

Study on a Mechanical Acupuncture Instrument with Computer Aided Controlled

Wangshen Hao, Xunsheng Zhu, Haowei Zhang, and Baojun Tian

Abstract—Acupuncture relies on the use of fine needles being inserted into specific points with varying amounts of manual or external stimulation. The Gate Control Theory states that acupuncture closes the gate' to pain and blocks pain perception in the brain via stimulation of large nerve fibers. The particular research develops a mechanical manipulation of acupuncture to simulate physician with the insertion of acupuncture needles which may produce similar therapy effect. Adopting two stepper motors, the mechanical acupuncture instrument is designed with synthesized movements of lifting, thrusting and twirling. The working process can be controlled by the command strings. The mechanical acupuncture instrument possesses several manipulations of acupuncture just as physician does, and the needle can be adjusted quantitatively and reliably. With quite effective therapy function of animal experiment, the mechanical acupuncture instrument can replace physician to a certain extent.

I. INTRODUCTION

ACUPUNCTURE, the practice of inserting needles into the skin and deeper tissues along 'meridians' to balance flow of bodily 'energy' or 'Qi', has been widely used in China since 2500 BC [1]. In 1970, this method of prescientific traditional Chinese acupuncture (TCA) was introduced into the United States. In 1997 the consensus panel of the Office of Alternative Medicine, NIH reviewed the data concerning the effectiveness of acupuncture, and concluded that there was sufficient data to support the complementary use of acupuncture for the treatment of addiction, fibromyalgia and low back pain [2]. Meta-analysis and other reviews have shown trends in favor of acupuncture for the treatment of headache, musculoskeletal and neck pain

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[3].

'Manual acupuncture' involves the manipulation of the inserted needles by the hand of the acupuncturist, such as lifting, thrusting, twisting, twirling or other complex combinations. It is believed that different manipulations may elicit different effect for different conditions [4]. It is a traditional method of acupuncture, and is most commonly used in clinical practice.

However, manipulation of acupuncture that determines the curative effect of some diseases is the core and hard to learn part. Its performance can reflect medial skill of the physicians. Manipulation of acupuncture is becoming one of the most important focuses of acupuncture study. As a Chinese tradition the manipulation of acupuncture was only passed on to the few apprentices, even to male but female. In this case Chinese physicians lead undoubtedly the theory and practice of manipulation of acupuncture around the world. This paper discuss with the computer aided control mechanical acupuncture device, which would try to save the famous expert skill and teach the green learner.

II. MEDICAL MECHANISMS OF ACUPUNCTURE

It's well known that Acupuncture induce analgesia and researchers have postulated several theories regarding its mechanism of action [5]. Acupuncture mediates release of endorphins in the cerebrospinal fluid and plasma met-enkephalins and prostaglandins [6], Scientists have documented that acupuncture-induced analgesia in animal models is blocked by administration of naloxone [7]. Nearly one third of laboratory mice didn't experience significant pain relief. Further studies revealed that mice with a poor analgesic effect from acupuncture often have a genetic deficiency in opiate receptors [8]. A second theory regarding the mechanism of acupuncture analgesia is called the gate theory. Acupuncture needles may stimulate peripheral nerves and effectively "block" other pain stimuli from being transmitted to the brain. Many acupuncture points actually correspond to free nerve endings [9]. Large peripheral nerves that can be identified grossly will often have acupuncture points distributed along their course, particularly when the nerves become superficial in their distribution. Acupuncture may activate type II, III, and IV afferent nerve fibers. Stimulation of type II fibers results in numbness; type III, in a

sensation of fullness; and type IV, in mild aching—all of which may explain the de Qi sensation that confirms correct needle placement. Acupuncture focuses on altering the flow of Qi to restore harmony of body, mind, and spirit. The central nervous system may also play an important role in mediating the effects of acupuncture.

III. DESIGN OF SYSTEM HARDWARE

The mechanical acupuncture instrument can be controlled either manually by the front board or automatically by the expert database (as shown in Fig. 1). Application of simulation to manipulation of acupuncture of physicians allows researchers to consider its dynamics. This, in turn, may reveal general regularities similar to those arising in physicians actually operating. Thus, in the multiply connected system formed by personal computer (PC), front board, interface unit, drive unit, and acupuncture instrument, the PC and front board may be treated as a controller of mechanical manipulation system, while the acupuncture instrument serves as a controlled object. In order to simulate the manipulation of acupuncture, the parameters of famous acupuncturists in the process of the acupuncturing are sampled to build the expert database.

