A REMOTE HAND FOR OKU

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Tajuk Projek : **A REMOTE HAND FOR OKU**

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ABSTRAK

Tetraplegia juga dikenali sebagai kuadriplegia adalah sejenis kelumpuhan yang disebabkan oleh penyakit atau kecederaan yang dialami manusia yang mengakibatkan mereka kehilangan sebahagian atau kesemua pergerakan badan mereka. Pesakit kuadriplegik biasanya tidak dapat bergerak di mana mereka memerlukan 24 jam pemerhatian dan bantuan 100% dari orang biasa untuk memenuhi keperluan dan kehendak mereka. Penggunaan suis dan peralatan elektrik yang terdapat di rumah pada masa kini sukar untuk dikelolai oleh pesakit kuadriplegik disebabkan oleh pergerakan mereka yang terhad. Pada asasnya, suis sering dipasang dalam dinding siap dan ia hanya boleh dihidupkan atau dimatikan secara manual. Begitu juga dengan perkakas elektrik yang lain, ia memerlukan penggunaan secara manual untuk menghidupkan atau mematikan peralatan tersebut. Oleh itu, projek ini dihasilkan adalah untuk mewujudkan satu mekanisme pencetus suis dengan kos yang rendah dan mesra pengguna untuk pesakit kuadriplegik. Dengan menggunakan pencetus suis ini, pesakit kuadriplegik hanya perlu meniup hembusan nafas pada tiub yang disediakan. Melalui perubahan tenaga yang berlaku daripada tenaga keupayaan kepada tenaga elektrik, suis yang dicetuskan akan menghidupkan peralatan elektrik yang disambungkan kepadanya. Oleh itu, dengan adanya pencetus suis ini, pesakit kudriplegia tidak lagi perlu meminta bantuan sesiapa untuk menghidupkan suis kerana ia tidak memerlukan sebarang pergerakan anggota tangan dan kaki untuk menghidupkannya. Dengan hanya berbekalkan tenaga daripada hembusan, sesuatu alatan elektrik dapat dihidupkan dengan pencetus suis yang dihasilkan dalam projek ini.

ABSTRACT

Tetraplegia, also known as quadriplegia is a paralysis caused by diseases or injuries that cause people to lose their part or all of their body movements. Quadriplegic patients usually could not make any movement where they need 24 hours of observation and 100% supported by common people to meet their needs. Nowadays, the use of electrical switches and equipments in home are difficult to conduct by quadriplegic patients due to their limited mobility. Basically, the switch is often installed in finished walls and it can only be turned on or off manually. Similarly, for other electrical appliances, it requires the use of the manual application to turn on or off of the equipment. As such, this project is done by creating a mechanism of trigger switch with is low cost and user-friendly for quadriplegic patients. By using the trigger switch, the quadriplegic patients just have to blow in the tube provided. Through the energy changes that occur from potential energy to electrical energy, the triggering switch will turn on electrical appliances that connected to it. Thus, with the trigger switch, the quadriplegia patients have no longer need to ask anyone's help to turn the switch because it does not require any movement of the hands and feet. Armed with only the energy of the blast, an electrical device can be activated by a trigger switch that is produced in this project.

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CHAPTER 1

A REMOTE HAND FOR OKU

1.1 INTRODUCTION

Quad comes from the Latin for four and plegia comes from the Greek for inability to move. The primary cause of quadriplegia is a spinal cord injury, but other conditions such as cerebral palsy and strokes can cause a similar appearing paralysis. The amount of impairment resulting from a spinal cord injury depends on the part of the spinal cord injured and the amount of damage done [1].

Injury to the spinal cord can be devastating because the spinal cord and the brain are the main parts of the central nervous system, which sends messages throughout the body. When the spinal cord is injured, the brain cannot properly communicate with it and so sensation and movement are impaired. The spinal cord is not the spine itself; it is the nerve system encased in the vertebrae and discs which make up the spine [1].

Quadriplegia occurs when the neck area of the spinal cord is injured. The severity of the injury and the place it occurred at determine the amount of function a person will maintain. A major spinal cord injury may interfere with breathing as well as with moving the limbs. A patient with complete quadriplegia has no ability to move any part of the body below the neck; some people do not even have ability to move the neck [1].

Sometimes people with quadriplegia can move their arms, but have no control over their hand movements. They cannot grasp things or make other motions which would allow them a little independence. New treatment options have been able to help some of these patients regain hand function [1].

In this project, an automatic switch which is design to triggered the switch by gust mechanism. This switch is design based on whiskers sensor application. In order to make it easier to use by quadriplegic patient, the user just have to blow in the tube to trigger the switch.

1.2 PROJECT OBJECTIVE

The objective of the project is to design a mechanism by using gust to trigger a switch. Beside that, this project also is created to design a switch trigger switch which converts potential energy to electrical energy.

