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Research Article

Glove Design Assistant With Hearing and Speech Difficulties

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Abstract

Communication is the proper transfer of feelings and thoughts to others. The most used communication among people is verbal communication, which is based on hearing and speech. However, it is observed that individuals with disabilities due to hearing or speech loss either do not use this communication method or can use it limitedly. These individuals communicate with each other through methods such as sign language, alphabet created using hand or finger movements. In this study, a system that can perceive sign language has been developed for individuals with speech and hearing impairments in order to communicate more easily with each other and with individuals who do not know sign language. Flex sensors are placed on the glove to be used in the developed system. Flex sensors were connected to Arduino with voltage divider circuits and varying voltage values were taken. In this system, a new sign language was developed based on the existing sign language. In the developed system, each combination of finger and hand gestures represents a separate word. These combinations are logically numerical sets consisting of logic 0 and logic 1 in computer language. Finger movements corresponding to the words to be used in the study were introduced to the developed system. The words corresponding to the combinations have been transferred to the system library and stored. In the study, the most used words in daily life were determined and test studies were conducted. A word introduced to the system in return for each combination made by the hand and finger movements performed by the user was exported via the screen.

Keywords: Hearing, talk, flexibility sensor, logic combination, glove.

İşitme ve Konuşma Güçlüğü Çekenlere Yardımcı Olan Eldiven Tasarımı

Öz

İletişim, duygu ve düşüncelerin akla uygun şekilde başkalarına aktarılmasıdır. İnsanlar arasında en çok kullanılan iletişim, temeli işitme ve konuşmaya dayalı olan sözlü iletişimdir. Fakat işitme ya da konuşma kaybından kaynaklı olarak engelli bireylerin bu iletişim yöntemini ya kullanmadıkları ya da sınırlı kullanabildikleri görülmektedir. Bu bireyler kendi aralarında çoğunlukla işaret dili, el ya da parmak hareketlerini kullanarak oluşturulan alfabe gibi yöntemler ile iletişim sağlarlar. Yapılan bu çalışmada konuşma ve işitme engelli bireylerin hem kendi aralarında, hem de işaret dili bilmeyen bireylerle daha kolay iletişim kurabilmeleri amacıyla işaret dilini algılayabilen bir sistem geliştirilmiştir. Geliştirilen sistemde kullanılacak olan eldiven üzerine flex (esneklik) sensörler yerleştirilmiştir. Flex sensörler gerilim bölücü devreler ile Arduino'ya bağlanmıştır ve değişen gerilim değerleri alınmıştır. Yapılan sistemde mevcut işaret dili temel alınarak yeni bir işaret dili geliştirilmiştir. Geliştirilen sistemde her parmak ve el hareketleri kombinasyonları ayrı bir kelimeyi temsil etmektedir. Bu kombinasyonlar lojik olarak bilgisayar dilinde lojik 0 ve lojik 1'lerden oluşan sayısal kümelerdir. Geliştirilen sisteme, çalışmada kullanılacak olan kelimelerin karşılık geldiği parmak hareketleri tanıtılmıştır. Kombinasyonların karşılık geldiği kelimeler sistem kütüphanesine aktarılarak depolanmıştır. Yapılan çalışmada günlük hayatta en çok kullanılan kelimeler belirlenmiştir ve test çalışmaları yapılmıştır. Kullanıcı tarafından gerçekleştirilen el ve parmak hareketleri ile yapılan her kombinasyon karşılığında sisteme tanıtılan bir kelime ekran aracılığı ile dışarıya aktarılmıştır.

Anahtar Kelimeler: İşitme, konuşma, esneklik sensörü, lojik kombinasyon, eldiven.

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1. Introduction

Communication is defined as the rational transfer and reporting of feelings and thoughts to others [1]. It is known that individuals with disabilities have difficulties in communicating due to hearing or speech loss. These individuals can communicate among themselves mostly through methods such as sign language, finger alphabet and gestures [2]. All around the world, different sign languages exist. Each sign language has its own vocabulary and gestures. These sign languages are known between deaf communities (friends and families of the deaf etc). However, out of these communities, these sign languages are not known generally, thus communication between deaf and hearing people is become so difficult [3].

Researches investigated different methods and systems to solve the difficulties in the communication of deaf and hearing people. Sign language studies can be examined in three classes as computer vision based, data gloves and speed-position sensor based, using both methods together. In the computer vision-based system, cameras are used to detect sign language signs, the feature vectors of these signs are extracted and images are obtained with image processing algorithms. In the second method, special data gloves and speed-position sensors are used to detect hand shape and arm movements. In the last method, the techniques in the first and second methods are used together with the sensors [4]. For Turkish sign language, Yalçın et al. tried to identify all the letters in the Turkish alphabet with the help of a single glove and obtain them visually [5]. Another study is on the translation of the sign language with a data glove, which is a portable system with sensors on it [6]. Candra et al., applied a different method in their study and used machine learning algorithms to predict the word associated with each movement, and they developed a design that can recognize both American Sign Language (ASL) and Indian Sign Language (ISL) [7].

It is easy for individuals with hearing and speech difficulties to communicate through visual means. However, it is very difficult for people who do not know sign language to communicate with these individuals. In this study, a system and a new sign language were developed in order to enable individuals with hearing and speaking difficulties to communicate more easily with each other and with individuals who do not know sign language. We aimed to develeop a portable system these individuals can communicate with themselves and other people simultaneously. Thanks to the developed system and sign language, each combination of finger and hand gestures represents a separate word in the library. In this study, it is aimed to expand the word volume and to communicate easily by means of these combinations in order for the users to communicate.

