Development of Musician Robots in Japan

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1. Introduction

Journal of the Robotics Society of Japan was published as the special issue " Music Playing Robots" in 1996. In the year before (in 1995) music playing robots' concert was held under the auspices of the Robotics Society of Japan. Moreover looking back over robot music's advance, in 10 years before (in 1985) many people were surprised by finding a robot, which was developed by Waseda University, playing an electronic organ in the Tsukuba Science Exposition.

The author has started to research and develop a recorder playing robot in 1977. In addition the automatic playing system for violin and cello have been developing since 1979. In 1982 they succeeded in playing in concert.

Recently in Japan, research projects on musician robots have been gradually becoming active. For example, a flute, a saxophone, a trumpet, a bagpipe, a xylophone, sanshind and a piano can be played by the respective robot which is researching and developing at more than ten universities in Japan .

This paper describes the Musician Robot (MUBOT) which can play a recorder, violin or cello developed by us[1,2].

2. Why is a Musician Robot ?

The research and development of Musician Robot (MUBOT) involves the following three objectives:

(a) Case study of robotics
MUBOT is set as a case study of robotics. In solving problems posed from the case study it is looking forward to contributing to the advancement of robotics.

(b) Application as an amusement robot
MUBOT provides musical performances or various entertainment. Even one who cannot play a musical instrument, can enjoy playing a musical instrument by means of MUBOT.

(c) Application as the simulator of a musical performance
The use of MUBOT is effective in experiments of studies on musical engineering.

The MUBOT has been developed on condition that a musical instrument has not been required to modify itself.

Figure 1 shows the relationship among the MUBOT, musical instrument, and performer. The performer is a human.

A musical performance requires not only a musical score but also a performer's idea for the music. The originality of the performer lies in how to cook and season the score, as does the expression of an artistic talent. The MUBOT acts directly on the instrument for providing a musical performance intended by the performer. The MUBOT never give s performance of its own free will.

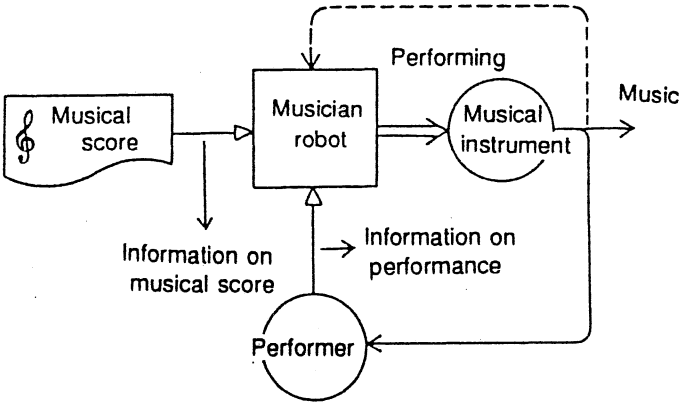

Fig.1 Relationship among musician robot, musical instrument and performance.

3. Recorder MUBOT

A recorder is performed by expirationand finger motion. Expiration of air requires a suitable flow according to each pitch of a sound. An electro-pneumatic converter controls the rate of air flow supplied from an air compressor. The relationship between the pitch of a sound and the flow has been previously found by experiment. Vibratos can be also applied by changing a flow with a certain frequency. Tonguing is done by opening and closing the air valve to the mouth-piece. Each sound hole of the recorder is opened and closed by a rubber fingertip actuated by a pencil-shaped air cylinder. The rear hole (octave hole) is made to provide overall and half opening, and closing. Figure 2 shows the picture of the recorder MUBOT.

