

## Research on Motion Control of Acupuncture Manipulation Instrument

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**Abstract:** Based on the engineering theory analysis of the acupuncture manipulation, the study puts forward the principle and method of the motion control which applied in the acupuncture manipulation, develops the acupuncture manipulation instrument on this foundation and provides a valid approach to the retrieval of experts acupuncture manipulation. So, this method can carry out the bran-new exploration towards the acupuncture engineering.

**Key words:** Acupuncture manipulation, motion control, instrument principle and method, engineering, retrieval

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### INTRODUCTION

Chinese medicine acupuncture is a treasure of the Chinese traditional culture, the most essence part of acupuncture is the acupuncture manipulation (Yang, 1995). To some diseases, the acupuncture manipulation is the key of the curative effect. The acupuncture manipulation is a kind of technical skill in most degree, in the past years, it is only sensed and hard to speech spread in the learning process, so fewer and fewer persons can master the acupuncture manipulation incomparable skill really. The experts who are still living have already bend fingers to count, it is urgent to save the incomparable skill of the old and famous experts' Chinese medicine acupuncture manipulation, so as to make more doctors be able to control the acupuncture manipulation and raise the cure level by acupuncture. At the same time, acupuncture manipulation should be strict to repeat researching the mechanism of cure illness (Zhu, 1999). Therefore, it is very urgent to research acupuncture manipulation parameter and form a specification standard by use of modern science and technology. Only forming the common language of the international academic exchanges, the Chinese medicine acupuncture could yield the brilliant achievement in the stage of the world.

At present, the mechanism of acupuncture curing illness and the clinical applications of the acupuncture on the important illness are focused on at home and abroad. In the last few years the research of the acupuncture instruments is also touched upon. The acupuncture instruments of the clinical application mainly include the

detect instrument of the acupuncture points, the electric needle instrument, the leading the even instrument of meridian and collateral, the laser acupuncture points instrument, the magnetic needle and the moxibustion instrument, etc. but it is almost the blank for the research of the acupuncture manipulation, accordingly, the standard criterion is disable to be mentioned. This research tries to analyze the engineering theories of the acupuncture manipulation, reveal the engineering substance of the acupuncture manipulation and explore a valid engineering path of the acupuncture manipulation.

### ENGINEERING THEORY ANALYSIS OF THE ACUPUNCTURE MANIPULATION

**Motion analysis of the manipulation:** The acupuncture manipulation, narrow sense is an operation method in the inserting needle process. The acupuncture period is between the times on which the needle has been inserting the needle into the acupoint and the time on which the needle has been pulled the needle out of the acupoint. The acupuncture manipulation includes the basic manipulation, the assistant manipulation, the reinforcement and purge manipulation. The basic manipulation has two manipulations (Zhu, 1996) lift and thrust manipulation, twist manipulation. The assistant manipulation is an assistance action on the needle handle, on the body of acupuncture needle and on the acupoint which located on the channels. The assistant manipulation mainly has massage along channel, flicking, scraping, rotating manipulation, flying method, vibration needling, etc. The reinforcement and purge manipulation

includes the single reinforcement and purge manipulation, the compounded reinforcement and purge. the single reinforcement and purge manipulation contains twist reinforcement and purge, lift and thrust reinforcement and purge manipulation, opening, closing and pivoting reinforcement and purge manipulation, etc., the compounded reinforcement and purge manipulation mainly has heat-producing needling, cool producing needling, etc.

The working of Chinese medicine acupuncture manipulation mainly has two fundamental motions (Tang, 1990), one is lift and thrust, another is twist, the different acupuncture manipulations can be combined or compounded by the two fundamental motions. Analyzing from the kinematics angle, the lift and thrust motion can be simplified into the linear motion and the twist motion can be comprehended for the rotational motion. These two motions can individually work so as to form the radical simple motion of the acupuncture manipulation and more complex motions can be comprehended the combination or compound of these two motions. The different modes of compound and combination (including the motion form, amplitude, intensity and frequency, etc.) constitute the different acupuncture manipulations.

