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Smart Wearable Navigation System for Visually Impaired Persons with Voice and Vibration Alert

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***Abstract* - The blind must rely on others when traveling and doing other activities. To solve this problem to some extent, we are introducing an ultrasonic walking stick for the blind as well as a portable voice and vibration alarm monitoring device. An intelligent key has been developed for the visually impaired, with the help of which ultrasonic sensors can detect obstacles. The blind and the deaf often suffer from the most basic things of daily life and can put their lives in danger while traveling, because our country does not have the necessary equipment to help them avoid the risk. The ultrasonic sensors in hand combine the properties of sound monitoring and benefit from the blind and vibrating alarm function, which benefits from the experience of deafness. The sensor can detect obstacles in the intended range (150 cm) to prevent the blind from being emitted by emitting a clear sound or a vibration of the deaf sensation by placing his finger on the button on the top of the device and vibrating there is a risk. The proposed device is used to guide blind or partially sighted people. It also offers voice alarm to avoid obstacles thanks to ultrasonic sensors. The accelerometer also monitors the person's position and is used to identify the detection of falls. An emergency switch is also integrated to send an emergency alarm to the persons concerned. The main advantage of the system compared to other systems in the region is its low cost, easy transport, reduced power consumption, light weight and it could be used by technically disabled people.**

Keywords: Smart Navigation, wearable sensor, visually impaired, voice assistance, ultrasonic sensor, obstacle avoidance, Arduino Uno.

I. INTRODUCTION

Blindness is a condition in which visual perception is partially or completely absent due to physiological or neurological factors. The main concept of the document is to provide electronic help to help overcome the lack of visualization performance by providing a simple, efficient and configurable electronic guidance system for blind and visually impaired pedestrians. The ultrasonic sensor is the electronic aid offered which detects obstacles in its path by continuously transmitting the ultrasonic waves. If an obstacle occurs nearby, the ultrasonic waves are immediately reflected back to the system. And then the ultrasonic receiver detects these ultrasonic waves. This method supports the microcontroller in retrieving information from ultrasonic waves, and then alerts blind pedestrians by voice message. The advantage of our proposed system is its voice announcement for easy navigation which can help a blind pedestrian to cross a busy street. In addition, this system is an auditory guidance system for visually impaired pedestrians that use the transformation of the audio signal by ultrasound.

The intelligent walking stick has been specially developed to recognize obstacles that can help the blind navigate carefree. Audio messages keep the user up to date and significantly reduce accidents. An automatic changeover with voice command is also integrated to support them in the private sector. This blind guidance system uses ultrasound due to its immunity to ambient noise. Another reason why ultrasound is popular is that the technology is relatively inexpensive and small enough to be transported without complex circuits.

II. PROPOSED SYSTEM

This project presents a prototype model and system concept for providing intelligent electronic assistance to the blind. This system is intended to provide general measures for object detection and to send information to the blind. The system consists of an Arduino microcontroller, an ultrasonic sensor, an accelerometer, an emergency switch and a vibration and voice alarm circuit. This project aims to develop an electronic travel aid kit (ETA) which helps the blind to find a route without obstacle. The ultrasonic sensor is the electronic aid offered which detects obstacles in its path by continuously transmitting the ultrasonic waves. If an obstacle occurs nearby, the ultrasonic waves are immediately reflected back to the system. And then the ultrasonic receiver detects these ultrasonic waves. The ultrasonic sensor is worn on the wrist with a band that detects obstacles near the path. It sends a signal to the Arduino in the person's pocket when an obstacle

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is detected. This method supports the microcontroller in retrieving information from ultrasonic waves, and then alerts blind pedestrians by voice message.

III. BLOCK DIAGRAM

3.1 Description of Proposed system

The hardware consists of Arduino Uno microcontroller board for interfacing all the sensors and GSM modem. Here for measuring the distance of upcoming obstacles SR04 ultrasonic sensor is used. For detecting the fall down of person ADXL335 accelerometer is used. The position of person is sensed by the axial movement of the sensor which monitors the position of person with reference to ground level.