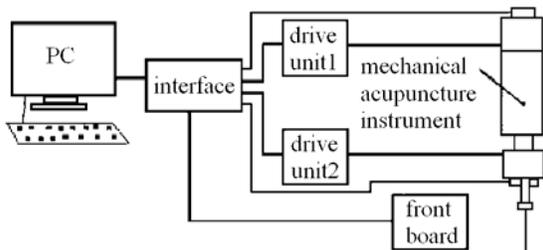


Fig. 1. Computer control structure chart.

3.1 Mechanical Unit of Acupuncture Instrument

The acupuncture instrument was made up of stepper motor for twirling and lifting & thrusting, sleeve, sliding block and acupuncture needle (see Fig. 2). Just as a syringe pipette, it could be held in the hand and operated flexibly.

A multiple-degree-of-freedom cramping apparatus was also made for free position setting. With fixed in the holder,

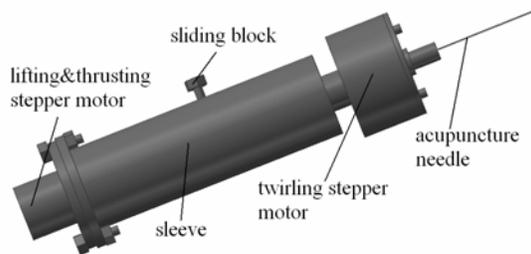


Fig. 2. The structure of acupuncture instrument.

the needle moves flexibly according to the command string. The movement parameters of the stepper motors are shown in Table 1.

TABLE I
PARAMETERS OF MECHANICAL ACUPUNCTURE INSTRUMENT

Item of Movement	Design	Real
Holder up-down stroke(mm)	60	60
Holder rotary angle(°)	90	90
Holder left-right stroke(mm)	20	20
Maximum unloaded lifting & thrusting rate(mm/s)	40	30
Maximum unloaded twirling rate(°/s)	4000	60
Maximum loaded lifting & thrusting rate(mm/s)	white paper -	30
	rubber -	30
Maximum loaded twirling rate(°/s)	white paper -	60
	rubber -	60

3.2 Electronic control Unit of Acupuncture Instrument

Fig. 3 presents the circuit diagram of a mechanical acupuncture instrument for manipulation of acupuncture using pulsed current of different intensities with control steps of the expert experienced database. In the diagram PC is responsible for Human-Computer Interaction sending the manipulation of acupuncture operating command for the drive to generate manipulation of acupuncture movement for the needle. And the two stepper motors are clockwise or anticlockwise rotating to drive the acupuncture needle twirling as well as lifting and thrusting. The needle as the execute unit touches with the patient.

IV. DESIGN OF SYSTEM SOFTWARE

Based on the manipulation of acupuncture database of several famous physician experts, we program the mechanical acupuncture instrument software in Visual C++6.0 language in Windows XP operating system [10]. The running interface of the program consists of the manipulation choose, operation times and the explanations of the corresponding manipulation as shown in Fig. 4. The most creative idea is that we could restore the action of the acupuncture experts by the mechanical acupuncture instrument via sampling the famous acupuncturists' manual manipulation of acupuncture to built up a intelligent digital expert database. For example a manipulation of "Shaoshanhuo" is selected to simulate and the result is shown in Fig. 5. The significances of the idea success are not only to retain the famous acupuncturists' skill, but also to educate the green learner more sensibly. This also gives a chance for the

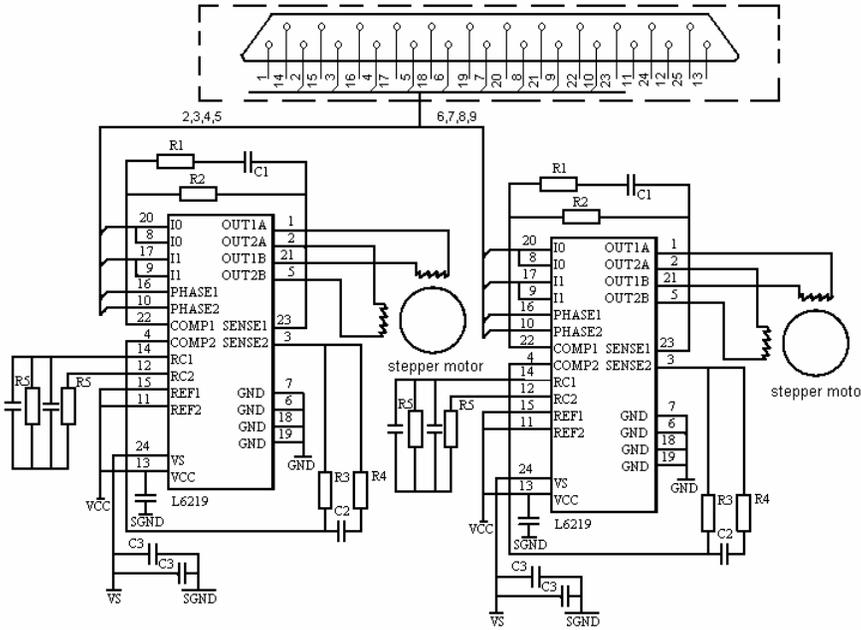


Fig. 3. Circuit of mechanical acupuncture instrument.

