A FUNDAMENTAL STUDY FOR ACUPUNCTURE TECHNIQUE ANALYSIS

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Abstract

It is believed in oriental medicine that there are some special points called acu-points, and meridians connecting acu-points, existing in the human body. Accordingly, acupuncture is such to cure or keep the human body healthy by stimulating related acu-points. Acupuncture was originated from ancient China with the typical Chinese thinking and special philosophy, and recently has been accepted as a useful curing method, attracting quite much interest and being studied by many medical institutions world wide.

The basic motion of stinging into the skin in acupuncture is called insertion. A precise insertion with little pain requires high techniques, obtained only by repeated training and experience. That is, the insertion technique has been learnt mainly from experience, so there has hardly been quantitative analysis in the literature. In this study, a training computer simulation system for acupuncture training was proposed for the purpose of a quantitative characterization of the traditional oriental technique. A measurement system using a high-speed camera was constructed to record and analyze the basic motion data of insertion such as velocity, angle, and trace. The characterization of insertion was done, and fundamental data for the development of such an education computer simulation system was obtained.

Keywords: Acupuncture, Training system, Insertion, Quantification of technique.

Presenting Author's biography

Dr. Chen obtained the degree of Doctor of Engineering in 1994 in the Department of System Engineering, Nagoya Institute of Technology (NIT) Japan. She has been working as a teaching stuff in NIT since 1994, and is presently an associate professor of NIT. Dr. Chen's research interests include such as medical engineering, human interface, virtual reality technology, and computer education/training systems.

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1 Introduction

It is believed in oriental medicine that there are some special points called acu-points, and meridians connecting acu-points, existing in the human body. Accordingly, acupuncture is such to cure or keep the human body healthy by stimulating related acu-points [1]. Acupuncture was originated from ancient China with the typical Chinese thinking and special philosophy, and recently has been accepted as a useful curing method, attracting quite much interest and being studied by many medical institutions world wide.

Acupuncture was well recognized in Japan from the past with widespread clinics and even some universities majoring in acupuncture. With an increasing attention and widespread of acupuncture activities, the need for acupuncture education is also increased [2].

Acupuncture technique has been trained mainly by words, text, and from experienced doctors. However, learning acupuncture is sometimes difficult because the technique cannot be exactly and quantitatively expressed by words or text [3]. For solving such problems, we have proposed a computer simulation training system using the VR technology [4,5], in which a 3D human body model with acu-points for positioning and a real-timely true-false judgment [6], and the ability of measurement of stinging force, operation force, was constructed [7]. Figure 1 demonstrates the construction of the proposed acupuncture computer training system.

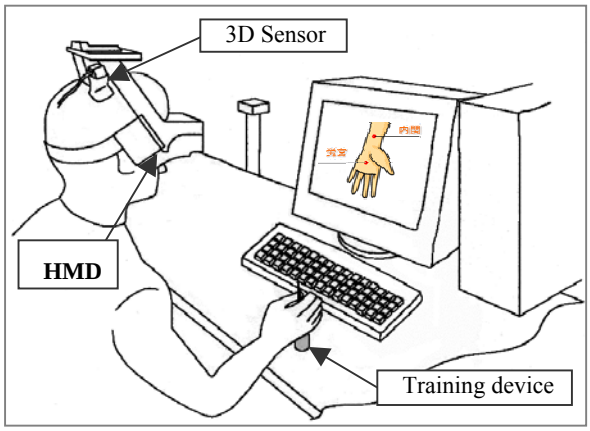

Fig. 1 Construction of the system

As one of the series of our study for acupuncture, this paper deals with the construction of such a system capable of evaluating quantitatively the insertion technique. As stated earlier, an insertion is the motion of stinging into 3-4mm depth of the human skin. Therefore, a correct stinging with little pain is necessary, and the master of such technique requires repeated exercises. The difficult increases further because there has been no standard and quantitative index for evaluation.

