

CHAPTER 4
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Jaw Motion Measuring System

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INTRODUCTION

In an effort to quantify the effectiveness of physical therapy treatment for patients with temporomandibular joint (TMJ) pain, a device to measure the range of motion of the jaw in three directions is needed. Clinical observations suggest that the range of motion of the jaw of TMJ patients is limited and improves after treatment. Other investigators have shown that the range of motion of the jaw is an important indicator of the severity of TMJ symptoms. Therefore, by measuring and recording the range of motion of the jaw before and after treatment, the effectiveness of various treatment modalities can be assessed. Since no suitable commercially available device was available for this purpose, a device for measuring range of motion of the jaw was designed.

SUMMARY OF IMPACT

Although the device has not been fully evaluated yet, an examination of the device suggests that it will provide valuable data on the change of the range of motion of the jaw resulting from various treatment modalities. The data enables the therapist to assess the success of a treatment for a patient with TMJ syndrome. In addition, the relative effectiveness of different treatment modalities can also be measured so that their relative effectiveness can be compared. By combining this data with other measures, such as pain scales, electromyographic data and bite force data, a more complete understanding of TMJ problems and its treatment can be obtained. This data should aid in quantifying TMJ problems and the factors affecting them, as well as the role of various treatment modalities in treating TMJ patients.

TECHNICAL DESCRIPTION

The device uses a uniform tapered cantilever beam system that measures jaw motion in 2 dimensions. The third dimension is measured using an LVDT device. A head mount, as shown in Figure 4.1, makes it

possible to measure the jaw range of motion relative to the head while allowing the patient to be comfortable during the measurement period. The head mount structure consists of a lightweight tubular aluminum frame assemble, which can be adjusted in three directions (anterior-posterior, lateral-medial, and superior-inferior) to accommodate variations in size and asymmetries of the skull. The tubular aluminum has a 0.312-inch outside diameter and a wall thickness of 0.058 inches.

The strain gauged cantilever module consists of two thin, flexible metal strips (0.003 inches thick) to measure superior-inferior and anterior-posterior motion with a rigid wire piece for connection to the patient. The LVDT module is connected to the patient with connecting rod and measures medial-lateral movements. The cantilever beam and the LVDT are held by a support stand attached to an L-shaped spindle clamped to the head mount.

The first approach to measuring the medial-lateral motion of the jaw is to use a third cantilever beam. However, this design faces the problems of interference with the other beams, therefore, this led to the consideration of an LVDT. The low-friction operation of the LVDT, combined with the induction principle by which the LVDT operates, gives it two useful features. First, the LVDT responds to the minutest displacement of the core and produces an output. The limitation is the readability of the external electronics that determines the useful resolution of the measuring system. The second is the null repeatability due to the inherent symmetry of the construction.

Rather than trying to build the instrumentation for signal conditioning, it was decided to use commercially available modules for the signal conditioning of the strain gage cantilevers and the LVDT. The signal conditioning system chosen (3B Series Signal Conditioning I/O Subsystem, Analog Devices) provides

relatively low cost, versatile methods of interconnecting the measurement system to a data acquisition, monitoring, or control system. Along with the modules a four channel back-plane and power supply are obtained. The signal conditioning system's output was connected to a commercially available data acquisition board (LSDAS-12, Analogic Corp.).

The C program interface software library that is provided by the company was used together with a commercially available software package (MATLAB, Math Works, Inc.). The program uses a series of input commands to determine whether the user wants to review the previous data or record new data and if so

for which patient and which trial. If new data is to be recorded, a graph of the displacement versus time is plotted for each dimension. The time over which data points are taken is determined by the user who can choose any time length from 10 to 60 seconds. Data acquisition begins when the user hits the Enter key after being prompted to do so. A graph of the data is plotted and at the end of the data-recording period, the maximum movement is displayed on the screen. The user is able to print the graph and record the maximum movement for each trial for that patient.

A Single Channel Remote Control Toggle Switch System

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INTRODUCTION

A single channel device providing remote control of a signaling device has been developed. The system is comprised of a single input switch, a toggle switch circuit, and an RF remote transmitter/receiver pair. This setup allows a severely disabled person with a single switch to toggle on and off a single device such as a lamp or radio that plugs into an AC outlet. Since the toggle circuit is separate from the rest of the system, other devices such as an infrared remote control or communication system can be adapted for use. For individuals with severely restricted motion, especially if they are primarily non-verbal, provides a relatively inexpensive alternative in the form of communication or/and control.