**Motion control of the manipulation:** Among the traditional Chinese medicine acupuncture, the control of the acupuncture manipulation mainly depends on the doctor's clinical experience and subjective feeling and carries out of the control by the doctor's hands. Although, the manipulation which is adopted in the process of the curing the illness is mostly same, there are different among the control of the same manipulation. It is because of the subjective indeterminacy and dissimilarity of the different control level of the acupuncture. Thus, the curative effect is induced. The control of the acupuncture manipulation is very limited for the young acupuncture doctor, the acupuncture manipulation is very difficult to master also and the long assiduity practice and accumulate experience is demanded in order to control the acupuncture manipulation freely.

In engineering, the accurate-orientation step motor can individually complete these two kinds of motions to carry out two radical simple manipulations. The modes which can compound or combine the complex motions must accurately carry on the motion control in order to ensure its stability and reliability. The current step motors have bigger step-angle so that they are hard to satisfy the requirement which make the step motor be subdivided. And because of the random end location of the linear

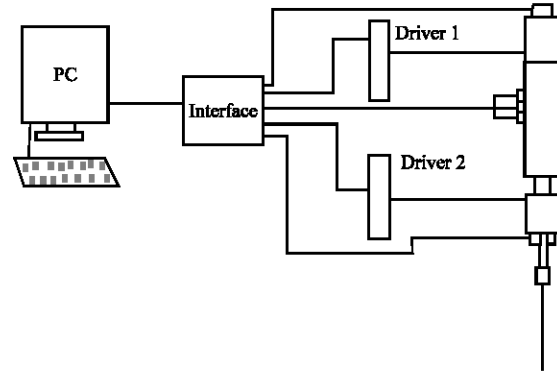


Fig. 1: The sketch of the system structure

motor and even motion between draw and twist motion, etc., the master-slaver structure control mode must be adopted. The master-slaver structure has three forms: PC-PLC, PC-single chip and PC-motion control card (analogy to the PC-PCL in this structure). The PC-PLC is close to the control card in performance and price but the latter is more PC-motion convenient and reliable in interpolation and programmer and the PC-single chip has long development cycle, easily brings out crashes and losing steps and can't compare with the others in the stability of system. It is a procedure in which the researcher must constantly modify and gradually optimize the program to simulate the complex acupuncture manipulation. Especially, with the research of the acupuncture deeply and applied universally, the application of acupuncture can be expanded by concentrating numerous manipulations into the database and creating expert system. Therefore, the PC-motion control structure mode is adopted.

The motion control card can download the related acupuncture programs from PC. When PC gives out the motion command, the motion control card will run the program to control the motor's motion. Figure 1 is the sketch of the system structure.

## DESIGN OF MECHANISM

The acupuncture manipulation is very complicated and some motions may repeat many times, so doctors are easily fatigue. Hence, the mechanism has the stationary structure and its altitude, horizontal and the front-back location can be regulated. Once the mille-needle seeks the point, the system can run automatically. The draw-motion is generated by the step motor screw which can transfer the rotate motion into the lineal motion. And the twist-motion can be generated by the step motor directly. Figure 2 is the sketch of the mechanism.

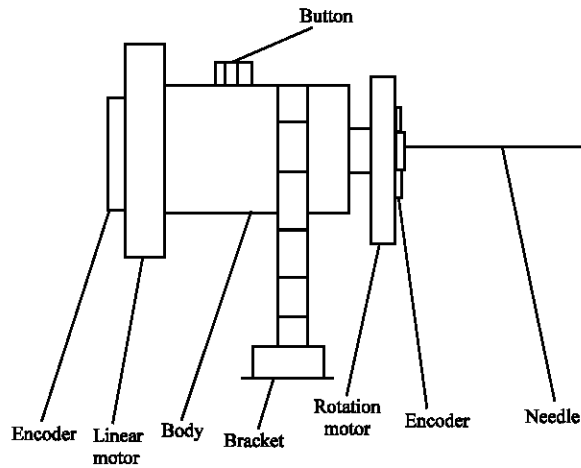


Fig. 2: The sketch of mechanism

### MOTION CONTROL

According to the analysis of the mention control above, in motion control, the master-slave control structure of PC control card is adopted (Li, 1990). This structure may carry out the control of the motion by use of the developed motion card by the third party.