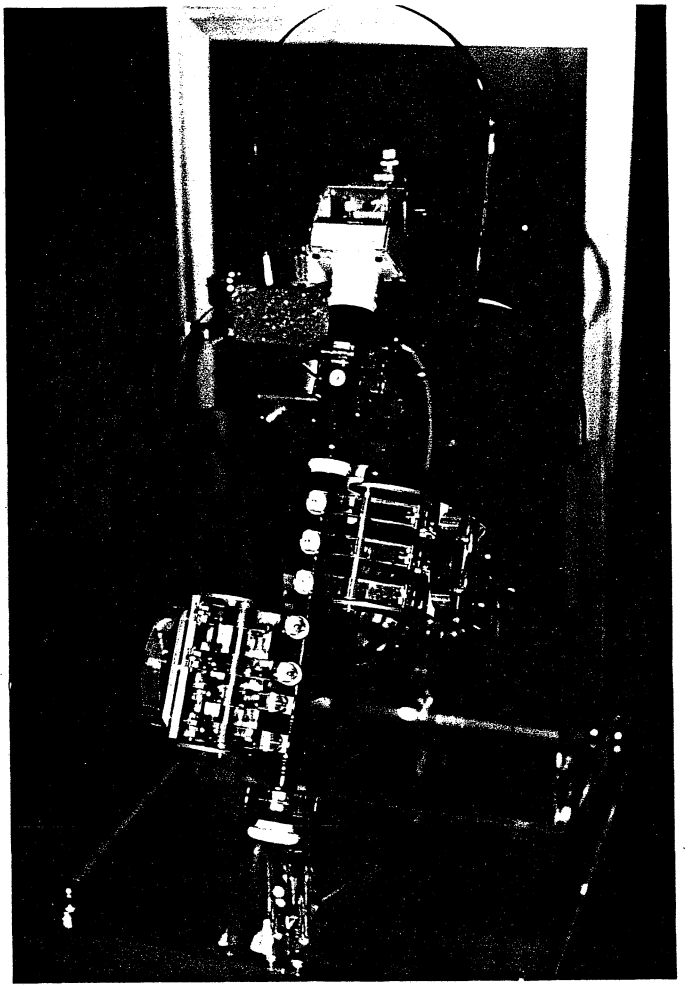

Fig.2 Recorder MUBOT

4. Violin MUBOT

The playing system of the violin MUBOT consists of the following mechanisms:

(a) Bow operating mechanism

(b) Fingering mechanism

The bow operation requires selection of an active string, pressure of bow against a string, and reciprocation of a bow. A bow must make contact with any desired one from among four strings, and move rectilinearly with appropriate pressure against a string. For these three movements, individual mechanisms and actuators are provided. The hand holding the bow is only linearly reciprocated on a fixed track. Then, the body of a violin is rotated around its long axis such that a desired string appears on the operating track of the bow. The reciprocation of the bow is performed by the arm consisting of a pantograph mechanism. The holder of the bow has a mechanism to control the pressure of the bow.

To determine a musical interval, the mechanical fingers of left hand are set at every half tone. They consist of the pencil-shaped air cylinders whose tip is covered with a small rubber. Figure 3 and 4 show the picture of the violin MUBOT.

