# ParaSpeak: A Speaking System for Paralyzed

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***Abstract:*** *We present a mountable device or system which will help the paralyzed person to communicate with others. The paralyzed people who are not being able to speak and cannot make others understand what they want is a major difficulty faced by them. A system will be created for the paralyzed person which will help them to get easily understood by others and provide a better communication medium. This paper describes the architecture, design, implementation and operation of the entire system. We are also going to see the flexibility and working of our system.*

***Keywords: mountable device or system, paralyzed people, air waves, microcontroller board, signals processing, message labelling.***

## 1. Introduction

Everyone in the world has always imagined that machines and humans go hand in hand and help each other. This was one of the reasons why we thought to make this thing true and go one step ahead in this category. *[13, 14]* Paralyzed people have to face so many obstacles in their way that no one can ever imagine. They have to live their life as it is without any life. When they want something, they cannot just call someone like normal people and ask for it. Paralysis affects the motor neuron system of our body and makes it difficult to move our body. A brilliant mind like Stephen Hawking had this kind of a disease which is also known as amyotrophic lateral sclerosis (ALS) or Lou Gehrig's disease. Stephen Hawking originally used spelling cards, indicating words with lifting eyebrows. There were many machines made which helped Hawking and we intend to do a similar invention but for a lower cost and a larger audience. *[1]*

We present ParaSpeak - a mountable, easy to handle and use device which will identify the needs of a paralyzed person by classifying the different air blowing movement frequency from their mouth into a signal based system and provide an appropriate message for the action performed. The sensor will detect this movement and the duration of the air wave, and take a decision which will be shown to the other person about what the paralyzed person needs at that instant with the help of an LCD screen.

## 2. Related Works & Projects

Advancement in the technology has brought many devices, but the one which was widely used and is still in existence is a spelling device which uses slow cortical potentials of electro-encephalograms to operate its system. This system consists of a screen with cursor on it and the alphabets which can be selected with the help of the cursor. This requires the person to go through a long term training and practise to get an acquaintance of the system. The training was continued till the accuracy of 75% or more was achieved. The research applied on the system revealed a rate of 2 character's per minute to be selected by a person suffering from amyotrophic lateral sclerosis. *[2]*

Another system uses Electroencephalogram (EEG) sensors to capture the thoughts and then transform into the appropriate form to provide the assistance for the patient's post-stroke and rehabilitation. The system uses the approach of deep learning for the feature extraction, pre-processing and classification. This is a complex system, but can be widely used post-stroke. *[3]*

A system has been developed which is a wearable device that uses the concept of a silent speech interface to convey the message produced in the thought process by collecting the neuromuscular signal from the skin surface. It can be used to deliver confidential communication as well as control the IOT devices. The architecture as well as its usability in the medical field is yet to be discovered. *[4, 11]*

Eye blink IR sensor is used to develop a project where a paralyzed person can perform the communication with the blink of an eye. The blinking of the eye is captured by the sensor. This system is implemented mostly in goggles and additional sensors provide monitoring support for patients to the system. The usability of this system is reduced in its implementation process and thus reduces its feasibility. *[5]*

*[6]* A hand or gesture control system is mostly implemented for the person suffering from a partial paralysis. The motion of hands are captured by the motion sensor provided to the controlling board to convert into appropriate messages. This system believes that the person can move one of its limbs to capture the motion. The current system provides a solution to many aspects of the problem but one aspect which these systems tend to ignore is a system for the completely paralyzed person which require the following aspects are not covered:

**Easy Interface: -** A person suffering from a paralysis requires an easy interface with less burden to operate the system.

**Cost Efficient: -** The system should be easily accessible to wide classes of people in a cost efficient manner.

**Less Complexity: -** Accessing the system by both the suffering person and interpretation by its family members should involve less complexity.

**Easy Message Convey: -** Simple system which can help to convey the essential message to the person taking care of the paralyzed person is required, so that the need of the paralyzed person can be fulfilled easily.

## 3. ParaSpeak

ParaSpeak is a mountable device which will help the paralyzed people to tell their needs with just blowing air at different frequencies. Our system is going to use the KY-038 Microphone sound detection module. For sound detection Module has two outputs:

1. AO - Analog Output, real-time output voltage signal of the microphone. Direct microphone signal as voltage value.

2. DO - Digital Output, when the sound intensity reaches a certain threshold, it output's high and low signals. You can use a potentiometer to configure an extreme value for the sonic. If the value exceeds the extreme value, it will send a signal via digital out.

