Development of Blink Restoration Model for Facial Paralysis Detection

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Abstract. On account of blink feature, patients suffer from facial paralysis that lead to disfiguration and loss of vision. Ultimately, facial pacing aims to improve the standard of life for individuals suffering from facial unilateral paralysis. A device is designed that can analyze electromyography signals from the healthy side of the face and trigger the corresponding muscle with electrical stimulation on the paralyzed side simultaneously. FES is one of the possible ways for restoration of blink of these patients. The system modelled will achieve the EMG signal extraction and blink detection algorithm for stimulation by real-time signals. Finally, the device has been experimented on humans, rabbits, dogs with EMG signal data set. The attenuation of power frequency is about 51dB with 80% accuracy.

Keywords: Electromyography, RISC, CMOS Process, Blink Detection

1. Introduction
The Now-a-days many of them, one in thousands of people are suffering with paralysis in face nerves. It leads to lack of control over trivial organs with blinking is the main problem. Due to this, there may be loss of vision of the human being. Several treatments and research were conducted to reduce these Facial nerve paralysis problems [1]. Surgical treatments for Facial paralysis include tarsorrhaphy, lower lid shortening, palpebral spring, and upper lid gold weight implantation. In this paper a novel technique called Electromyography (EMG) has implemented to specify the eye lid strength and the healthy eye blinking. The solution for the above issue is solved by the given modules as EMG Extractor and Blink Detection algorithm [2]. Many researchers have contributed on Eyelid Functional-Electrical-Stimulation (FES) about 30 years, but there are some disadvantages such as vision limitations. The remaining of this paper will discuss on the methodologies in design of the system, algorithm and finally the test results provided done in MatLab and Lab-View.

2. Related Work
Reanimating the eye twitch was the key goal in the production of prosthetic, transcutaneous pacing technologies for unilateral facial paralysis. This seems to be a product of two factors. First, in spite of paralysis, blinking is required for the eye to remain moist and healthy. Secondly, normal blinking is a basic action that can only be assumed to have two states, and eyes are kept closed for a fixed time in most instances. One way to detect the blinks is to use electromyography (EMG) measurements. An infrared-based measurement has also been suggested as an alternative that overcomes problems the electrical measurement might have, such as cross-talk of the stimulation signal to the measurement.
channels [2]. Between 2012 and September 2018, 75 patients with unilateral facial palsy had 88 upper eyelid lipofilling procedure[10]

3. Methodology

3.1 Implementation

3.1.1. EMG Extractor: To differentiate blink of the eye of rabbits, the recorded EMG signal is trained. The EMG signal is sampled with amplitude around 100 Volts, The sampled signal is amplified and applied as input for subsequent circuit modules[3]. On account of a blink, the magnitude changes from range of one-volt to four-volt in EMG signal and frequency in hertz. The range is from hundreds of two to hundreds of five in Hz. The noise so generated in this process is eliminated by a Band pass filter, and the parameters like threshold voltage and amplitude are examined for accurate blink rate[4]. The EMG extractor had certain modules like preamplifier, a band-pass filter, a post-amplifier and a peak detector [4]. The recorded EMG signal is initially pre-amplified by an instrumentation amplifier to reject common mode interference. The filter used is 4th-order Chebyshev band-pass filter. The signal is further magnified by a non-inverting amplifier. The attenuation of the proposed filter is 51dB at 50 Hz, which could meet the frequency of interference suppression of power grid noise to signal ratio. The EMG signal which is filtered can obviously differentiate the position of the movement of the eyelid with a band-pass than viewed by circuit parasitic. This complete EMG extractor is developed in LABVIEW software which can easily be process the design into hardware product[5]. This is the circuit of operational amplifier circuit shown in figure.1

![Figure.1 EMG Extractor circuit](image)

| Table 1: The Value of Resistors of the 4th Order Chebyshev Band-Pass Filter |
|--------------------------------|-----------------|-----------------|-----------------|
| Description  | R1a(Kohm) | R1b(Kohm) | R2(Kohm) |
| Stage 1      | 58.12     | 12.7       | 292         |
| Stage 2      | 43        | 10         | 200         |
| Stage 3      | 43        | 5.1        | 820         |
| Stage 4      | 20        | 2.7        | 430         |

3.1.2. Blink Detection: The EMG signal which is processed connected as input to the blink detector for decision of the state of eyelid. A 10-bit ADC is used for digitizing the signal with transceiver function rate of 2 kHz. The MCU will trigger the lid of the eye which is damaged by sending a set of parameters to the emulation stimulator. This blink detection algorithm is developed in MATLAB software. Thus we can dump the algorithm into any processor (FPGA)
for the blinking process [6]. The following figure gives you the future process followed after the extraction of EMG signal and used for holding phase.[7][8]. The figure 2 is the algorithm of sample and hold circuit which gives the details of the circuit.

![Signal Flow using Sample and Hold algorithm](image)

**Figure 2.** Signal Flow using Sample and Hold algorithm

### 4. Results & Discussion

#### 4.1 EMG Extraction:

To differentiate the blink of the humans or rabbits, the system is developed in LABVIEW for the easy processing the EMG signal with the frequency range of 200-500 Hz. This system can be used for humans with less power. The attenuation of power frequency is about 51dB with 80% accuracy. In figure 3 the red color graph is the analog details of the healthy person. Figure is the graph of emg_healthy person.

![EMG signal of human](image)

**Figure 3.** EMG signal of human
4.2 Blink Detection Algorithm: EMG signal is to be processed using the MATLAB (2018) software. On detecting the peak by fixing the threshold amplitude and threshold voltage. The peak is detected with time intervals for train pulses. This system is analyzed using EMG signal data set in humans practically. When the square signal is generated it indicates that the peak is identified. The blinking time interval of the healthy eye is having three continue windows with the required time interval. The peak time interval is processed for future stages for the muscle reaction of the eyelid. The shown figures (figure.3 & figure.4) are the results obtained. First figure.3 is the analog signal of EMG signal dataset. By fixing a threshold amplitude value to EMG signal, the amplitude more than the threshold is taken into consideration. The peak of the signal is detected and that is the blinking time of the eye. The accurate value is mentioned based on the EMG data set. Figure.4 is the digital data of the analog signal shown in figure.3. For myopathy and neuropathy the unhealthy is identified between 40 and 45% and that is rectified with healthy graph in figure.3.

![Figure 4](image)

**Figure.4.** Peak detection that is generation of square signal

5. Conclusion

In this paper, a EMG blink system has been designed and developed by using software in which design steps and requirements included in real time blink detection were discussed. By using this system, design problems solved by reducing the stimulation parameters like amplitude and increased the adaptability for blink detection. The system stimulates the signal with 1mA of current and a frequency of 50Hz. the system was achieved a accuracy of 80% synchronized with maximum blink detection rate. Developed system will sample and it can also be kept in hold for time interval whenever required. The real-time blink detection and electrical synthesis can be implemented in FPGA combined with ASIC’s.

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