In this study, a measurement system using high-speed camera was constructed to record and analyze the basic motion data of insertion, such as velocity, angle, and trace. The characterization of insertion was done, and fundamental data for the development of such an education system was obtained.

2 The insertion

Acupuncture started from insertion that stings an acu-point with a needle, accompanied mostly by pain. A unique method of using a tube to hold the needle, as shown in Figure 2, is now used in Japan. The acupuncture action is such a sequence to put the needle on the acu-point, to hold the tube (left hand), and to bounce lightly the handle of the needle using the middle and the index finger to let the needle go into the skin for 3-4mm and keep stable.

A perpendicular put-in acupuncture action is taken after insertion. It is necessary for the put-in action to let the needle go perpendicular to the skin surface [8]. A tiny force tailoring is also important in the insertion. It is known that the human feels pain the most during an insertion, and the insert velocity is also important because a fast insertion may always give little pain.

From the explanation above, it is understood that quite an intensive training and experience are required to master the insertion technique. Training is usually done by practice of the trainees with each other, or using some alternatives such as an apple feeling similar to the skin. However, training with each other may be accompanied with repeated pains, and there are no quantitative standards for what is the correct.

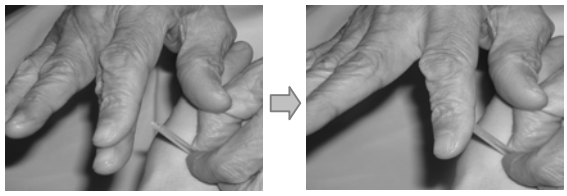

Fig. 2 Insertion of acupuncture

Based on the above situation, this study pays attention to the motions of doctor, such as the velocity of fingers and needle, the angle, and the trace, for the purpose of getting an idea motion performance, the characters of it, and the target values for training. A training supporting system using the obtained standard values is proposed. Measurement was done with a system described in the following.

3 Measurement system

The schematic of a system for measurement of insertion motions is shown in Figure 3.

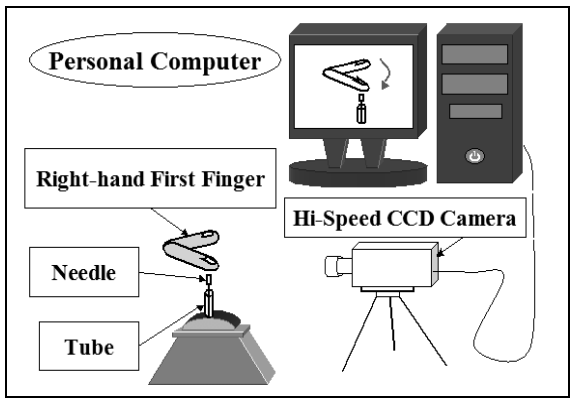

Fig. 3 Schematic of the measuring system

There is no limitation in this measuring system to insertion motions, so any practical motion in acupuncture can be recorded as it stands. Insertion was done over a sliced apple put on the table. Markers were attached to the handle of needle and the index finger of the right hand. The insertion motions were recorded by a high-speed CCD camera (a PHOTRON made FASTCAM-512PCI 32k, with Nikon lens), under conditions of 1000 frames per second, 512x512 pixel resolution, and for 3 seconds recording. Pictures were real timely transferred to a personal computer (Gateway with Windows 2000) for data processing.

Figure 4 demonstrates the details of measurement. Pictures were edited with image analysis software (PcVector) into separate picture. Changes in marker position were taken for each frame, and the velocity values were calculated according to the position-time relationship using MATLAB software. The insertion angle was also calculated from the position change.