The threshold-sensitivity can be adjusted via a potentiometer on the sensor. This module consists of a sensitive capacitance microphone for detecting sound and an amplifier circuit. The output of this module is both analog and digital. The digital output acts as a key, and it activates when sound intensity has reached a certain threshold. The sensitivity threshold can be adjusted via the potentiometer on the sensor. The analog output voltage changes with the intensity of sound received by the microphone. You can connect this output to Arduino analog pins and process the output voltage. *[7]*

ParaSpeak is different from the other solutions available in the market as it tries to conquer the drawbacks of all the different systems and keep its work at the right place. As we know, the cursor system is good but it requires large training for the patient which will make them tired just learning the system. Our system is not going to be that hard to learn and is fairly very easy. Another system which uses the neuromuscular muscles signals from the skin surface is a great invention. But, it is of very little use for the paralyzed person and the person who has to understand (interpret) because they both need to buy the system and learn to operate it. *[2]*

*[5]* The eye blinking system is not feasible due to some of the components like the IR sensor which may calibrate a false reading due some interfering waves. Also if the person blinks normally, the system would interpret it as some signal by the patient and will provide the message pertaining to that signal, which would not be a true output that was expected. *[6]* The hand gesture system using a glove can only help those people who can still move their hands and make movements and gestures with them. But, if the patient is completely paralyzed with just having their respiratory system working, then the hand gesture system will also fail miserably.

ParaSpeak tries to overcome all of these different drawbacks faced and uses a rather simple approach and cost-efficient way to design a system for the paralyzed to make their life easier.

## 4. Understanding Thoughts

Human brain sends signals through the neurons to produce speech, this signal is forwarded to the vocal cord which lets the human speak what they are thinking. In the case of the paralyzed person, all these senses are not in working condition, so producing voice is difficult to them. Understanding what they want to speak is a difficult task as the neurons are not responsive, but a paralyzed person can indicate the message by blowing the air from their mouth. Breathing is a fundamental function which is required to live. The air blown from the mouth can be varied by the paralyzed person which could help as an indicator for any message. *[15]*