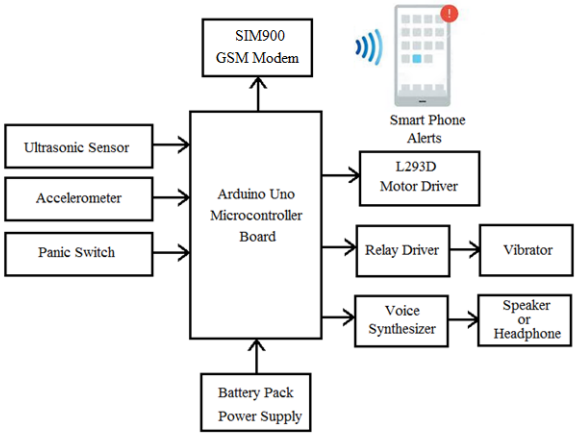

Figure 1: Block diagram of proposed system

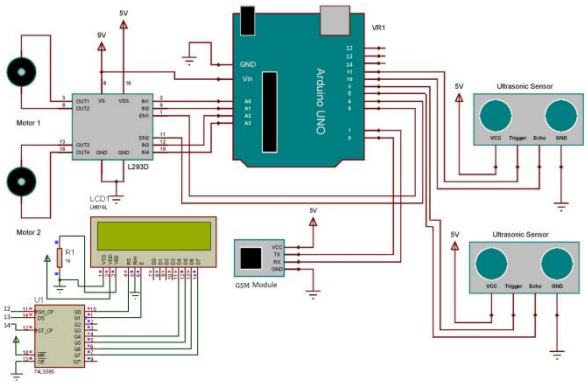

Figure 2: Circuit diagram of proposed system

If the ultrasonic radar sensor detects a obstacle closer to within safer range then alert sound along with vibration is produced. Then after arduino sends a alert message through SIM900 GSM module to the corresponding person through SMS text intimating the emergency status of visually impaired person. Thus the navigation system provides safety and real time monitoring of personal safety to the persons wearing the unit.

IV. HARDWARE DETAILS

4.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 (technical sheet). It has 14 digital input / output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power outlet, an ICSP header and a reset button. It contains everything necessary to support the microcontroller. Simply connect it to a computer with a USB cable or power it with an AC / DC adapter or battery to get started.

The Arduino platform itself is very useful for microcontroller projects, but this alone is not enough to boost the popularity and wide acceptance of the platform. Instead of closing the interface card design and development environment, the entire Arduino project is deeply rooted in the emerging practice of open source hardware. Unlike open source software, for which Linux is generally the most frequently cited example, open source hardware seeks to work together where physical objects are the result. It is a distributed hardware development model with employees generally located in different parts of the world. Open source projects do not allow closed systems, but the individual the freedom to access the source files of a design, make improvements, and pass those improvements on to a wider community.

4.2 Ultrasonic Ranging Module HC - SR04

The HC-SR04 ultrasonic distance measuring module offers a contactless measuring function from 2 cm to 400 cm. The distance accuracy can be up to 3mm.

Figure 3: HC-SR04 Ultrasonic Sensor

The modules include a transmitter, a receiver, and an ultrasonic control circuit. The basic principle of work:

1. Using the I/O trigger for at least 10 microseconds of high level signal.
2. The module automatically sends eight 40 kHz and detects if there is a pulse signal.

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3. If the signal returns high, the time with a high output I / O duration is the time between sending the ultrasound and returning.

Test distance = (high level time×velocity of sound (340M/S)/2.

4.2.1 Timing diagram

The timing is shown below. Just apply a short pulse of 10uS to the trigger input to start the distance measurement. The module then sends an ultrasonic pulse of 8 cycles at 40 kHz and increases its echo. The echo is a range object that has the pulse width and the proportional range. You can calculate the range over the time interval between sending the trigger signal and receiving the echo signal. Formula: US/58 = centimeters or US / 148 = inches; or: the range = high level time * speed (340 M/S) / 2; we recommend that you use a measurement cycle of more than 60 ms to avoid a trigger signal for the echo signal.

