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Development of Wearable Device for Hearing Impaired people Using Arduino

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Abstract

Hearing impaired people are apt to be in danger because they can't detect danger with sound. Hearing impaired people have less risk-detection ability than non-disabled people because of lack of hearing. There are many devices to help the hearing impaired, such as hearing aids. A hearing aids can be helpful, but it may not be available depending on the degree or type of hearing loss for example, to the hearing-impaired people with little remaining hearing of high frequencies, ordinary hearing aids are not very useful for understanding the high frequency consonants and it requires a high cost, from thousands to tens of thousands of dollars. Also, it is difficult for the underprivileged, such as the low-income bracket and the elderly, to use them because they are difficult to manage. Therefore, this paper describes the development of low-cost wearable device to assistant a hearing-impaired people using Arduino. Also, it accepts values from switches or sensors and can control external electronic devices such as LEDs and motors to create objects that can interact with the environment. In this is paper, through sound sensors, the ambient sound was taken as an analogue value and transmitted to the aduino board, and the vibration motor was operated when the noise was generated, so that the user could be aware of the occurrence of danger.

Keywords: *Arduino, Hearing impaired, Wearable*

1. Introduction

According to WHO, hearing impaired makes up 5% of the total, and according to domestic statistics, hearing impaired makes up 0.5% of total [1]. Age-related hearing loss is the most common form of sensorineural hearing loss A review of the prevalence of age-related hearing loss in Europe found that by age 70 years approximately 30% of men and 20% of women have a pure-tone average (PTA) hearing loss of 30 dB or more in the better ear, and 55% of men and 45% of women by age 80 years [2].

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Hearing impaired people have less risk-detection ability than non-disabled people because of lack of hearing. Liquefied petroleum gas exploded in the house where the deaf couple lived, seriously injuring the couple. It was an accident that occurred because they couldn't recognize it even though it exploded with a loud noise.

Also, they often walk on the wall because they can't hear the sound and can't recognize a car's horn when it comes near. A hearing aids can be helpful, but it may not be available depending on the degree or type of hearing loss for example, to the hearing-impaired people with little remaining hearing of high frequencies, ordinary hearing aids are not very useful for understanding the high frequency consonants [3] and it requires a high cost, from thousands to tens of thousands of dollars.

Also, it is difficult for the underprivileged, such as the low-income bracket and the elderly, to use them because they are difficult to manage [4].

Artificial cochlea surgery, which began in the early 1980s, It has been investigated that over 80,000 people have been treated around the world, and about 2,000 have been treated in Republic of Korea [5].

In the case of cochlear implants, to improve useful hearing ability and to adapt when there is no effect after attempting auditory rehabilitation by using a hearing aid of at least three months or more for a sensory neuropathic patient having a higher level of hearing in both ears.

Artificial cochlear implants require the use of microphone, speech processor, headset, etc. equipment and may require re-operative due to postoperative trauma or device injury [6].

Therefore, in this paper, regardless of the type of disability, inexpensive wearable devices have been developed using Arduino to help detect danger by informing them through vibrations.

The device was developed using the Arduino pro mini, sound sensor, vibration module. Arduino pro mini was adopted because the board needed to be miniaturized to be made into wearable device. Use sound sensor to measure noise and calculate average of measured values. Vibration is generated when noise is at least 20% higher than the average value. It is easy to charge the battery by using a 5pin charger and it minimized the risk of failure by simplifying components.

2. Hearing impaired assist device

2.1 Hearing aids

The hearing aids were developed in the 1900s and there have been many improvements from the carbon band that used carbon microphone, to today.

But the fundamental principle of amplifying sound remained unchanged.

As shown in fig. 1, the hearing aid amplifies the signal input from the transmitter, goes through the volume control, and outputs the signal through the receiver [7].

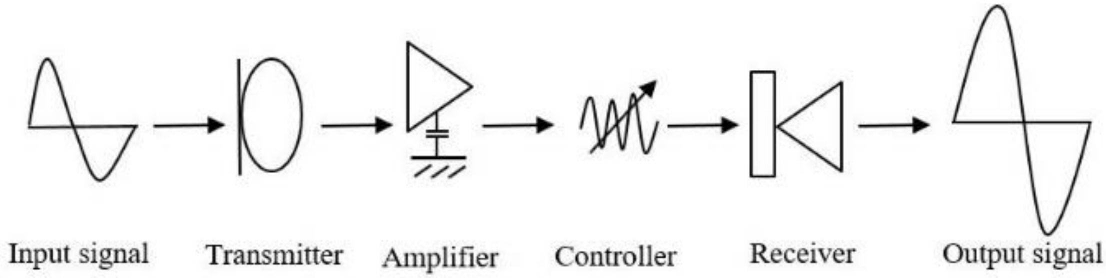

Figure 1. Hearing aids operating principle

2.2 Arduino device

Arduino is a single board microcontroller based on open source. It's made up of boards based on the Artmel AVR and recently, there are products using Cortex-M3 (Arduino Due).