1.3 PROJECT SCOPE

There are two scopes in this project. The first scope is design a prototype of switch trigger. The final scope is focus on the mechanism of mechanical in order to convert it to electrical output.

1.4 PROBLEM STATEMENT

Quadriplegic is paralysis caused by illness or injury to a human that results in the partial or total loss of use of all their limbs and torso. The movement of the patient is limited and always need for someone to take care of them even in a small movement.

In order to reduce the burden of the caregivers, a switching prototype is design so that the quadriplegic patient can independently turn “ON” and “OFF” of the switch by them selves.

CHAPTER 2

LITERATURE REVIEW

2.1 WHISKER SENSORS

Whiskers are much more than simple touch sensors, and it is not surprising that they are widespread among many different animal species. Some insects have two advanced antennae that can compensate for the limitation of the sensing capability by their vision system [2]. Seals can hunt in dim water by detecting with their whiskers the turbulence generated by the moving prey [3]. Different mammals use their whiskers to navigate in the absence of visual cues without colliding with obstacles [4][5]. Cats also use their whiskers to detect the contour of the prey's body to determine the head location [6]. Rats use active movements of their vibrissae (whisking) to extract information about the spatial properties of objects, including distance, size, shape and surface structure [7][8][9]. The texture discrimination capabilities of rats can be compared to humans using their fingertips.

From an engineering point of view, whiskers offer several advantages. They are independent of the lighting conditions, they do not rely on the surface properties of the objects to be sensed and they do not involve strong contact with the environment.

Moreover, whiskers do not require a complex electronic interface and can be considered as cheap and robust sensors (at least from a technical point of view).

A simple whisker sensor can be made from a length of a flexible wire anchored at one end. When the free end touches an object, the wire will bend and this can be detected by piezoelectric element or simple switch [10]. This kind of whisker sensor has been described by Wang and Will [11]. Their whiskers were mounted on a pneumatic actuator so that the whisker could be retracted for protection when heavy lifting was performed. A single switch can be used to locate and recognize an object, but it is very slow because after each reading the whisker has to be re-oriented to measure another contact point at a different position.

The used of whisker sensors or antenna-like sensors has also been reported in mobile robots. Simple whisker sensors can be mounted on mobile robots to provide warning obstacles. Long antenna-like whisker sensors were mounted on the SRI mobile robot Shakey [12]. These whiskers were made from shape-memory allow because the high electricity of this material allows it to tolerate a relatively large amount of bending without suffering permanent deformation. An articulated whisker probe has been described by Russell [10]. This whisker was actuated by horizontal and vertical voice-coil actuators. The probe used a switch type impact sensor to detect contact with an object. The sensor was able to construct outline images of objects.

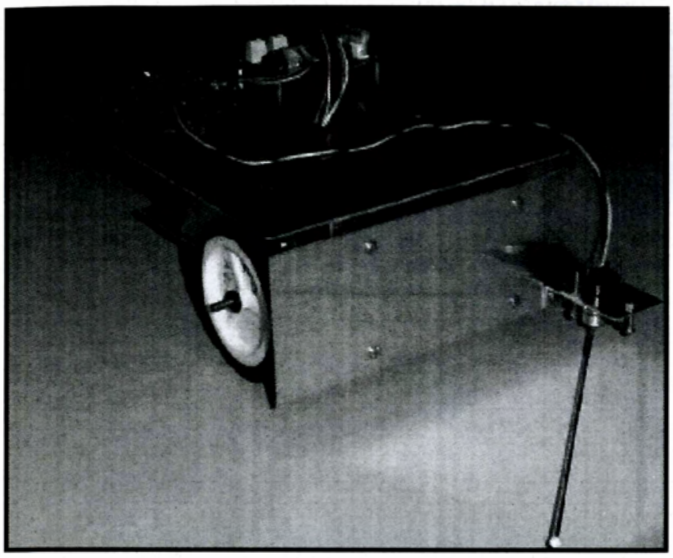

Figure 2.1: A whisker sensor based mobile robot

Source: Jaury A. Wijaya and R. Andrew Russell. Object Exploration Using Whisker Sensors. Monash University. 2002.

A passively articulated whisker sensors was developed by Russell [10]. He used a curved rigid fibre composite whisker with the root mounted on a potentiometer coupled with a light spring. The potentiometer measured the angle of rotation when the whisker tip touched an object. Similar whiskers were also develop by Jung and Zelinsky, and were successfully implemented on their mobile robot for high speed and close wall following [13].