SUMMARY OF IMPACT

The device has been in use by a nineteen-year-old female with cerebral palsy who had no voluntary control of extremities with only residual motion of the head, neck, and face. She is unable to speak and the parents required a means by which she could signal them when a need arose. Although remote control units are commercially available, there are none found that provides a toggle function via a single switch by which a device could be toggled on and off. Therefore, the present device was designed and fabricated. For approximately the last year, the device has been in use by the female patient in her home. Due to the position of the rooms and other factors, the parents had requested that their nineteen-year-old daughter be able to turn a lamp located in her room on and off using a single switch. A few problems have been encountered such as the positioning of the switch and damage of a connector, yet both are quickly corrected.

TECHNICAL DESCRIPTION

The three device components comprising the system are shown in Figure 4.1, an input switch, the toggle circuit, and the RF transmitter/receiver pair. The input switch used is commercially available (Tape Switch), as is the RF transmitter/receiver pair (Radio Shack). The toggle circuit consists of a D-type Flip-Flop (CD4013BC) and a dual multivibrator (CD4528BC). Each time the input goes high, the Flip-Flop changes states on the outputs. Each output is connected to one of the two multivibrators, which produces a pulse that remains high for 4 to 5 seconds. This output controls a corresponding switching transistor, which is connected to either the on or off switch of the RF transmitter. A simple modification of the RF transmitter provides external access to the two switches and the battery connections that allows the toggle circuit to activate the transmitter functions and provide a single battery supply. The transistors are connected in parallel to the two switches on the RF transmitter, allowing for normal operation of the transmitter if needed. By using off-the-shelf components, only the toggle circuit has to be tested for reliability; however, this includes compatibility test with the transmitter. Although the RF transmitter uses a 9-volt battery, the 6 volt (4 x 1.5-volt AA batteries) battery pack is found adequate for the transmitter. CMOS devices are selected for the toggle circuit since battery life and minimal supply current is required. In addition, the simplest circuit design possible that provides the appropriate function reliably is needed. The RF transmitter only needs current when transmitting and since its function is not altered in the modification, the device requires only the minimum current.

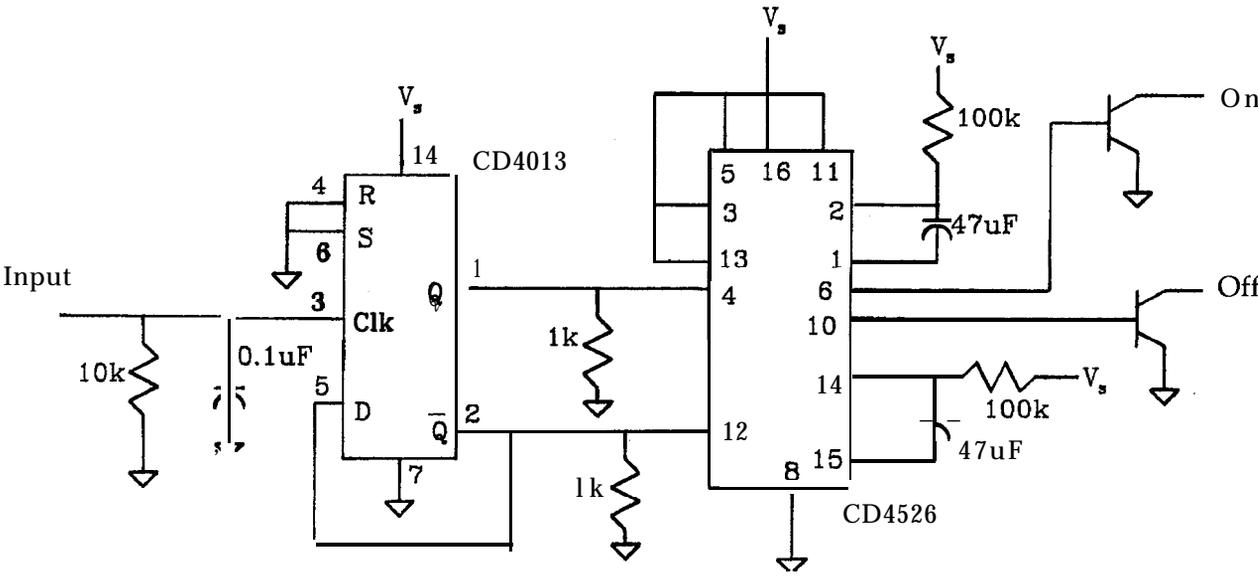


Figure 4.1. Schematic Diagram of Toggle Circuit.