**Control theory of PC motion card:** Figure 3 is the theory chart of the whole control system. PC undertakes the management of the interface and the real time control of the system such as display of the system status, the running track of the program, carrying out the control repertoire and controlling the outside signals, etc. and the control card carry out all the details of the motion control such as the output of the pulse signals and direction signals, checking the original and limit location signals, automatically controlling the velocity of the ascend and the descend. The high accuracy position lock and save are carried out by the hardware catching original and the coder index signal and the control card can programmable track the limits of the error, acceleration and the control output, etc. thus the safe and reliable motion control are ensured.

**PC-control card:** The kernel of the Motion Control System is the motion control card. Here, the GT-400-SV-PCI motion control card, step motor and its driver are used. The GT-400-SV-PCI motion control card can control two sets of performance mechanisms at the same time. As in Fig. 3, a set of performance mechanism are described, the principle of another set of performance mechanism is alike. The parameters of the motion control card are as follows:

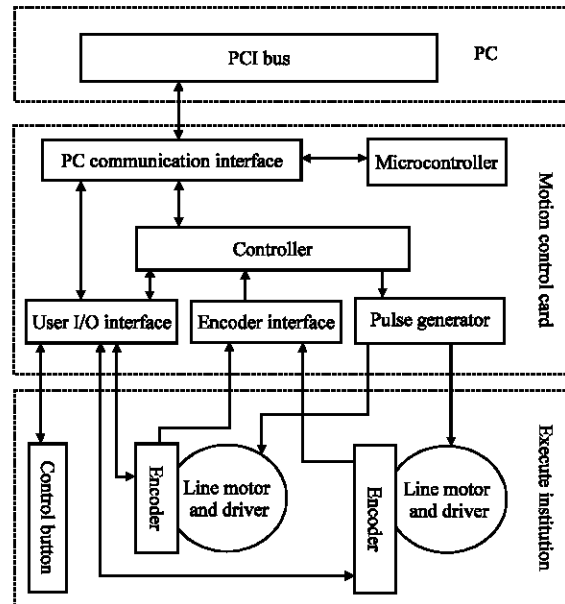


Fig. 3: The theory chart of the motion card

- The model number of the control card: GT-400-SV-PCI
- The mode of the control card: half closed-loop
- The numbers of the control shaft: four shafts
- The frequency of the sampling: 8 MHz
- The generation frequency of the impulse: 1 MHz (MAX)
- The period of the shaft sample: 200 us (MIN)
- The request of the power: +5 V ICC = 1.5 A, +12 V ICC = 30 Ma

Figure 4 is the inner structure of the motion control card. The double-buffer principle is used to download the shaft parameters and the related control orders into the motion controller, thus, the synchronous motion may be carried out. The parameters and running orders don't take effect before the controller receives the refresh orders (Wang, 1987). Once the controller receives the refresh orders, the controller will copy these parameters and orders of the next cycle into the effective registers. The encoder will take the draw-motor location feedback into the controller and then compare this value with the preset value of the system, so the step motor can locate accurately. At the same time because of the random locations in which the step motor ends, the draw-motor must return to the original location so as to the system can run without any errors.

Each step motor can select an appropriate velocity curve thus the lost steps of the motor will be solved magnificently. Here, the mode of S-curve is adopted.