Tsujimura and Yabuta described a sensor consisting of a force/torque sensor mounted at the root of a flexible insensitive probe [14]. The contact along the probe was estimated using force and moment data measured by force/torque sensor. Their shape detection experiments were carried out using a robot manipulator with the probe equipped with a force/torque sensor mounted on it. Kaneko eliminate the force sensor and used only four components for their system which is an insensitive flexible, beam, a position sensor, a torque sensor and an actuator. They called their sensor an active antenna. The sensor was able to localize the contact position along the beam by using active motion. When additional angular displacement is induced in the beam after it makes contact with an object, it is possible to estimate the contact position along the beam using torque information [2]. They have also developed a 3D version of the active antenna, which consist of an insensitive flexible beam, two actuators to move the beam 3D space, two position sensors to measure the angular displacements and two axis moment sensors [15]. Another method used by them is the dynamic active antenna. By analyzing the natural frequencies of the beam when it strikes an object, they were able to estimate the contact position [16].

2.1.1 WHISKER SENSOR DESIGN

Cat and rat whiskers are stiff hairs which act like levers, pivoting at the bulbous root which is rich in sensory nerves. Unlike the insect antenna which is rich with sensory nerves along the antenna. The project was motivated by observation of cat and rat whiskers. Using an insensitive probe as the whisker with the sensor mounted at the root gives advantages of simpler and cheaper design. Because the whisker will often be touching the object, it will easily broken if it is made from fragile materials [17]. Figure 2.2 below shows a schematic view of a whisker sensor.

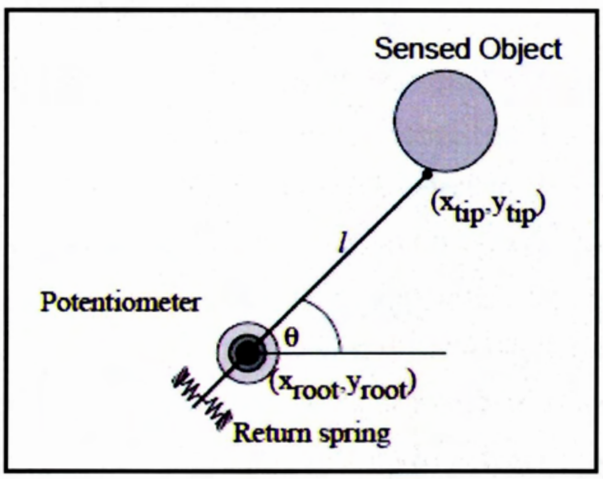

Figure 2.2: A schematic view of the whisker sensor

Source: Jaury A. Wijaya and R. Andrew Russell. Object Exploration Using Whisker Sensors. Monash University. 2002.

It consists of a straight rigid wire mounted on a low friction potentiometer together with return springs. It used 20cm length and 1.6mm diameter steel welding wire as a whisker. A 4mm diameter plastic ball was attached to the tip of the whisker to improve its ability to slide over a range of surfaces. The whisker is free to rotate about one axis to allow it to track the surface of the external object. The whisker angle rotation of θ is measured by the potentiometer and the spring returns the whisker to its initial orientation when it is not touching an external object.

2.1.2 MORPHOLOGICAL CONSIDERATIONS

In many animal species especially in rodents, the spatial arrangement of the whiskers on the animal's head is highly preserved within each species, and the length of the whiskers systematically increases from the anterior (rostral) whiskers to the posterior (caudal) whiskers. In addition, the neuroanatomy of rats shows that the prominent part of the somatosensory cortex devoted to the processing of whisker signals, the barrel cortex, has a beautifully preserved topology of the precisely arranged whiskers [18].

These observations raise the question of how important the morphology of the whisker sensory system is. As a trivial example, cats can "measure" the width of a gap by help of a set of whiskers with different length arranged adequately, thus reducing the processing of the signals to a simple binary touch detection. Furthermore, animals use whiskers extensively as distance and collision sensors. Fast and easy evaluation of distances to objects is crucial when moving at high speed, for example when fleeing from predators or when hunting. Such evaluation of sensory information can be greatly facilitated by an appropriate morphology of the sensor distribution. In the simulation experiment presented below, we show that for a given task, a particular arrangement is found to be more suitable than others, in agreement with results found in a similar experiment conducted with a real robot.

2.1.3 MATERIAL PROPERTIES OF WHISKERS

For simple tasks for example if whiskers are used as simple binary touch detectors, we could expect that flexible whiskers do not provide a significant advantage over rigid whiskers. However, we show that a change in the material properties of the whiskers leads not only to morphological modifications, but also to a substantial speed-up of the artificial evolution process, as well as a change in the obtained behavior [19].

2.1.4 IMPROVED WHISKER SENSOR DESIGN

The limited signal resolution led to several design changes (Figure 2.3). The small 9 pF range was difficult to measure accurately [20]. To improve the signal range over the range of whisker deflection and to resist corrosion, the copper plates were replaced with a layer of the same silver epoxy used on the inner cone. The silver epoxy showed none of the corrosion previously observed on the copper plates. The epoxy waterproof layer on the base was replaced with a layer of commercial grade plastic wrap that was thinner and more uniform in thickness. The waterproofing still creates parasitic series capacitances in the sensor, but the thinner layer increased the value of this parasitic capacitance reduced its dampening effects. The diameter of the inner cone was increased by 5%. This limited the overall distance the whisker could deflect, but increased the surface area of all the capacitor plates resulting in a higher total capacitance.