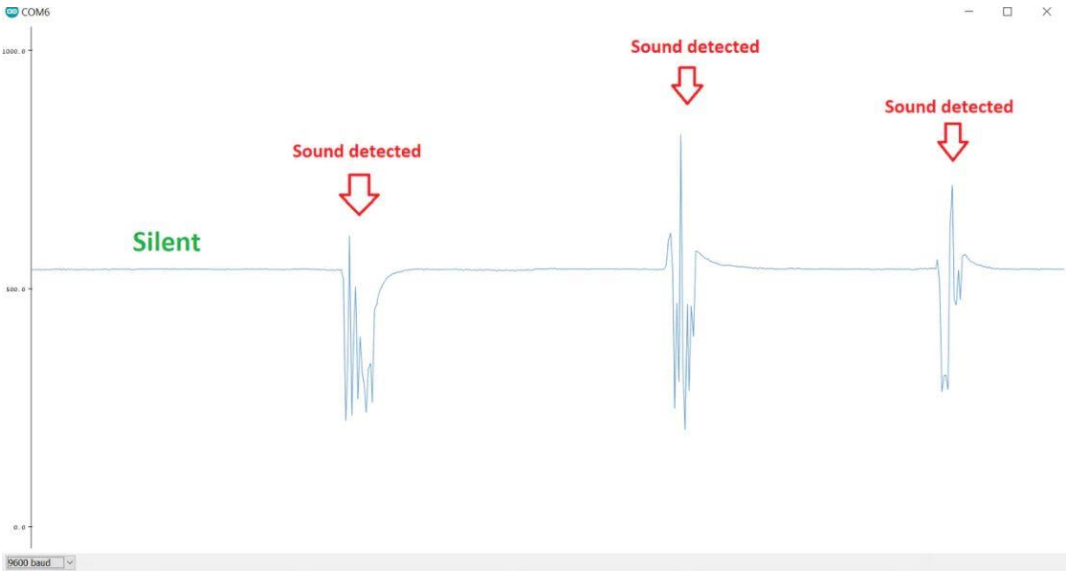


**Figure 1. Sound detection at various frequency**

*[10]* The variation in the air blowing with respect to its amplitude and frequency can be captured by the sensor and this can help to understand what the person wants to say. The paralyzed person needs basic training to get started with the system, it should know the label associated with a particular air blowing frequency. *[12, 13]* To make the system easily learnable to the person, the message associated with the frequencies will be widely spread. The paralyzed person can convey the message by blowing the air in a frequency associated with the message. Any movement of air in the area of a particular frequency can be detected by the sensor. The signal is then sent to the microcontroller board which analyses these frequencies and provides the associated output. *[16]* The frequency and the message associated with it can be adaptive i.e. it can be changed according to the person with the assistant of the technical in charge. This method of analysing the thoughts will work as a helping assistant for the paralyzed person to convey the daily necessity messages to his/her family members.

## 5. Frequency Analysis & Processing

The air will be blown by the paralyzed person in different frequencies according to the message they want to say. So, the analysis of these different frequencies becomes an integral part of our solution system. The KY-038 Microphone sound detection module is going to take all the needed frequencies from the paralyzed patient and send it to the microcontroller board. The technical in charge will set these multiple different frequencies according to the messages required by the family and the paralyzed person. Less air blown for a short period of time will correspond to lower frequency and greater air blown for different amounts of time will correspond to multiple different frequencies set in the system. The frequency analysis will be done as mentioned above.

*[10]* The frequency analysis is an important step, but for the system to actually work, we need to process the information as well. The frequency processing will be another integral step to the overall system. This step will correspond to the generation of output based on the multiple different inputs. Some input generated by the patient will be analysed, put into some category, go into the processing part in the microcontroller board, which then will generate a corresponding output and finally display it on the LCD Screen. *[9]* This will help the paralyzed person and their family to communicate much more effectively rather than moving some parts of their body, or blinking their eyes. The Audio signal from the output of the amplifier is a varying voltage. To measure the sound level, we need to take multiple measurements to find the minimum and maximum extents or "peak to peak amplitude" of the signal.

## 6. Demonstrating Messages

The processed signal is converted into the numerical form, which is now passed to the code which checks with the various labels of frequencies of messages and output of this further passed to the LCD display controller which displays the message in the understandable language. Now, two cases may exist, where the person is in front of the paralyzed person and can read the message and provide the thing which is needed. Second case is where the person is not at home, in this case, the message will be sent in the form of Text-message to the registered family member phone number. In this case, the system is useful where the paralyzed person's family is nuclear and are working personnel. They can be made known about any important situations related to the paralyzed person's health. Many times, it is not possible to take constant care of the paralyzed person, in this case, the message in the phone can help them to fulfil the paralyzed need. In any of these cases, this system takes the utmost care of the paralyzed person. It provides all the necessary as well some additional features which can reduce the communication gap between the paralyzed person and their family members. *[11]*