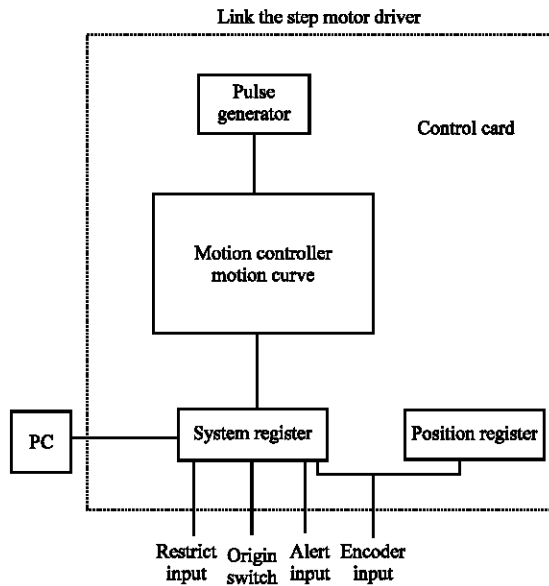


Fig. 4: The inner structure of the motion control card

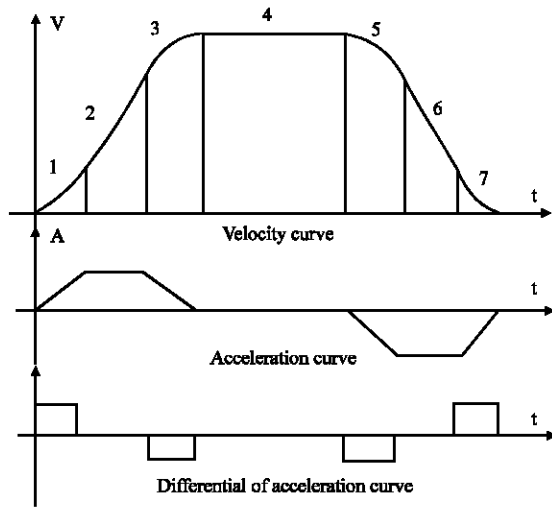


Fig. 5: S-curve modes

Under this mode, users can modify the object location. Figure 5 is the S-curve modes. S-curve mode is given to the two shafts by using the functions of the dynamic linked system and the object location, biggest velocity, biggest acceleration and differential of acceleration are set thus the acceleration of the step motor is more even and the losing steps and the stability of the step motor are optimized obviously.

**DEBUG AND RUN**

According to the system structure, the hardware and software are installed, especially while installing the

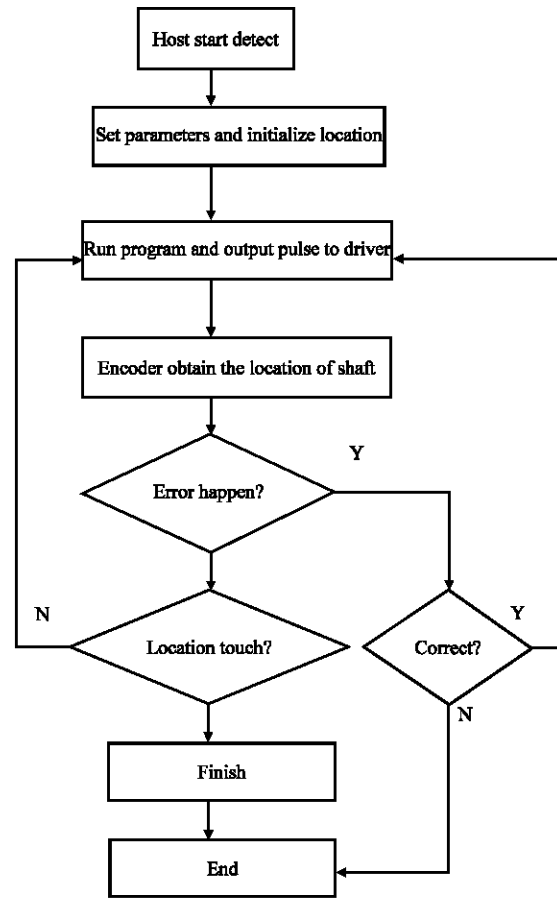


Fig. 6: The working flow chart of the acupuncture instrument

motion control card, users must operate according to the manual. Under Windows Xp Operation System, the VC++ codes are developed by using the dynamic linked database (Anpeng, 2001) (The codes are ignored here). Figure 6 is the working flow chart of the acupuncture instrument.

**CONCLUSION**

The related experiments have been carried out in the modern acupuncture laboratory of the Shanghai University of T.C.M using the acupuncture manipulation instrument. The experiments indicate that the acupuncture manipulation instrument can successful imitate some famous experts' manipulation. Certainly it is long for instrument to be applied in clinics to replace the acupuncture experts. The acupuncture instrument need to be improved and the system must to be optimized. But without question, the research and development of the

acupuncture manipulation instrument provide a valid approach to the salvage of the acupuncture expert's manipulation. At the same time, it carries out the all-new exploration towards the acupuncture engineering.

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