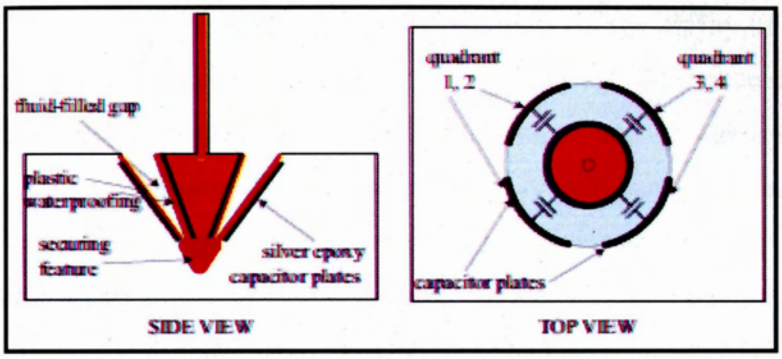

Figure 2.3: Schematic of improved sensor secured at the base, with larger inner cone, shielded wires, silver plates, and more uniform coating.

Source: W.C. Eberhardt, Y.A. Shakhsheer, B.H. Calhoun. A Bio-Inspired Artificial Whisker for Fluid Motion Sensing with Increased Sensitivity and Reliability. University of Virginia

The inert silicone oil filling the gap was unlikely to match the surrounding fluid in any environment where the sensor may be deployed. This would cause unwanted moments on the whisker based upon the sensor's orientation to gravity, for example a sensor with a whisker parallel to the ground would deflect downward and provide skewed results. The polydimethylsiloxane (PDMS) layer separating the gap fluid from the environment and providing to the whisker deflective properties was removed and the whisker cone was held in place by a silicone attachment at the cone tip. This allows the surrounding fluid to fill the gap.

The whisker deflection was previously measured by capacitance. The lack of range, reliability in the results, inability to measure dynamic whisker deflections, and inability to directly measure capacitance in non-inert fluids led to the redesign of the whisker deflection measurement modality. To measure whisker deflection, the whisker cone is excited with a sine wave at a desired frequency, and the output peak-to-peak voltage, corresponding to the whisker's position, is measured across a load resistor. This sine wave sensing modality was used in prior art to measure the capacitance of the sensor directly. The capacitance measurements were limited to a range of 7-16 pF in the silicone oil, a range which is very difficult to sense [20].

Changing the measurement modality helped improve the ability of the sensor to detect whisker deflection. The goal is to maximize the voltage difference detected, with respect to input voltage, between maximum compression and maximum openness to improve sensitivity to whisker position (referred to as gain range) as opposed to the sensor capacitance. A secondary goal is to lower power consumption by choosing the lowest appropriate frequency for the sine wave, which will be generated through the battery-powered backend electronics. Higher frequencies that lead to high output voltages do not necessarily lead to maximum resolution. To identify a new measurement modality and to improve sensing resolution, we developed a model of the sensor's electrical behavior across frequency.

The original sensor design used long, thin wires to connect a capacitance meter to the metal plates [21]. The small diameter prevented the capacitance reading from changing as the wires moved. As the measurement modality changed to a sinusoidal input at high frequencies (>1 MHz), the small unshielded wires acted as antennae. The measured signal would comprise of up 60% electromagnetic interference from the input signal. The wires were replaced with RG-174/U coaxial cable. This reduced the noise observed in the signal output to about 5%. Some interference remains from the unshielded wire between the silver epoxy and coaxial cable (Figure 2.4).

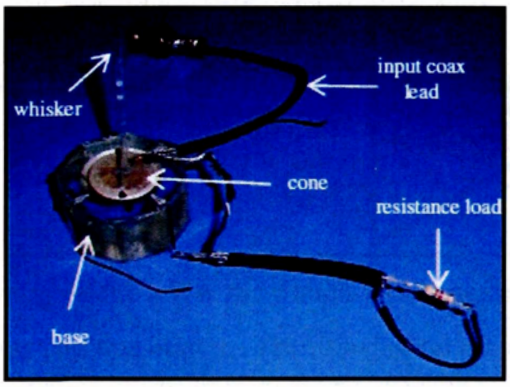

Figure 2.4: Improved sensor with a resistance load and coaxial cables

Source: W.C. Eberhardt, Y.A. Shakhsheer, B.H. Calhoun. A Bio-Inspired Artificial Whisker for Fluid Motion Sensing with Increased Sensitivity and Reliability. University of Virginia