

# Automated Motion of a Robot based on Emotion Analysis

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**Abstract.** Several people in this world are suffering from neuro-motor disability which makes their life difficult and such people become dependent on others. In some cases, such people can speak clearly whereas in other cases their speech may not be very clear. Here, we present a solution to control the movement of such people who are not able to walk because of their disability but are able to speak clearly. Their speech is analysed, and a mapping of movement has been defined for an emotion. Further, a prototype has been built in the form of an arduino robot to demonstrate that the mapping is able to control the movement which can further be refined in future to make it more accurate and mapped with relevant movements according to the need in real-life. Other practical applications of this work include covert operation, feedback industry etc.

## 1. Introduction

According to a survey conducted in U.S., approximately 1.7 percent of the population in their country is suffering from paralysis which is a kind of disorder in the central nervous system and leads to the inability of moving the upper/lower body parts depending on the kind of damage to the nervous system. Similar is the situation in other parts of the world and today paralysis is a more widespread disorder than it was previously thought to be. The causes that have been identified for the disorder includes stroke, accidents, spinal cord injury etc. Most of the patients who suffer from this disorder, face a lot of challenge in performing their day to day tasks, and lead a normal life. The easiest way to make their movement possible is a wheel chair. But even if they use a wheel chair for their movement, the paralysed person needs to depend on another human being for controlling the movement of the wheel chair. Therefore, there is a need to provide a solution for such people so that they can live an independent life. Also, they find it difficult to control the other things in the environment around them, apart from their movement alone as they are unable to move their body parts [1, 2, 3, 4, 5].

People who are suffering from a neuro-motor disability are in a condition where they are awake and very well aware of their surroundings but are unable to perform any action due to paralysis in the body (with the exception of eye movements like blinking). The people who are suffering from such a disorder may be categorized into two: (1) one is the set of paralysed people who are able to speak but not move their body parts and (2) the other are not able to speak or their speech is not understandable enough. Therefore, they cannot easily communicate or interact with other people through speech. However, some actions which a paralysed person can easily perform is blinking, thinking and feeling [2, 5].



In our work, we have tried to propose a solution for the first category of people who are able to speak clearly. To help these people to interact better with their surroundings, a machine-learning based methodology for emotion detection from speech has been proposed. Also, a prototype of a wheel chair in the form of an arduino robot has been developed. The movement of this robot has been controlled through emotions rather than speech or any other form of commands.

The rest of the paper has been organized as follows: the literature survey has been presented in section 2. Methodology and experimental analysis have been presented in section 3 and 4 respectively. Finally, the conclusion of the paper is stated in section 5.

## 2. Literature Survey

In the medical field so far, machine learning has been used for the detection of Alzheimer's disease [6], Parkinson's disease [7], neuroimaging [8] etc. Classification of electroencephalogram signals with different machine learning methods has been used for detecting the age too [9]. Also, because of the increasing dominant old population, service robots have been developed which can help aged people [10, 11]. However, in our paper, we have applied machine learning for emotion detection from speech for the benefit of people with neuromotor disability, who are unable to perform any action due to paralysis in the body.

In their paper, Lally [12] et. al have applied Watson's parsing and semantic analysis capabilities for analyzing various characteristics of questions. Kollia et. al [13] have described the use of Watson Experience Manager (WEM) at the National Technical University of Athens from the perspective of educational utilization. A machine learning technique in IBM Watson that uses medical as well as lexical features extracted from the record of a patient and automatically generates a list of the patient's medical problems has been proposed by Tsou et. al [14]. IBM Watson has also been used along with Raspberry pi for home automation and controlling the devices remotely over the internet [15]. However, in this work, we have used IBM Watson for detecting emotions from the text, which is produced from human audio using Google Speech Recognizer.

Moreover, speech analysis has been used for developing mimicking robot [16], interacting robots [16] etc. but in our paper, we have programmed the Arduino Bot to accept the input from the IBM Watson Tone Analyzer and move according to the analysed emotion.

## 3. Methodology

In this section, the steps followed for performing the automated sentiment analysis for controlling the robot movement has been presented.

### 3.1 Automated Sentiment Analysis for Robot Movement through IBM Watson

Automated analysis of sentiment is an area of interest for several researchers and would be helpful for several real-life applications. It can empower the human-computer interaction by ensuring a more natural way of communication. It would be interesting to have a computer that can perceive and reciprocate to a human non-verbal communication like emotions instead of responding to the traditional programmed events created using a mouse or keyboard. Further, emotions can be used to personalize the computer setting based on user needs and preferences. In this work, we have tried to analyse audio to detect the emotions and then further give command to the robot for forward, backward, left, right and stop moves. Therefore, people who are not able to control the robot with their voice commands can control it through their emotions [1, 2, 5, 12, 13, 14].

There has been an immense advancement in the field of text mining over the past few years. Due to this, large amount of resources (textual) available online can be analysed very easily today. Here, we have used Google Speech Recognizer for converting the audio to text and detect the emotions using IBM Watson Tone Analyzer. The emotions are further mapped onto the motions for sending commands to the robot. This system can be used to control a real robot by sending normal text as the input to tone analyser [3, 12].

### 3.2 About Arduino Robot

The robot is a small 2-wheel car with a castor wheel. Its main electronic components include:

- Arduino Mega – it is a micro-computer based on the ATmega1280.
- L293D – it is a monolithic integrated motor driver which has 4-channel and can control a set of 2 DC motor simultaneously in any direction.
- Bluetooth HC-05 – it helps in sending and receiving of the data in a similar way as can be done using a serial monitor.