Also, it accepts values from switches or sensors and can control external electronic devices such as LEDs and motors to create objects that can interact with the environment [8, 9].

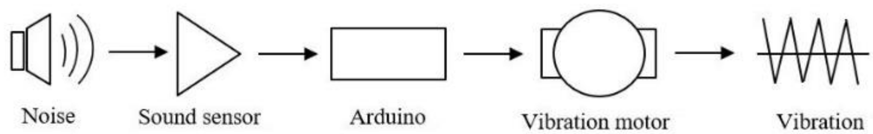

Figure 2. Arduino device operating principle

3. Device Implementation

3.1 Hardware Design

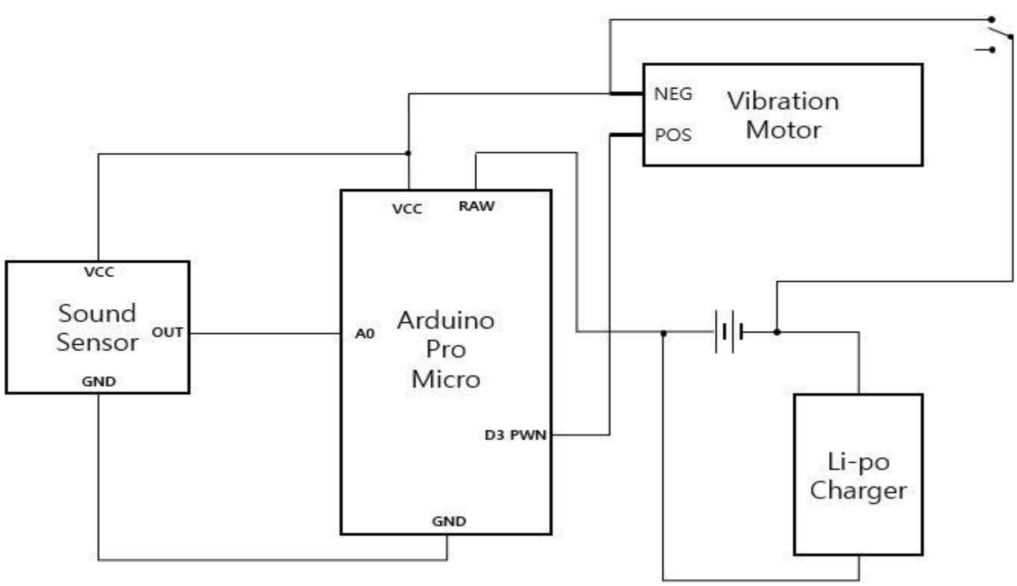

Figure 3. Schematic Design

Fig 3 is a Schematic Design of device. Through sound sensors, the ambient sound was taken as an analogue value and transmitted to the Arduino board, and the vibration motor was operated when the noise was generated, so that the user could be aware of the occurrence of danger. When noise occurs, the vibration motor activates and notifies the user. 300mAh lithium polymer battery and 5pin charger makes it easy to charge and use outside. And it only operates the power using the toggle switch to increase intuitiveness to operate the device.

3.2 Software Design

First, lead the value of the sound sensor and accumulate the entered values to obtain an average.

