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Research Article

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Smart Automation Footwear: Arduino Powered Innovations in Wearable Technology

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Abstract

Everyday we're getting closer to a world like the one that has always been portrayed to us, with smart energy systems, home automation, etc. Everything that we do we hear the word "smart" which tells us how everything now works with internet. Connecting things to the internet makes our life more convenient and simpler. Though we have everything we need, we keep yearning for more technology which helps reduce our physical work and gets our work done faster and easier. One such idea that we have produced is "SMART SHOES".

Keywords

Smart shoes, Deep learning, Sensors, Motors, Bluetooth

Introduction

Smart shoes are a smart technology footwear which provide enhanced comfort and protection while walking, running, and performing any physical activities. They are connected to smartphone applications through Bluetooth and are embedded with monitoring navigation and positioning, electronic systems, microchips, pressure sensors, and a battery. Smart phones have been an excellent advantage to us, and we are quite sophisticated with the usage of them. Not just the smart phones but all the smart devices make our works more convenient. The smart devices are usually connected to internet or to our phones through Bluetooth and various protocols. The smart shoes are just like the usual shoes that we wear but they could be a bit heavier than the normal shoes. So, this paper presents the smart shoes for common people. These shoes are precisely used for children and blind people. In the smart shoes, Arduino Uno is used, the ultrasonic sensor is used. The ultrasonic sensor helps to detect the objects at a particular distance. Along with the ultrasonic sensor, buzzer, battery, and jumper wires are also used. These components are connected in a circuit and implemented on the shoes. This way the shoes can be connected to whichever devices we want through internet protocols or Bluetooth. These shoes can be used by blind people, children, and common people indoor or outdoor based on their requirement and convenience. So, for blind people the smart shoes help in way so that they don't get hurt due to any obstacles in their way at home or outside when they're alone. With these shoes they don't have to always depend on other people and can manage things on their own. For children these shoes can provide supervision to their parents. If somebody is busy with work and have no one to watch over their kids and they're outside, then they can make their kids put on the smart shoes and connect them to Bluetooth. A range will be asked as the input from the user and the range can be within 20 to 30 metres. The user can enter their desired range. When they enter the range, if the kids move out of the range due to any circumstances an alert message will be sent to the user's phone. Also, an inbuilt tracker will be there in the smart shoes for tracking the person whoever is wearing the shoes. It can either be kids or old people who can't take care of themselves on their own or it might as well be a disabled person. In situations where someone needs to

find them, the tracker in the shoes can be used if the phone and smart shoes have connection through some protocol [1-4].

Smart Automation Footwear using Arduino, enhanced with nanotechnology, represents a groundbreaking synergy of advanced materials and intelligent automation. At the heart of this innovative footwear lies the integration of nanoscale components, such as nanomaterials and nanoelectronics, to revolutionize its functionality. Nanosized actuators enable precise and controlled movements, contributing to the seamless automation of various features. Additionally, nanocoatings on the shoe's surface provide advanced functionalities, such as water resistance and antimicrobial properties, ensuring a high level of comfort and hygiene. Altogether, the Smart Automation Footwear using Arduino, empowered by nanotechnology, represents a paradigm shift in wearable technology, offering a blend of smart features and nanoscale advancements for an unprecedented user experience [5, 6].

Related study

The already existing smart shoes are from feet me, boltt, and digitsole. The shoes that are in existence are moderately high priced and with their features they are mostly useful to athletes. According to the already existing systems and papers, the shoes that are in existence are for blind people and athletic people (sports people). The shoes are comprised of features are proficient for blind people in such a way that, if they come across any obstacle then the ultrasonic sensor in the shoe will sense the obstacle and the shoe will be buzzed so that the person wearing the shoe will feel the vibration in their shoe and understand that they have an obstacle [7]. The existing papers presented the use of ultrasonic and infrared sensors for distance dimension in the enlargement of an obstacle detection system for senior and people with vision impairment. The results upon investigation showed that ultrasonic and infrared sensors have miscellaneous characteristics in terms of output voltage measurements. It's clearly identified that ultrasonic sensor gives an output representative that's linear whereas infrared sensor shows output that's non-linear [8, 9]. But both the sensors can detect objects that are at a distance within their disposable range (Figure 1).