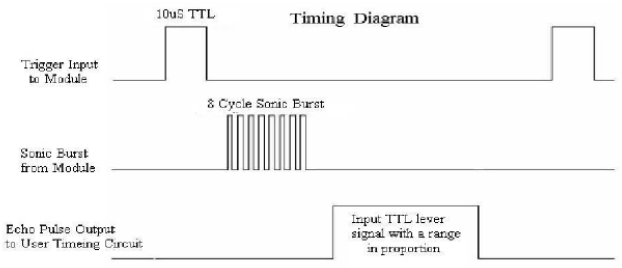

Figure 4: Timing Diagram of Trigger and Echo Modules

4.3 ADXL335 - Triple Axis Accelerometer

The ADXL335 is a three-axis MEMS accelerometer with extremely low noise and an energy consumption of only 320 uA. The sensor has a full detection range of +/- 3 g. The ADXL335 is a 3-axis analog accelerometer. Basically, this gizmo can measure the speed of movement, also known as force G, in three directions: up / down (z), forward / backward (x) and laterally (y). The directions of the axes change depending on how we position the IC sensor.

The ADXL335 has a measurement range of at least ± 3 g for each axis. This sensor emits signals in the form of voltage changes in the range from 0 to 3.3 V. At zero gravity, the voltage value of pin Z is exactly in the middle between 0 V and 3.3 V = 1.65 V.

The accelerometer can measure static gravitational acceleration (1 g) as well as tilt detection applications and also dynamic acceleration due to movement, shock or vibration. The axis indicated by the ADXL335 1g depends on how you position the chip.

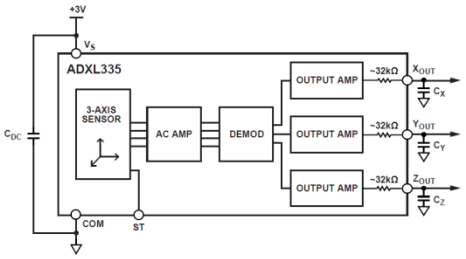

Figure 5: Functional Block Diagram of ADXL335 Accelerometer

This special ADXL335 card must be powered by a 3.3 V source. It is also configured to provide updates 50 times per second. That's a lot of resolution for our road condition detection device. Since the Arduino Uno can handle the reading of 3.3 V signals without conversion, we can directly use the X, Y and Z output pins of the ADXL335 (3.3 V) with the Arduino analog input pins (5 V) Connect Uno.

4.3.1 Theory of Operation

The ADXL335 is a complete 3-axis accelerometer system. The ADXL335 has a measurement range of at least 3 g. It contains a micro-machined surface polysilicon sensor and a signal conditioning circuit for the implementation of open loop accelerometer architecture. The output signals are analog voltages proportional to the acceleration. The accelerometer can measure static gravitational acceleration in tilt sensing applications as well as dynamic acceleration due to motion, shock or vibration. The sensor is a polysilicon micro machined surface structure which is built on a silicon wafer. Polysilicon springs hook the structure above the surface of the wafer and provide resistance to acceleration forces. The deflection of the structure is measured using a differential capacitor composed of independent solid plates and plates fixed to the moving mass. The fixed plates are driven by square waves 180 ° out of phase.

4.3.2 Axes of Acceleration Sensitivity

Acceleration deflects the moving mass and unbalances the differential capacitor, resulting in a sensor output whose amplitude is proportional to the acceleration. Phase-sensitive demodulation techniques are then used to determine the amplitude and direction of the acceleration.

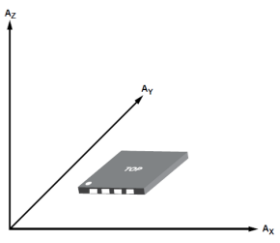

Figure 6: Output Response vs. Orientation to Gravity

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The output of the demodulator is amplified and removed from the chip via a 32 kΩ resistor. The user then adjusts the signal bandwidth of the device by adding a capacitor. This filtering improves the measurement resolution and prevents aliasing.

4.4 Dual-DC Motor Driver L293D

The L293 and L293D are high current semi-H quadruple current drivers. The L293 is designed for bidirectional control currents up to 1 A at voltages from 4.5 V to 36 V.