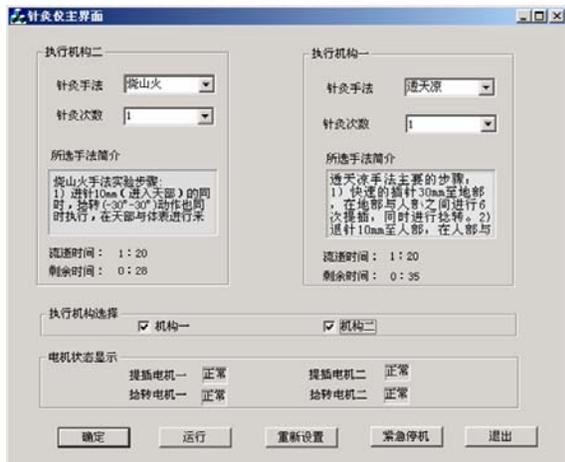


Fig. 4. Running interface of system software.

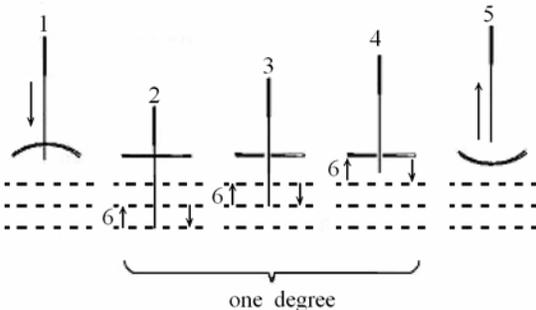


Fig. 5. Diagram of "Shaoshanhuo" acupuncture manipulation.

nonacupuncturist could also do the acupuncture therapy without the appearance of acupuncturist.

V. DISCUSSION AND CONCLUSION

The instrument has been experienced in Shanghai Second Medical University Renji Hospital with animal trial (mice). The result shows that the computer aided control manipulation of mechanical acupuncture can be operated conveniently, stably and reliably. The therapy result is quite wonderful and can replace the physician manual manipulation acupuncture to a certain extent. mechanical acupuncture instrument could preserve the traditional characteristic of the manual manipulation of acupuncture which provides a new way for the acupuncture mechanism study.

It is expected for this system to execute as an instrument for the advance of the studies of the manipulation of acupuncture mechanisms, bringing out significant improvements for the treatment and patients' life quality, and at the same time, inherit famous acupuncturist's best efforts.

The mechanical acupuncture instrument is applying for the invention patent.

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REFERENCES

- [1] Wu JN. "A short history of acupuncture," J Altern Complement Med, vol. 2, pp.19-21, 1996.

- [2] NIH Consensus Development Conference on Acupuncture," JAMA, vol. 280(17), pp.1518–1524, 1998.
- [3] PearlD, Schillinger E, "Acupuncture: Its use in medicine," Western Journal of Medicine, 1999, pp.171:176–180.
- [4] Xing W, Li Q "Effects of different manipulations of acupuncture on electrical activity of stomach in humans," J Tradit Chin Med, vol. 18, pp.39–42, 1998.
- [5] Lee, Hyangsook; Ernst, Edzard, "Acupuncture analgesia during surgery: a systematic review," Pain, vol. 114, pp. 511-517, 2005.
- [6] Kiser RS, Gatchel RJ, Bhatia K, et al. "Acupuncture relief of chronic pain syndrome correlates with increased plasma met-enkephalin concentrations," Lancet 2, pp.1394–1396, 1983.
- [7] Omana I, Olvera V, Santos P, Calderon JL. "Naloxone prevents reduction of pain responses evoked by acupuncture in neuropathic rats," Proc West Pharmacol Soc, vol. 37, 1994, pp.135–146.
- [8] Ulett, G.A.; Han, S.; Han, J.S., "Electroacupuncture: mechanisms and clinical application," Biol Psychiatry, vol.44, pp. 129-138, 1998.
- [9] Wang KM, Yao SM, Xian YL, et al. "A study on the receptive field of acupoints and the relationship between characteristics of needling sensation and groups of afferent fibers," Sci Sin, vol. 28, pp.963–971, 1985.
- [10] Swanke, John E, VC++ MFC Extensions By Example, Lawrence, Kan. CMP Media, 2000.