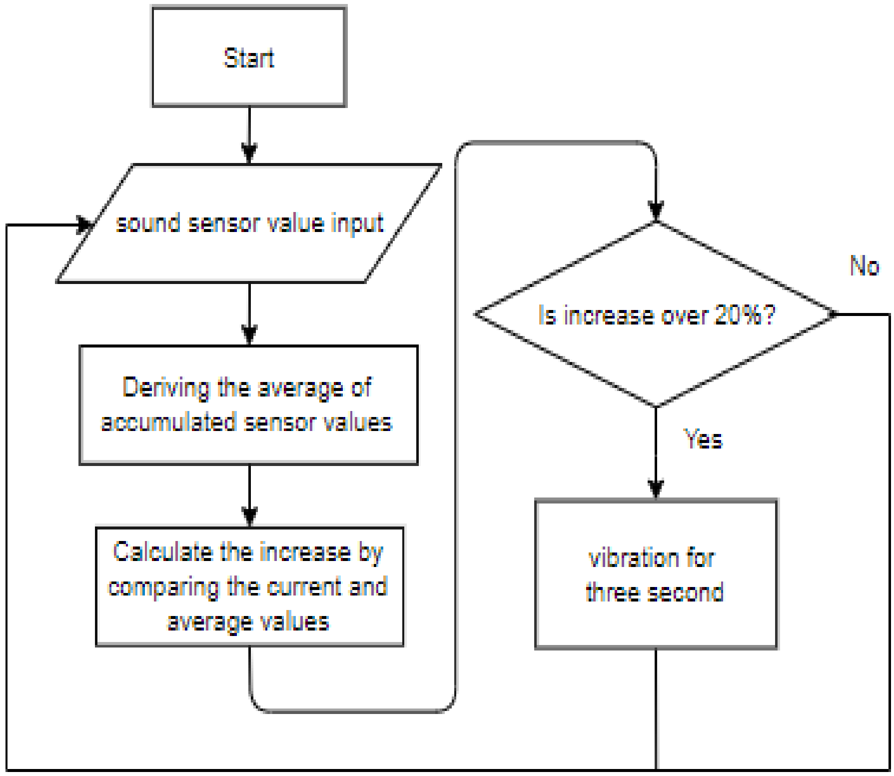

Figure 4. Flow Chart

Compare the average value with the current value to check if noise is generated. If the current value is more than 20% bigger than the average value, device vibrates for three second.

```
  else
  {
    if(End - start >= 3000)
    {
      analogWrite(3, 0);
      a = false;
    }
  }

  // Calculation and accumulation of average values
  average_stack[stack_count] = average;

  for(int i = 0; i<10; i++)
  {
    average_before += average_stack[i];
  }
  average_before /= 10;

  stack_count++;
  if(stack_count >= 10)
  {
    stack_count = 0;
  }
}
```

③ (lines 60–67) ① (lines 70–83)

```
void loop()
{
  long End = millis();

  // Average noise calculate
  average = 0;
  for(int i = 0; i<100; i++)
  {
    sound_stack = analogRead(A0);
    average += sound_stack;
  }
  average /= 100;

  // Noise increase rate calculate
  increase = ((average - average_before)
             /(double)average_before)*100;

  // Vibration motor control
  if(a == false)
  {
    if(increase > 20)
    {
      start = End;
      analogWrite(3, 255);
      a = true;
    }
  }
```

Figure 5. Execution Code

After turning on a power source in order to prevent initial malfunction, only data are accumulated for a while, and vibration does not occur.

The code is divided into four parts. In the part ①, the average noise is calculated by reading 100 noise values. In the part ②, calculates a noise increase rate by subtracting the preceding noise value from the current noise price and dividing it into the preceding noise average value At first, the data type of the “average before” was in but the data type was changed to double due to a problem calculated as 0% if the noise growth rate was less than 100%. Part ③ is the code that controls the vibration motor. When the increase rate of noise is 20% or more, the vibration motor is vibrated for three seconds. Control vibration time by using a mills function. In part ④ calculates the average value and accumulates the data.

4. Result

The Fig. 6 is hardware implementations and consist of six components such as toggle switch, Arduino board, sound sensor, vibration motor, battery and charging module.

The Fig. 6 is hardware implementations and consist of six components such as toggle switch, Arduino board, sound sensor, vibration motor, battery and charging module.

No.1 in Fig.6 is a sound sensor, it accepts surrounding sound as an analogue sensor and delivers it to an Arduino board. No.2 is an Arduino board, the average of the noise value is calculated and stored using the analog value transmitted from the sound sensor in 1 sound sensor, and if the average value is increased by more than 20% compared with the previous average value, the vibration motor is operated.