## 7. Use Case Diagram

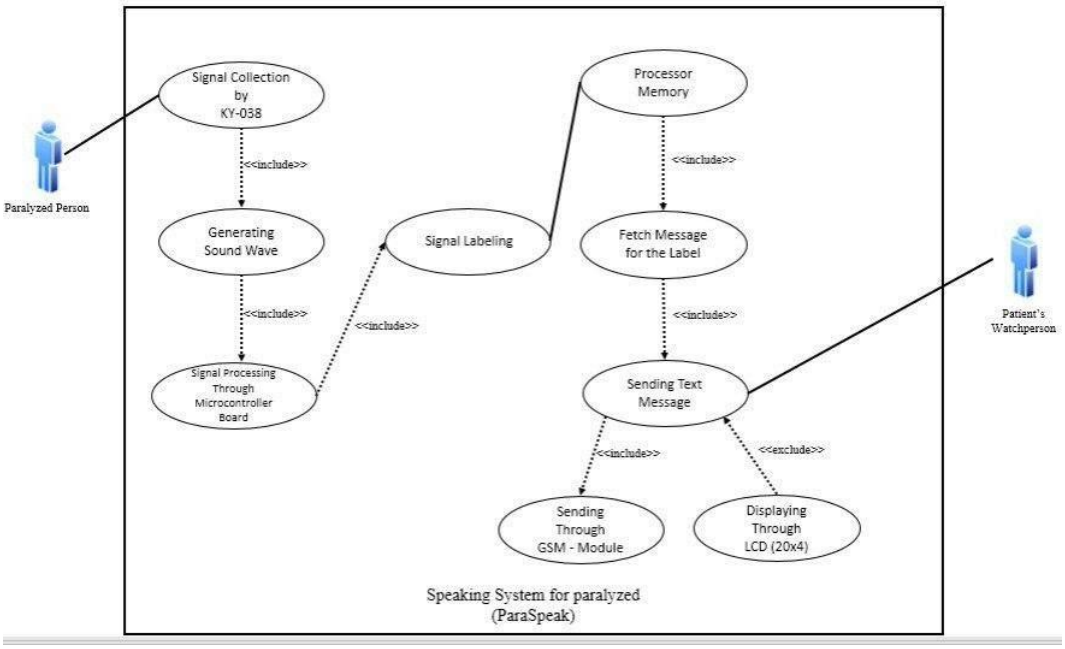


**Figure 2. Use Case Diagram**

The workflow of the system can be perceived through the use-case diagram above. The system is initiated with the paralyzed person blowing air in the sound sensor KY-038. The signals are generated based on the intensity and frequency of the air blown. The generated signals are sent further to the microcontroller board which performs the further processing on the signals. The signals are allotted to its respective message labels. The labels for the signals are feeded to the LCD display. LCD provides the output message which can be perceived by the person taking care of the paralyzed person and provides the necessary help required. One more way the message can be sent is through the GSM module in the form of text message to the person taking care of the paralyzed person. This will provide an assistant through which one has to not always be present in front of the system to read the message from the LCD screen and provide assistance. The message can be read from the mobile phones and immediate help can be provided to the paralyzed person.

## 8. Components Used

### 8.1. Uniko Ekam Microcontroller Board –

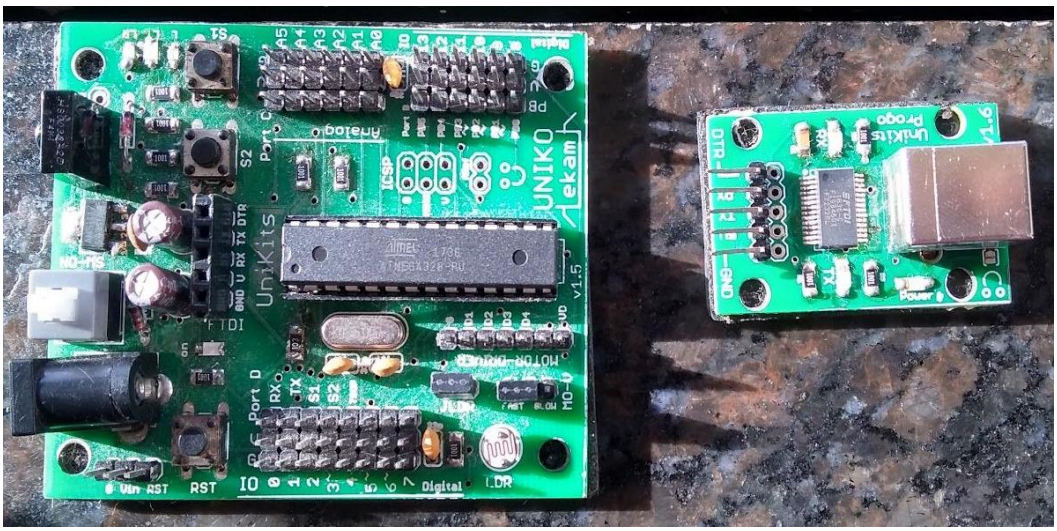


**Figure 3. Uniko Ekam Microcontroller Board**

A very similar board to Arduino Uno. This board just has more number of Vcc and GND pins than Arduino Uno. The Microcontroller is the same ATMEGA328P with 14 Digital Pins and 6 Analog Pins.