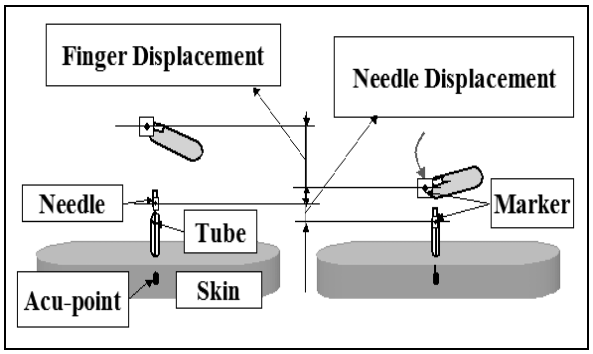

Fig. 4 The method of the measurement

4 Results and analysis

4.1 Experiment condition and results

Insertion was done 10 times each on three males of the 20th in age, who were all the beginners to acupuncture. The average value was calculated from the 10 measurements and made into 3 graphs for 3 different persons (testee A, testee B, testee C) respectively, as functions of time sequence. The trace and angle of finger and needle was expressed in graph in which the y-axis for perpendicular motion and the x-axis for the parallel. Characterization was done to the measured results.

4.2 The needle velocity

Figures 5, 6, and 7 show the needle velocity of testee A, testee B, and testee C, respectively, obtained with a PC by tracking the marker on the handle with the high-speed CCD camera. The moment of needle attaching skin was taken as the zero point on the time axis. The results of the needle velocity of 3 persons are overlapped and shown in Figure 8.

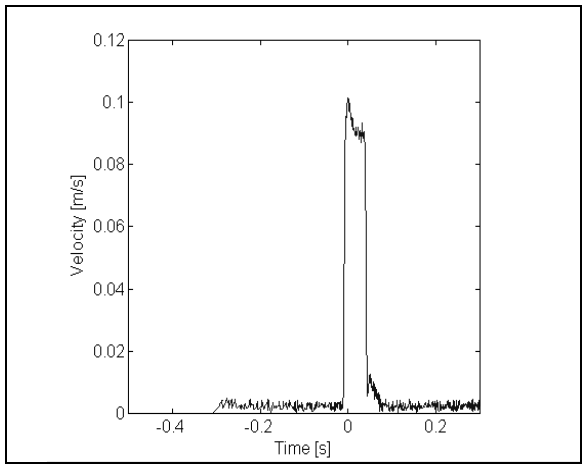

Fig. 5 The velocity of the needle (testee A)

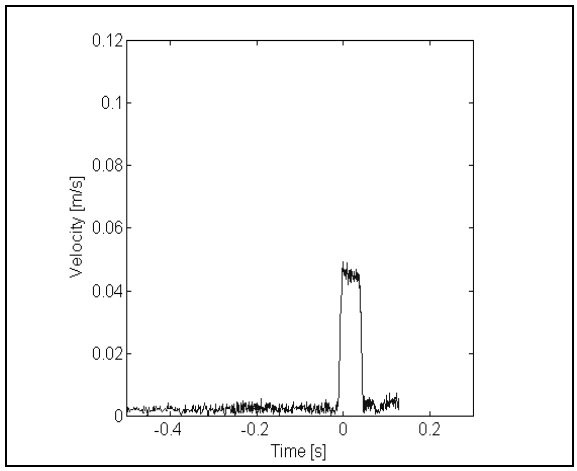

Fig. 6 The velocity of the needle (testee B)

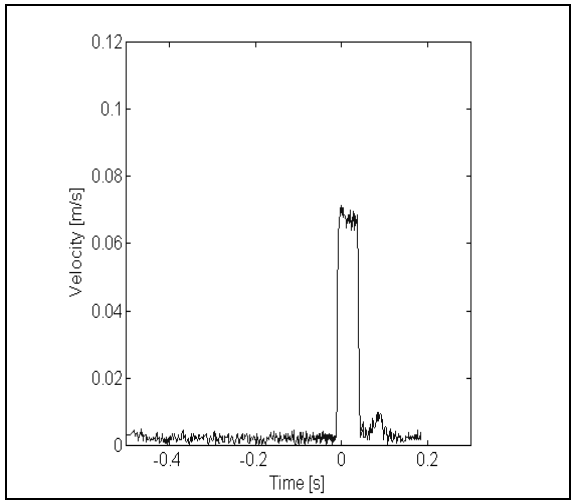

Fig. 7 The velocity of the needle (testee C)