Smart shoes for visually impaired and senior people: (i) It can be used daytime and night-time, (ii) It works in almost all-weather conditions, (iii) It can bear damage control until a limit, and (iv) It can be used within the light fog, smoke, and rain.

Experimentation

Proposed model

The proposed system uses Arduino Uno as the microcontroller and main part of the circuit of smart shoes.

The system's model proposed here is that a person who wants to use the shoe can use them under any weather conditions and can bear damage control until some limit. So how the smart shoe works is, when a person is wearing the shoe and they walk either indoor or outdoor, whenever there is an obstacle outdoor like speed breaker or a manhole, etc then the shoe that's connected to Bluetooth will detect that particular obstacle and it will send an alert message to the user's phone that will be converted to an audio message and the inbuilt voice help will read out the alert message to the user.

Another feature of the proposed model is that, once the shoes are connected to Bluetooth, the user will be asked to enter a range within 25 - 30 metres. When the user gives the range input the range will be stored and this design is serviceable to kids or whoever we want within our surroundings. So, if the person wearing the shoes moves out of the entered range, then the user will be notified and alerted so the user can find the person wearing the shoes (Figure 2 and figure 3).

Objectives

- To detect the obstacle in front of the person.
- To warn the authorized person about the detection of the obstacle that might cause them to fall or get hurt.
- To alert the user if the person wearing the shoe moves out of the entered range.

Outcomes

- Detecting and informing the user about the obstacle.
- Alerting the user about the person moving out of the range entered.

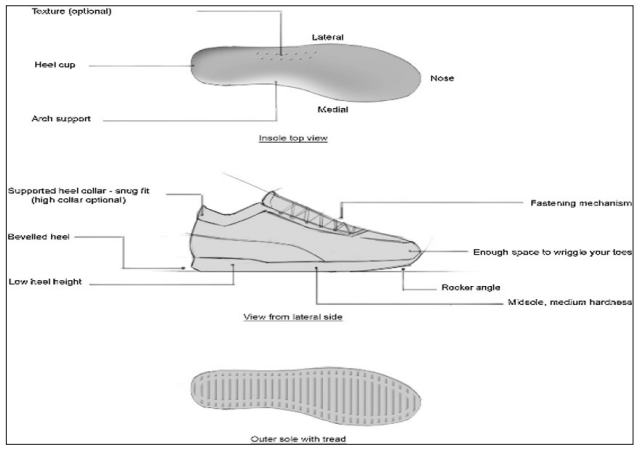

Figure 1: Smart shoe structure.

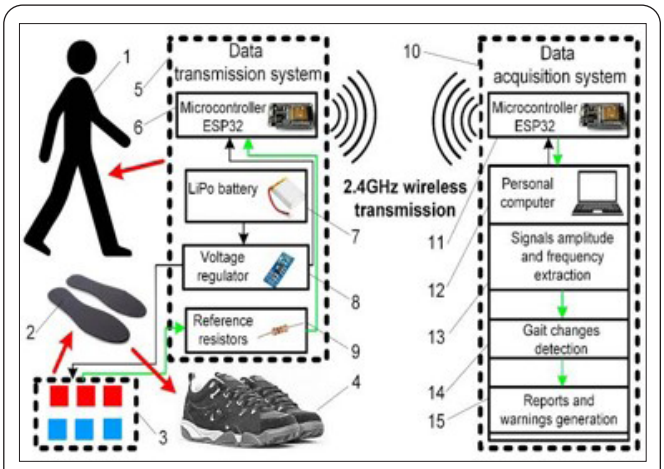

Figure 2: Architecture diagram.

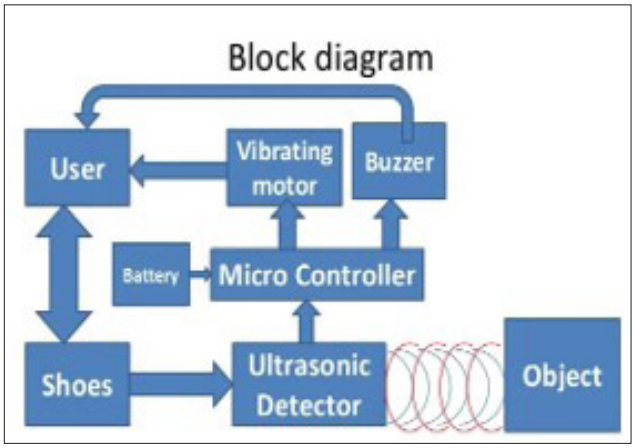

Figure 3: Block diagram.