2. System Design

In this study, it is aimed to design a system to help those who have hearing and speech difficulties. As a preliminary study, in this system flexible (flex) sensors, Arduino microcontroller, Thin Film Transistor (TFT) LCD flat panel display are used. Flex sensors are carbon-component elements with a thin flexible substrate inside [8]. The flex sensors with analog resistance feature are placed on the glove(s) to be used in the system. Researchers generally used flexible sensors with 4.5 inch and 2.2 inch sizes for such studies. In this study, flexible sensors with 4.5 inches were preferred considering the finger sizes. Flex sensors produce resistance when bent and increase resistance value as the bending increases (Figure 1). A voltage divider circuit was created with the help of flex sensors and resistors in order to convert the resistance values read in flex sensors to voltage values. The total circuit voltage is divided over the resistors by dividing it in accordance with Kirchoff's Voltage Law (KVL), and the voltage on each resistor is directly proportional to the value of that resistor. Arduino Mega was used as a microcontroller. Arduino is an open source electronic platform with hardware and software. The motherboard in the hardware part of Arduino consists of many components (microcontroller, external power supply, input and output pins etc) that come together. In the software part of Arduino, it has a program called IDE (Integrated Development Environment) and open source coding can be done [9]. TFT screen type was preferred in order to provide the best resolution in the images to be obtained in the study. It is a type of LCD flat panel display where each pixel is controlled by 1 to 4 transistors. The flex sensors were placed on the glove and a voltage divider circuit connection consisting of a resistor was made with flex sensors (Figure 2). As the flex sensors fold and open, the resistance values of the sensors will change and this change will also cause the flex sensor voltage to change. This system will determine which finger makes flexion movement with the voltage changes coming from the voltage divider circuits to the microcontroller and determine the finger combinations and will select the defined word from the system library and transfer it to the external environment (Figure 3).

Figure 1. Testing Flex sensors. Resistance values are different during flexion anad extention of hand.

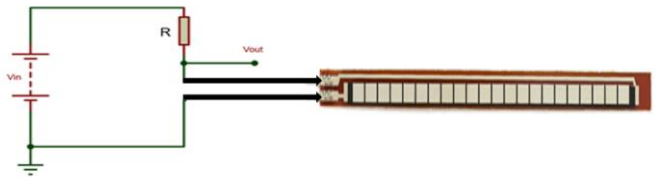

Figure 2. Voltage divider circuit and flex sensor connection.

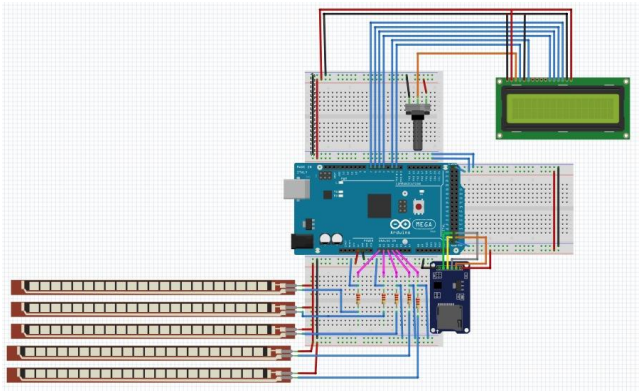

Figure 3. System circuit diagram. Each flex sensor is connected to Arduino with resistors. Arduino Mega is used for microcontroller. The output of Arduino is connected to the TFT LCD flat panel display.

3. Preliminary Research Results

In the study, flex sensors were placed on a glove. Flex sensors were connected to Arduino with voltage divider circuits and varying voltage values were taken. It has been observed that the determined finger or hand combinations can be determined according to these changes. These combinations were detected by the microcontroller with the help of flex sensors placed on the glove. In the system, a new sign language was developed based on the existing sign language. With this developed sign language, the combinations of each finger and hand movements represent a word in the library. These combinations are logically numerical sets of 0 and 1 in computer language. In this preliminary study, 5 flex sensors and one hand were used, 2^5 different combinations were obtained in total. Finger movements corresponding to the words to be used in the study and determined in return for combinations were introduced to the system and stored in the library.

In this study, the most used words in daily life were determined and tested. In the test study, a word was transferred to the outside via the screen for each combination made with hand and finger movements performed by the user. Figure 4 shows finger combinations of four different words (Hello, World, I, Turkish) and a screen shot in English. The logical equivalence of the combinations expressing which finger movements are determined by these words are shown in Table 1.

Figure 4. Test run and system output. Each word has different finger combinations.

Binary equivalent	Signs	Thumbs Finger	Index Finger	Middle Finger	Ring Finger	Little Finger
1	*Hello*	1	0	0	0	0
3	*I*	1	1	0	0	0
13	*Turkish*	1	0	1	1	0
31	*World*	1	1	1	1	1

Table 1. Combinations and words corresponding to combinations introduced to the system

4. Conclusion

In this study, a system has been developed for individuals lost their hearing or speaking abilities to reintegrate into society and to communicate with other individuals. A prototype was designed to eliminate obstacles by detecting combinations of hand or finger movements determined with the help of flex sensors and visually transferring the printouts to the external environment. With a new language developed, it is aimed that individuals with hearing and speaking difficulties can communicate more easily with each other and with individuals who do not know sign language. A word can be drawn from the system library for each combination made with finger or hand movements and displayed on the screen.

In the future, the use of two hands will be provided and 2^{10} combinations will be obtained and more words will be stored in the system library. The voice commands will be integrated to the system with the aim of that visually impaired individuals can easily use the system and communicate. The second language option will be added, thus it will be possible to print both Turkish and English by applying the same finger combinations. Furthermore, using this system, two people who do not know the same language will be able to communicate with them comfortably.

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