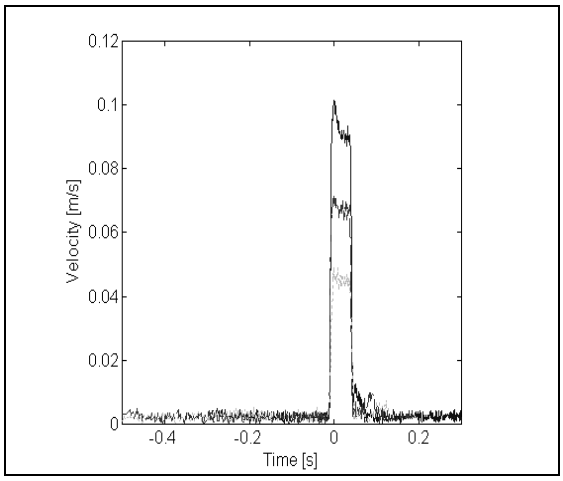

Fig. 8 The velocity of the needle (overlapping)

From the results of the 3 persons, the time interval between the start and attaching is the same, taking the value of approximate 0.05 second. However, the insertion velocity is different for each other, indicating the uncertainty of beginners.

4.3 The velocity of the first finger

Figures 9,10 and 11 show the velocity of the index finger of testee A, testee B, and testee C, respectively, obtained the same way as that of the needle. The results of finger velocity of the 3 persons are overlapped and shown in Figure 12.

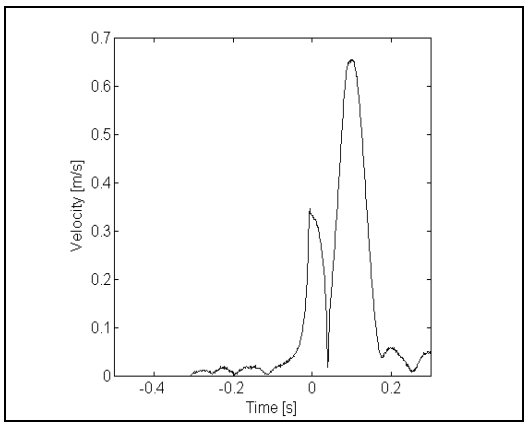

Fig. 9 The velocity of the first finger (testee A)

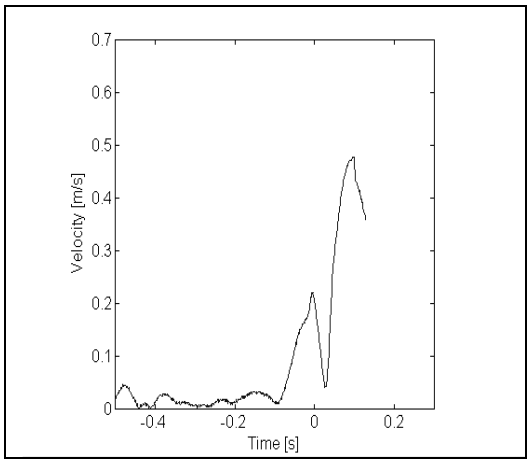

Fig. 10 The velocity of the first finger (testee B)

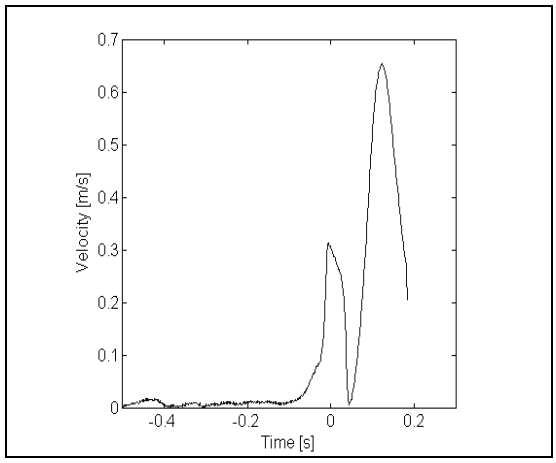

Fig. 11 The velocity of the first finger (testee C)