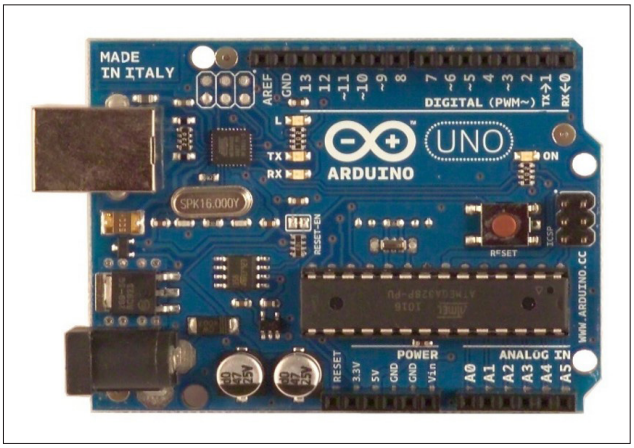

Figure 4: Arduino.

Advantages

- It is very cost-effective.
- It works in almost all-weather conditions.
- It can detect within the light fog, smoke, and rain.
- Obstacles are easily detected and identified.
- Person wearing the shoe (if they're kids or mentally ill people) can't escape from supervision).

Experimental setup

Figure 4 presents Arduino. Figure 5 working block diagram.

Sensors from which data is taken (ultrasonic sensor)

The data for the project is taken from the ultrasonic sensor or laser sensor that is organised in the shoe.

Taking visual input

To detect what the object is, we should take video as input. A camera will be fixed through which the object can also be identified as what it is.

Detecting and alerting

The main objective is to detect the object/obstacle, it is detected by the ultrasonic sensor that's fixed in the shoe and it the Arduino (microcontroller) will make the buzzer vibrate with the help of the vibrating motor. Also, when the person wearing shoe moves out of the entered range, the user will be notified.

Arduino Uno is a complete breadboard which is characterized by microcontroller named ATmega328P. All the components in Arduino Uno are attached. It has 5 V supply. Ultrasonic sensor is a sensor which detects objects at a distance. It has 4 pins: Vcc (voltage controller) pin, Trigger pin, Echo pin and Ground pin. The echo pin receives the reflected wave, and the trigger pin acts as the transmitter. The battery generates the power to the components of the system. Usually, 9 V battery is used. This is an Arduino signalling device which is also known as Beeper. This buzzer needs 5 V power supply, and the use of the buzzer is that it gives a high-pitched noise that will alert the person wearing the shoe.

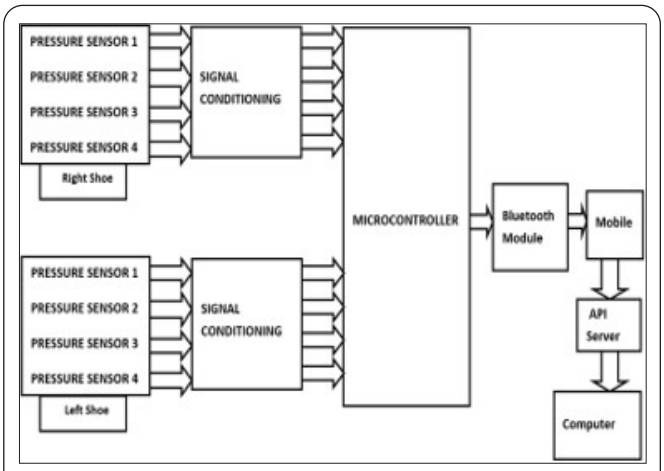

Figure 5: Block diagram (working).

Figure 6: Example.

Procedure

This is a forward-looking project that's developed for the visually impaired, kids and some cases where people can't take care of themselves. An ultrasonic sensor-based system which can detect range, structured with microcontrollers (Figure 6).