### 3.3 About IBM Watson Tone Analyzer

Tone Analyzer has been designed based on the concepts of psycho-linguistics which is a domain of research that studies the relationship between linguistic behaviour and psychological theories. It assigns scores to the tone dimensions based on the linguistic analysis as well as the correlation between the linguistic features of written text and emotional / language tones. For example – people exhibit various type of moods as a result of which different tones are observed and reflected in their daily communications like joyful or sad, open or conservative, analytical or informal. These tones are analysed has it creates an impact on the effectiveness of the communication by the people in different contexts [1, 3, 4, 5, 12, 13].

### 3.4 Steps Followed

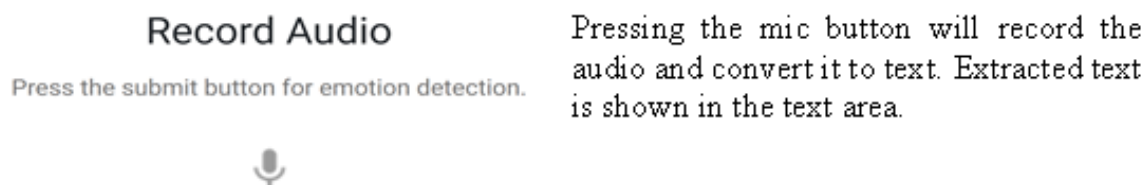
The steps followed for extracting the emotion from the audio and feeding the command to the robot are as follows (entire process has been depicted in Figure 1):

Step 1: Google Speech Recognizer is used to convert speech to text as shown in Figure 2. It is integrated inside the client side of user's browser.



**Figure 1.** Process of automated sentiment analysis.

Step 2: Next, the text needs to be fed into IBM Watson tone analyser to fetch the emotions as shown in Figure 3.



**Figure 2.** Process of converting speech to text.

Step 3: Then the fetched emotions from Step 2 can be mapped to some directions for movement as indicated in Table 1 and accordingly the robot can be controlled.

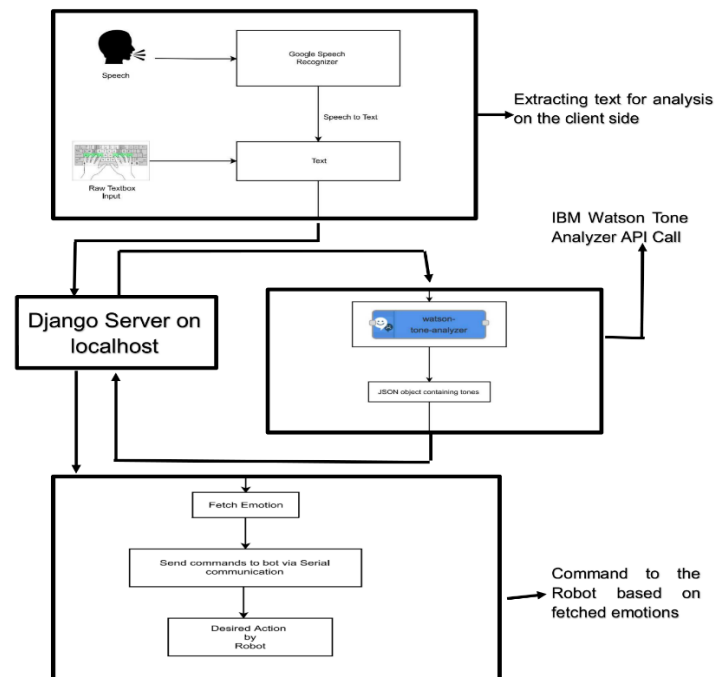
**Table 1.** Mapping of emotions with the direction of movement.

Emotions	Movement
Fear	Forward
Sad	Backward
Joy	Left
Anger	Right
Others	Stop

**Figure 3.** Tone analyzer service

### 3.5. Flow Diagram of the Proposed Method

The complete flow of the steps mentioned above has been presented as a flow diagram in Figure 4.

**Figure 4.** Control Flow for the Proposed Method

#### 4. Experimental Analysis

The Arduino Bot has been programmed to accept the input from the IBM Watson Tone Analyzer and move according to the analysed emotion. IBM Watson Tone Analyzer has a trained machine learning model based on support vector machine (SVM) to predict tone. For this model, IBM has leveraged many categories of features, including lexical features from various dictionaries, n-gram features, the existence of second-person references in the conversation, some dialogue-specific features such as saying thank you, etc. It was experimentally found by IBM that about 30% of the sample data has multiple tones [4, 12]. For each tone, model was trained independently using a One-vs-Rest paradigm. This analyser accepts plain text or a JSON file with approximately 128KB of text and returns a JSON file as output that specifies the tone of the input. In this work, the words of a person have been captured and converted into text first and then provided to the tone analyser which extracts the tone and maps it with a feeling. Corresponding to the feeling then a movement command is sent to the robot. The experiment was performed with 50 people and in 95% cases correct movement of the bot was observed.

#### 5. Conclusion

In this work, we have proposed a method of controlling the movement of people having neuro-motor disability who are unable to walk, based on their emotion. A prototype in the form of a robot was built to check that the mapping of emotions can be done with the four directional movement of the robot after extracting the mood/tone from the words spoken by the person. In 95% of the cases, correct movement of the bot was observed. Further, the wave features of the voice may be analysed to improve the accuracy. Also, this emotion-controlled movement feature can be used in other areas like covert operation, feedback industry etc. In future, we would be analysing the thought process of the people with neuro-motor disability by capturing the brain waves and processing the EEG signals to determine eye blinks, concentration, attention etc. and control their movement accordingly because in many cases such people cannot speak properly.

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