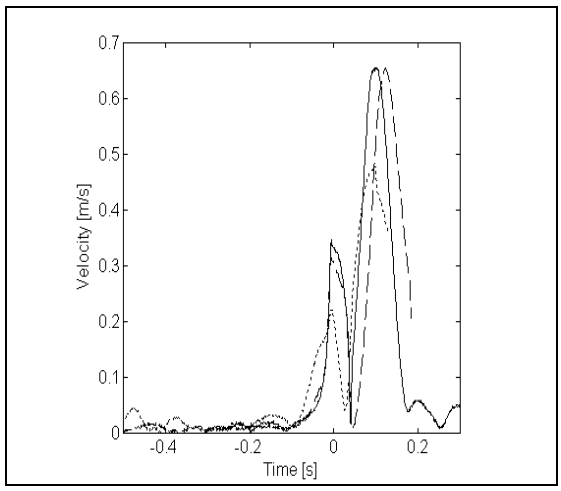

Fig. 12 The velocity of the first finger (overlapping)

The velocity increases once, then decreases, and increases again as shown in the graph. The first increase indicates the action of needle insertion, and the second increase represents the motion of finger soon after the needle insertion. Comparing the velocity of three persons, it is seen that there are different characters from person to person, represented by different graphs. Accordingly, training can be done by comparing with a standard from the experienced doctor.

4.4 The track of the needle

Figures 13, 14 and 15 show the tracks of the needle of testee A, testee B, and testee C, respectively. The moment of needle insertion was taken as the standard point, i.e., the zero on the X-axis. The results of needle traces of 3 persons are overlapped and shown in Figure 16.

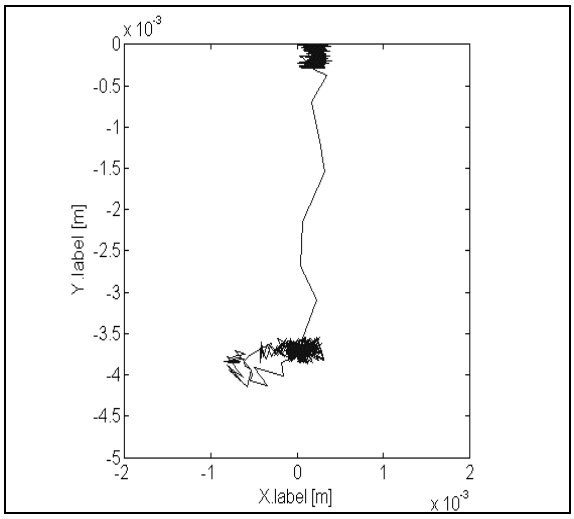

Fig. 13 The track of the needle (testee A)

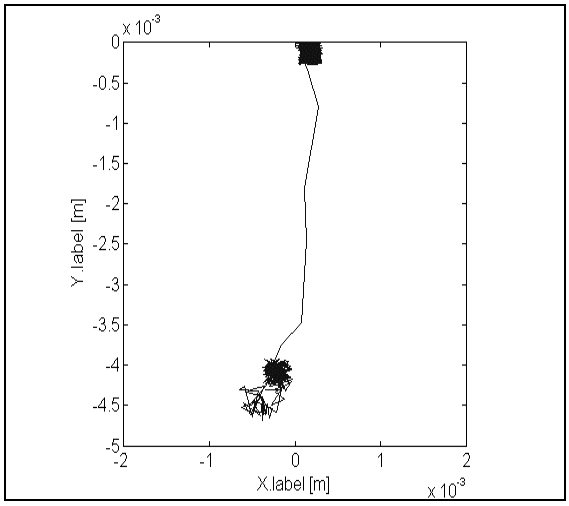

Fig. 14 The track of the needle (testee B)