Pre-processing

Firstly, the data transmission system with the help of microcontroller, battery, voltage regulator and resistors the input of the obstacle will be taken and processed.

Data accession

For each obstacle that's detected by the microcontroller, the system will detect the kind of obstacle with the camera and buzzer will vibrate on whichever side the obstacle is present. The way it works is, if the obstacle is huge or it's like a manhole kind of thing in which the person may fall, then the buzzer will give a firm or vigorous vibration which will alert the person immediately that the obstacle can cause them serious harm. Also, if the person also understands on which side they have the obstacle, it will make it easier for them to just walk in the opposite direction.

Alert information

So, the detection of the objects done by the ultrasonic sensor, the microcontroller, which is connected through some protocol to the Bluetooth, will send an alert message in text format which will be read out to them will the voice assistant in their phone by default. The voice help support is a major application for the blind people, but it's also used for the people who are old and have lost their vision due to age or any other reasons.

Range detection

The ultrasonic sensor will also detect the range. So, when you connect the shoe to phone through Bluetooth, a pop-up message will be displayed, and the user will be asked to enter a range within which they want the person wearing the shoe to be there. Once the range has been taken as an input the user will not have to worry about the person wearing the shoe to be disoriented from them. If the person moves out of the range, the user will get an alert message on their phone which will of course alert them.

Results and Discussion

The person using the smart shoes can, (i) get alerted regarding the obstacle, (ii) get a vibration on which side the obstacle is present so makes it easier for them to walk, (iii) alerts the user if the person wearing the shoe walks out of the entered range, (iv) the vibration level depends on the danger that can be caused by the obstacle, and (v) the camera that's fixed can also visualize what object the obstacle is and identify and let the person know through voice assistant that's in their phone.

Existing system outcomes

- The output data is in the format of thermal imaging.
- A simple method to block IR is an ordinary 'space blanket', 'emergency blanket' or 'thermal blanket. They are made up of Mylar foil materials and it will block IR imagery.
- Conventional motion detection systems which use thermal imaging are mostly dependent on hardware hence produce signals to the antenna which may be of less distance.

Proposed system outcomes

- The output data is in the format of video mode specified by the user.
- No moving objects can escape the proposed motion detection system because visible cameras cannot be blocked directly using any material.
- The proposed system for detecting the motion sends an alert mail to the registered person present anywhere in the world.

Future Scope

There is good scope for smart shoes. We can use this system in many cases, like we got blind people or people who lost their vision due to old age or kids or even people who are mentally unstable, if we implement this system in such cases then it will be very easy to detect and it immediately sends the alert to the authorized persons so that we can respond immediately and we can prohibit them from getting hurt or any other things that might happen. The "Smart Shoe Market" research report shows how the market growth has been flattened over the contemporary and what would be the future market projections during the anticipated period from 2023 to 2028 (Figure 7) [10].

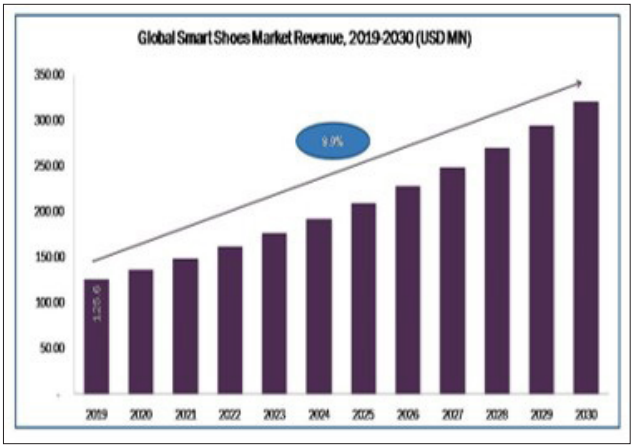

Figure 7: Global smart shoes market revenue.

Conclusion

This paper illuminates that all the problems, issues faced by the human behaviors. The purpose of this proposed system is to come up with a device that acts as an aid to the visually impaired, mentally unstable, people who lost their vision due to age or kids. The main features of the smart shoes are obstacle detection, range detection and alerting the user. There is scope for improvement in this project. Some more features can be added, and this system can be developed more consistently.

Acknowledgements

None.

Conflict of Interest

None.

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