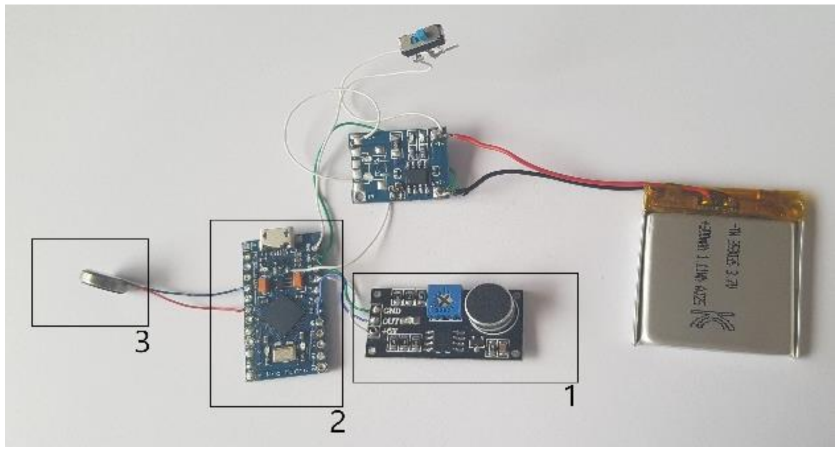

Figure 6. Hardware Implementation

No. 3 is a vibration motor, which informs the user of the noise generated by vibrations depending on the value calculated on the Arduino board, and thus the user of the danger.

Value.1	Value.2	Value.3	Value.4	Value.1	Value.2	Value.3	Value.4
37	41	-9	0	470	58	710	1
37	41	-9	0	510	102	400	1
37	41	-9	0	598	154	288	1
37	41	-9	0	648	215	201	1
37	41	-9	0	618	283	118	1
37	41	-9	0	598	348	71	1
37	41	-9	0	687	410	67	1
37	41	-9	0	677	481	40	1

Figure 7. Value of variable when noise occurs

The Fig. 7 is a representation of the change in the value of each variable.

First value is the average, which represents the current noise value. And the second value is the average before, which represents the value of the noise that occurred just before. The third value is the increase, which represents the value of the noise increase. And the last one is value int a, it indicates whether the vibration motor is operated.

As shown in Fig. 7 if noise is not generated, it is found that the variable value does not increase, the increase rate does not fluctuate, and therefore the vibration motor does not operate. This can be seen by the fourth value of the oscillating motor not changing.

And also as shown in Fig. 7 the vibration motor can be operated if the increase rate is 20 or higher due to noise from the test result. This enables the user to be aware of the occurrence of noise and also to be aware of the occurrence of danger from noise.

5. Conclusion

In this paper, wearable device for the hearing-impaired people using Arduino is developed. The simple structure is easy to manage, intuitive design is not difficult to use, and the price is inexpensive and approachable, so it will be useful for those who are having trouble using existing auxiliary tools.

While it can be manufactured at a low cost using an Arduino, there is a problem with relatively poor sensitivity and poor accuracy of sensors. And the precise control and setting cannot be performed due to the limit of the Arduino itself. It is also worth considering such measures as arbitrarily setting the increase width of noise to notify danger through vibration.

Therefore, in order to complement existing problems, not only the method presented in this paper, but also a variety of assistants for the deaf must be developed.

References

[1] Ministry of Health and welfare. Survey of disabled people. *http://kosis.kr/index/index.do.*

[2] Abby McCormack & Heather Fortnum, “Why do people fitted with hearing aids not wear them?”, International Journal of Audiology, pp. 360-368, 2013.
DOI: https://doi.org/10.3109/14992027.2013.769066

[3] M.K. Han, J.H. Lee, J.S. Kim, “Comparison of the usefulness with Frequency Transposition Hearing System and Conventional Hearing Aids for the Deaf,” The Korean Association of Speech Sciences, Vol. 3, pp. 50-56, April 1998.

[4] S. Kochkin, “Marke Trak V: Why my hearing aids are in the drawer,” The consumer’s perspective, The hearing Journal, Vol. 53, pp. 34 - 41, February 2000.

[5] H.A. Moon, “Case Review of Internal Device Failure in Cochlear Implant System,” Korean Academy of Audiology, Vol. 3, No. 1, pp.88 – 90, June 2007.
DOI: https://doi.org/10.21848/audiol.2007.3.1.88

[6] H.A. Moon, “Problem Cases in Managing Cochlear Implantees,” Korean Academy of Audiology, Vol. 3, No.2, pp. 167 – 169, December 2007.
DOI: https://doi.org/10.21848/audiol.2007.3.2.167

[7] K.W. Lee, “Structure and Principle of Hearing Aid,” 2012.

[8] Y.S Lee, S.M Son, K.W. An, S.H. Lee and S.W. Lee, “Smart system using Arduino for blind,” KOREA INFORMATION SCIENCE SOCIETY, 2015.

[9] D.S. Seo, M.S. Kang, Y.S. Jung, “The Development of Real-time Information Support Cart System based on IoT,” International Journal of Advanced Smart Convergence (IJASC), Vol. 6, No. 1, pp. 44-49, 2017.
DOI: https://doi.org 10.7236/IJASC.2017.6.1.44