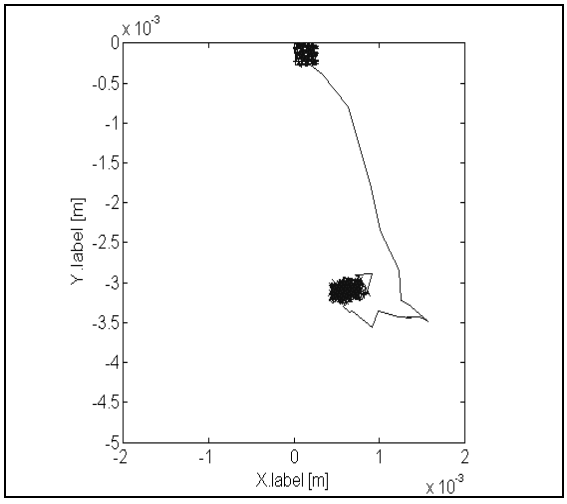

Fig. 15 The track of the needle (testee C)

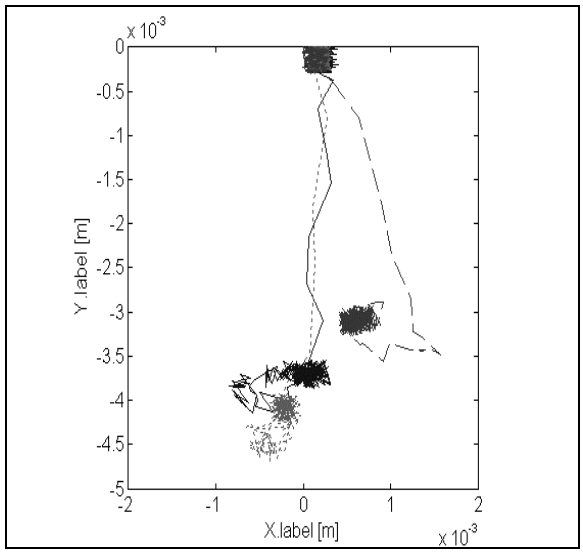

Fig. 16 The track of the needle (overlapping)

The change of position implies the degree of perpendicularity of needle insertion, i.e., the more the straight the trace, the more perpendicular the needle insertion. It can be seen a turbulence at the start and the end points for position change due to the impacts.

4.5 The track of the first finger

Figures 17, 18 and 19 show the tracks of the first finger of testee A, testee B, and testee C, respectively, with the start taken as that of the moment for needle insertion. The results of finger track of 3 persons are overlapped and shown in Figure 20.

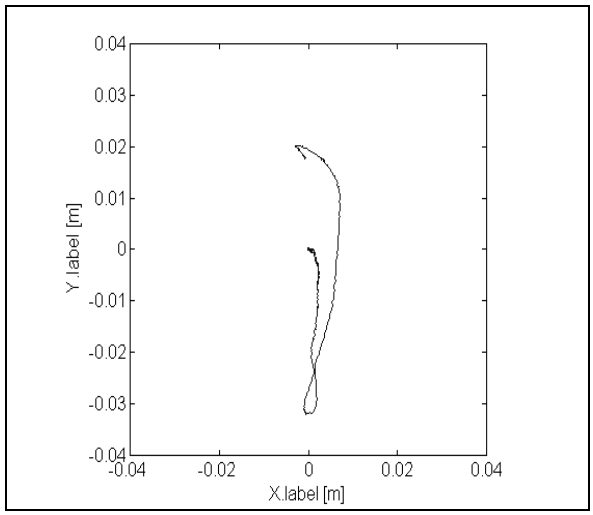

Fig. 17 The track of the first finger (testee A)

