over a community by the usage of a sim card over a network range subscribed with the aid of the network operator. It could be connected to a controller via serial, USB or Bluetooth connection. To ship messages the usage of this GSM module, it is required to be configured the usage of 'at' instructions. GSM module requires 12v outside power deliver and linked to controller the usage of 3 pins i. E., tx, rx and gnd.

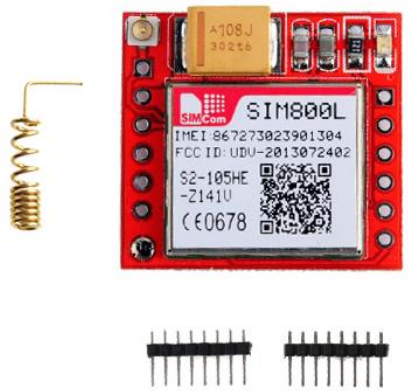

Fig. 6. GSM Module

5.5 GPS Module

The GPS receiver or GPS module can study the geographical coordinates of a place with the help of at least 4 GPS satellites. The geographical coordinates of any region on the planet are specified in phrases of latitude and longitude. The GPS module constantly gives the statistics approximately function of modern-day vicinity on the planet floor with admire to the equator of the earth in terms of latitude and longitude, in which it's miles situated. We have selected GPS module shown for designing smart walking stick. The information provided by GPS module can be converted into readable format by controller. This GPS module is designed using standard NMEA protocol to transmit the position data via serial port. This module can be configured with Arduino using Serial library. Hence, Tx, Rx and GND pins of GPS are connected to the respective pins of Arduino.

Fig. 7. GPS Module

5.6 Moisture Sensor

The moisture sensor is used to measure the water content(moisture) of soil. Whilst the soil is having water shortage, the module output is at excessive degree, else the output is at low level. This sensor reminds the user to water their flora and also monitors the moisture content of soil. It's been extensively utilized in agriculture, land irrigation and botanical gardening. Specs operating voltage: 5V, Working Current: <20mA, Interface type: Analog, Working Temperature:10°C~30°C.

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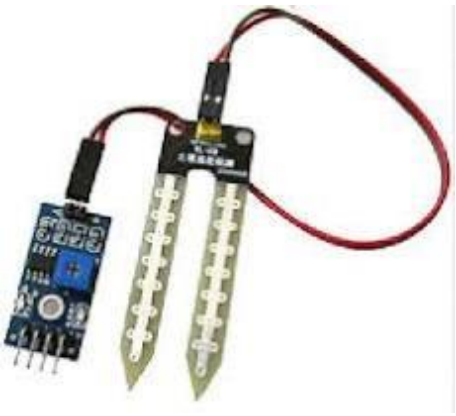

Fig. 8. Moisture sensor

5.7 Buttons

The buttons module is responsible for generating events related to key presses. The source of events are changes to GPIO pins. By default, a button press is indicated by the pin switch from the low to the high state.

Fig. 9. Button

5.8 LCD 16*2 Display

A 16*2 LCD is a primary module in which 2 represents traces and 16 represents characters in which every character is displayed in five*7-pixel matrix. This liquid crystal display has two registers namely command and facts. The command sign in is used for storing command commands given to the LCD to do predefined duties like clearing and controlling the display, initializing and so forth. The statistics sign up is used for storing information that's given by way of the person.

Fig. 10. LCD Display

VI. SCOPE OF THE SYSTEM

- To design and increase a low fee and affordable smart stick for common and poor people.
- To develop a smart stick to avoid leg weakness and improper navigation of indoors and outdoors
- To design a smart stick that can act as a companion for the aged individual people.
- To implement a stick that can allow the care taker of the aged individual to track and keep an eye on where they go.
- Allowing the aged individual people finding of way through a complex environment.
- To make orientation and navigation possible for these people in unknown environment.
- To allow aged individual people become fearless and comfortable about independent mobility or travel.

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- The emergency button at the pinnacle targets to facilitate the person whilst in risky conditions, the GSM module will provide coordinates to the GSM module to send message to the care taker.

VII. CONCLUSION

The smart walking stick for blind people is an concept to offer blind people with assistance in case of emergency. This stick is designed to be unbiased in nature i. E., the processing unit and the strength deliver to it's miles made to be had inside the stick itself. The strolling stick is designed to be weightless so that it's easy for blind people to hold. It has various features that would help the blind people like object detection, slippery area detection, tracking the user through GPS, sending alert messages through GSM and also predicting whether the user is travelling or not. Considering the future development, the size of module embedded in the proposed walking stick can be reduced by designing a PCB to make it compact enough to fit inside the handle of walking stick without losing the traditional shape. In addition, the proposed. Smart walking stick for blind humans is a practically possible product considering the fact that it's far value effective. Even though similar functionalities can be obtained by using some wearable bands and smart phones, blind people who most often forget them or have very little desire to carry them do not show interest to carry multiple gadgets.

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