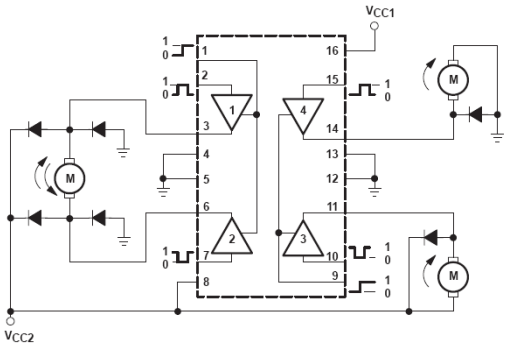

Figure 7: Internal structure of L293D

The L293D is designed for bidirectional control currents up to 600 mA at voltages of 4.5 V at 36 V. Both devices are designed to drive inductive loads such as relays, magnets, DC and bipolar stepper motors and other high current / high voltage loads in positive power applications. All inputs are TTL compatible. Each output is a total totem control circuit with a Darlington transistor sink and a Darlington pseudo-source. The pilots are activated in pairs, pilots 1 and 2 being activated by 1.2EN and pilots 3 and 4 activated by 3.4EN.

TABLE 1

L293D Drive Logic Table

Inputs			M1, M2 Output
Enable	D1	D2	
H	H	H	Both outputs HIGH (motor brake)
H	L	L	Both outputs LOW (motor brake)
H	H	L	Current flow from M1 to M2 (rotates dir 1)
H	L	H	Current flow from M2 to M1 (rotates dir 2)
L	X	X	High impedance (motor coasts)

X = Doesn't matter
H = Logic High
L = Logic Low

4.5 SIM900A GSM Modem

This is the real SIM900 GSM module manufactured by SIMCom. SIM900 was developed for the world market and is a quad-band GSM / GPRS engine which operate with the GSM 850 MHz, EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz frequencies. SIM900 has GPRS multi-slot class 10 / class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 24mm x 24mm x 3mm, the SIM900 can meet almost any space requirement in user applications such as M2M, smartphone, PDA and other mobile devices.

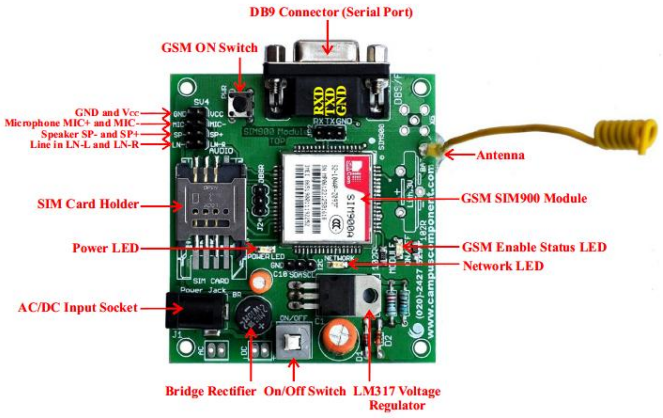

Figure 8: SIMCOM SIM900 Modem Pin Details

The special feature of this modem is that it also accepts a SIM card and works like a mobile phone via a subscription from a mobile operator. So it looks like a cell phone. It offers various applications such as SMS for sending and receiving messages via the modem. Here, the costs of sending and receiving messages on a mobile phone should be charged. All these tasks are performed on a GSM modem. This modem must support an "extended AT command set" to send / receive SMS messages.

V. BENEFITS OF PROPOSED SYSTEM

1. Voice and vibration alarm in front of objects
2. Automatic detection of falls
3. Panic emergency animation function
4. Remote monitoring with Android Mobile App
5. Compact and easy to maneuver
6. Portable watch for fast tracking

VI. RESULT AND DISCUSSIONS

The accelerometer detects the person's fall from the X, Y and Z coordinates and sends warnings to the monitoring user's mobile application via a Bluetooth connection. There is also a panic button with which the visually impaired person can send an emergency alarm in critical conditions. The advantage of our proposed system is its voice announcement for easy navigation, which can help a blind pedestrian to cross a busy road, which with a buzzer is displayed as an additional warning in noisy environments.

VII. CONCLUSION

The portable intelligent navigation system helps the blind move from one place to another without the help of others. This stick reduces the dependence of the visually impaired on

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other family members, friends and guide dogs when they walk. The proposed combination of different work units results in a real-time system that uses ultrasound to monitor all obstacles and provide wireless feedback to make navigation safer. The Smart Stick detects objects or obstacles in front of the user on the band worn on the wrist and sends a warning using the GSM modem. The microcontroller receives signals from the ultrasonic obstacle sensor in the wrist and alarms in the form of voice messages via the voice reader module and in the form of vibrations. The advantage of the system is that it can be an inexpensive solution for millions of blind people around the world.

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