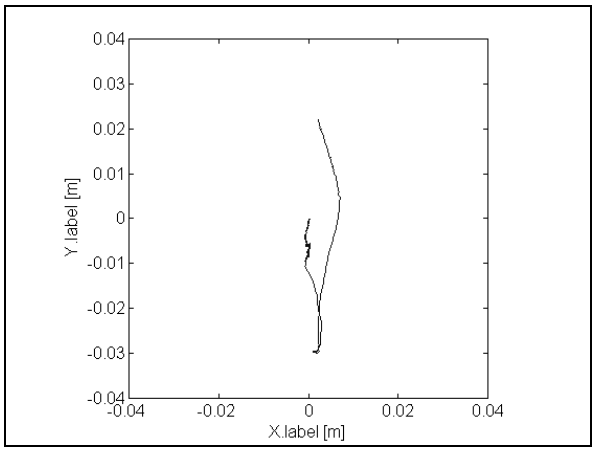

Fig. 18 The track of the first finger (testee B)

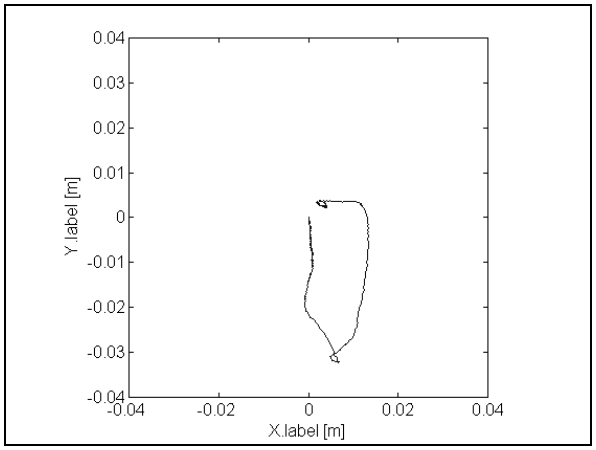

Fig. 19 The track of the first finger (testee C)

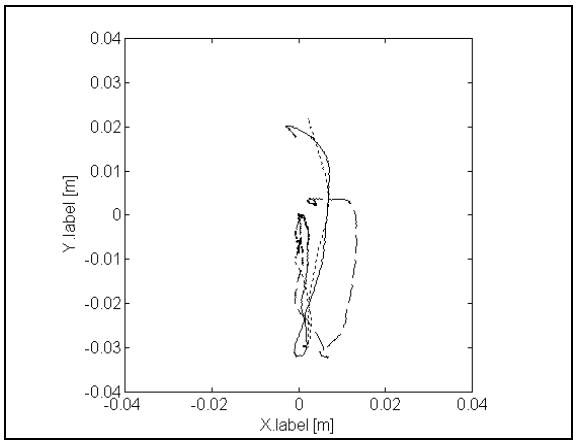

Fig. 20 The track of the first finger (overlapping)

It is seen from Figure 20 that the index finger decreases in position at the beginning, and then increases due to the momentum from needle insertion action. The technique perfection can be judged from the finger motion traces during insertion, whether being perpendicular, stable, or not. And there is a relationship between the change of finger position and that of the needle. The deviance of finger directly results in that of the needle, as seen from Figure 15 and Figure 19 of the person C.

5 Conclusions

In this research, a training system was proposed for solving the problems in acupuncture technique education and training, in which we pay attention to the operation of the acupuncturist hand, and calculate ideal value such as velocity and trace of the finger and the needle, break the character, then decide the index value for training system. As the first step in this paper, a measurement system using high-peed camera was constructed to record and analyze the basic motion data of insertion, such as velocity, angle, and trace. The characterization of insertion was done, and fundamental data and knowledge for the development of such an education simulator system was obtained.

For further study, it should be based by this fundamental experiment, make a conversion of the measurement data to three dimensional, and measure the force of pushing hand and inserting hand of acupuncturist. Furthermore, It should be identify index of force, velocity and trace of acupuncturist. Finally, the training simulator system that cans quantitative evaluation the acupuncture technical is developed.

6 Acknowledgement

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