### 8.2. KY-038 Microphone Sound Detection –

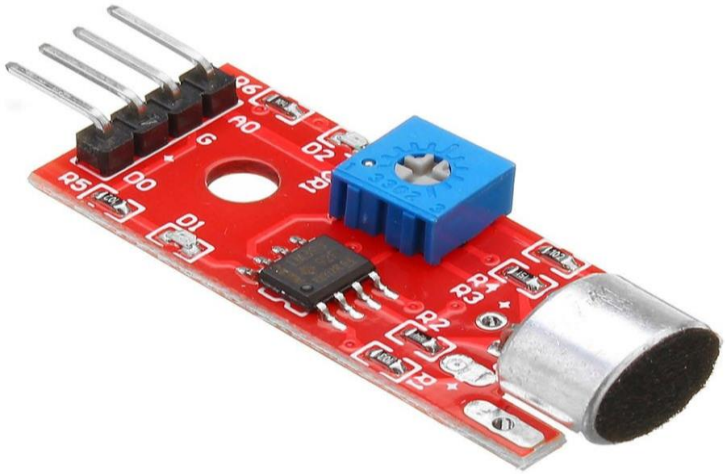


**Figure 4. KY-038 Microphone Sound Detection**

KY-038 is a Microphone sound detection module. It has 4 pins - AO (Analog Out), DO (Digital Out), Vcc, and GND.

**8.3. 20*4 LCD Screen –**

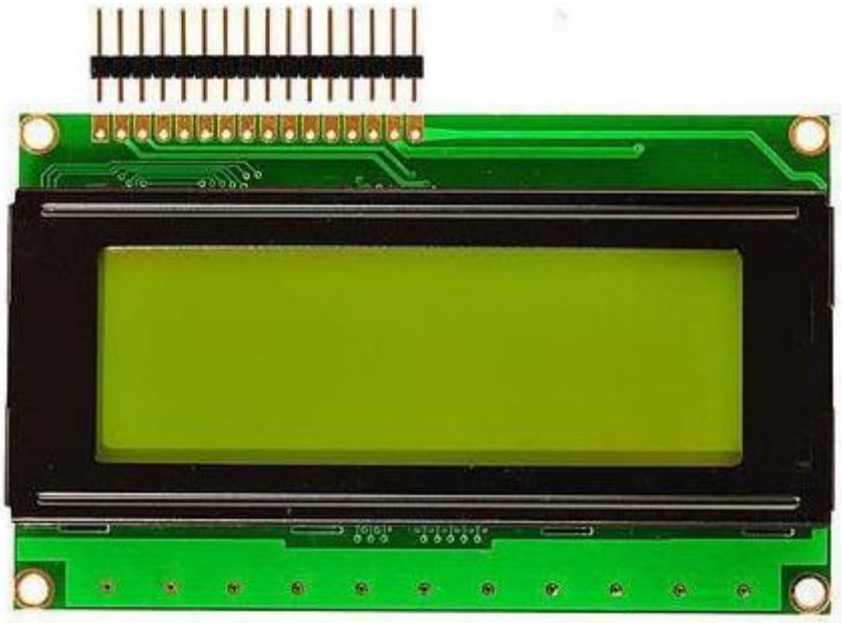

**Figure 5. 20*4 LCD Screen**

A 20*4 LCD means it can display 20 characters per line and there are 4 such lines. In this LCD each character is displayed in a 5x7 pixel matrix.

**8.4. Sim900a GSM Modem –**


**Figure 6. Sim900a GSM Modem**

The SIM900A is a readily available GSM/GPRS module used in many mobile phones and PDA. SIM900A is a dual-band GSM/GPRS engine that works on frequencies EGSM 900MHz and DCS 1800MHz.

## 9. Future Scope

The speaking assistant system provides all the necessary features which are essential for its complete functioning. But there are few remaining areas which can be explored to further add more advanced features into the system:

1. Health monitoring sensors can be added to provide the remote health analysis of the paralyzed person.

2. A sensitive and more advanced sound detection sensor available in future can be used to provide more accuracy.

3. More deeper analysis of the sound signals can be done, which would help to allocate more labels to the sound signals.

4. Testing the system on more and more people can help to evaluate the real time functionality of the system and eliminate the errors that may arise.

## 10. Conclusion

Paralysis makes the person enable to perform the daily chores. The family members of that person need to be present every time to understand and provide the help needed to that person.

ParaSpeak is an assistant system which will help the family members to understand the thoughts of the paralyzed person to fulfil their needs and will also allow them to concentrate on their other work with the help of the message assistant. The system tries to fulfil the communication gap which exists between the paralyzed person and the person taking care of them and provide a very cost efficient and easy to use system through the help of modern technologies.

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