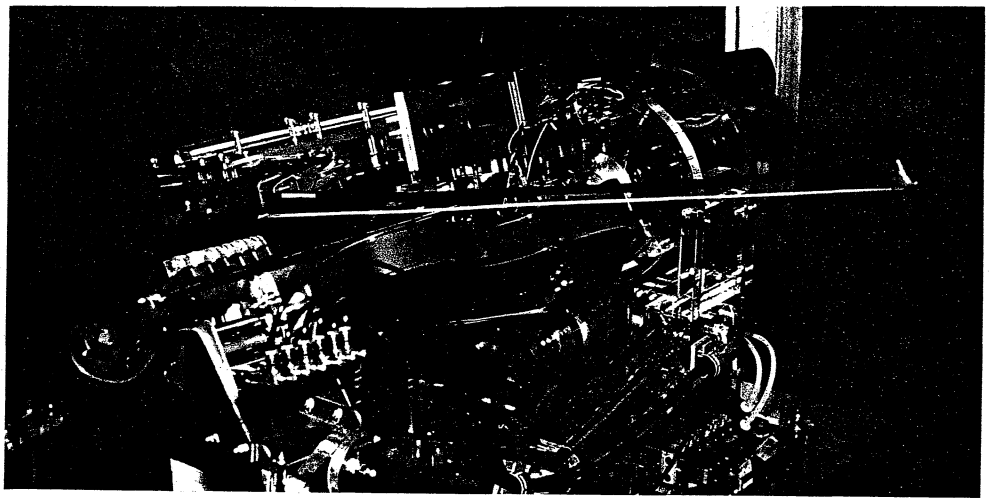

Fig.3 Violin MUBOT

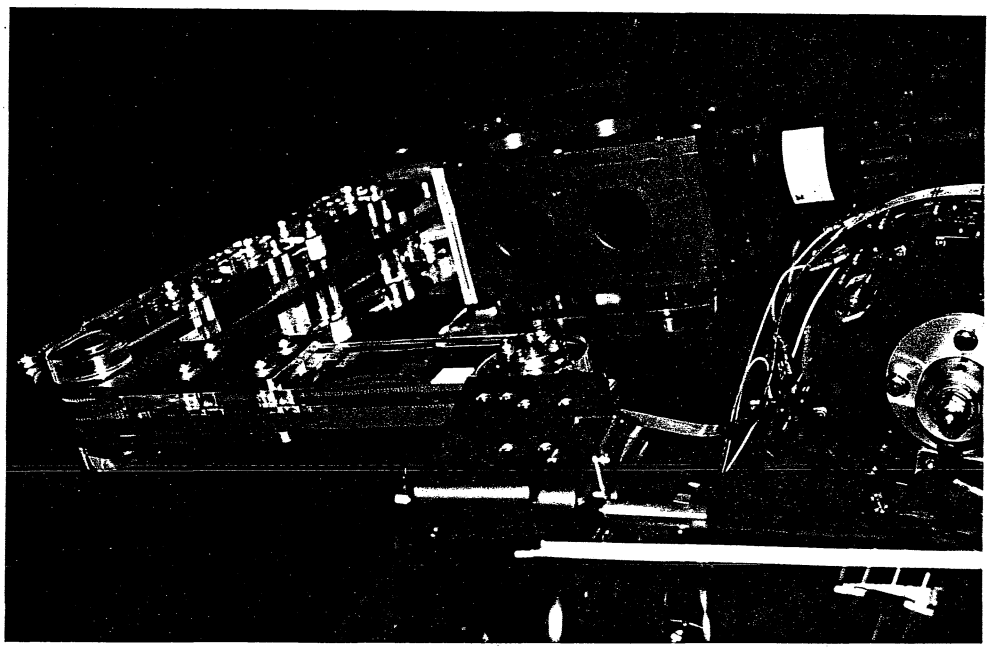

Fig.4 Bow operating mechanism of the violin MUBOT

5. Cello MUBOT

The cello MUBOT has basically the same system as the violin MUBOT. However, a cello is heavier than a violin, such that the mechanism of the cello MUBOT is concretely different than that of the violin MUBOT. Similar to the violin MUBOT mentioned above, the bow operating mechanism requires three movements: selection of an active string, pressure of bow against a string and reciprocation of a bow. The reciprocation of the bow is a simple mechanism. The whole mechanism moves on the arc-shaped rail to a position at which a desired string can be touched. In contrast to a violin, the body of a cello does not move. The pressure of the bow is applied by pressing the wooden portion of the bow in the vicinity of the point of contact of the bow and the string. The fingering mechanism consists of the pencil-shaped air cylinders as in the case of violin MUBOT. They are arranged in a 6 x 6 array at the interval of a half tone,totaling 24.

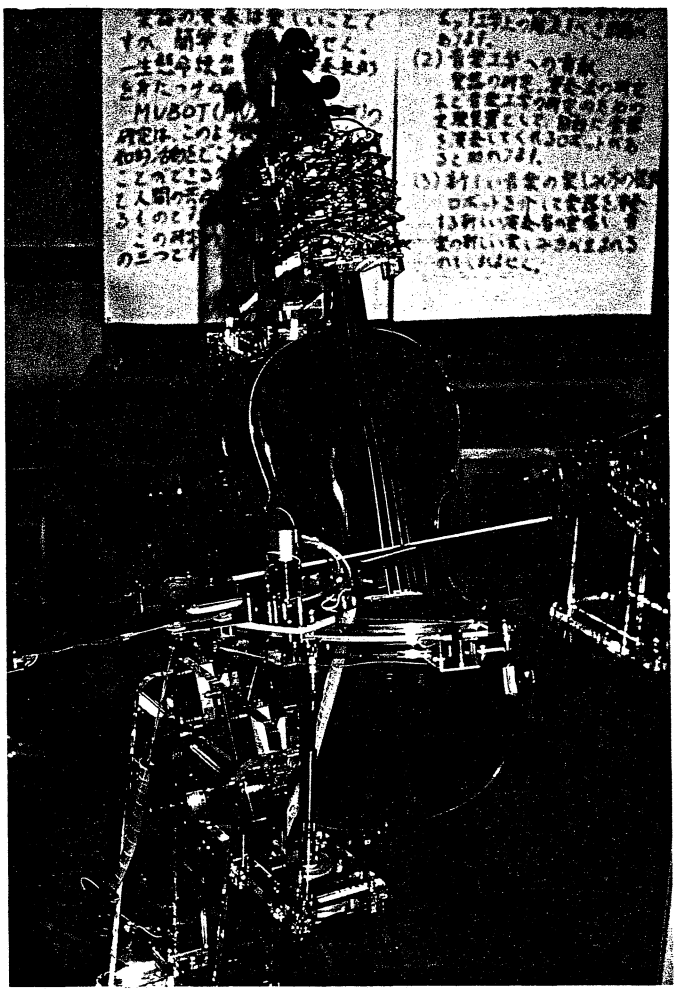

Fig.5 Cello MUBOT

The holder of the fingers is capable of moving along the direction of the strings. The effect of vibrato is enabled by reciprocating the holder with the motor and eccentric cam. Figure 5 shows the overall view of the cello MUBOT.

6. Conclution

We have developed musician robots each of which is an expert in recorder, violin and cello. And they can also play in concert as shown in Fig. 6.

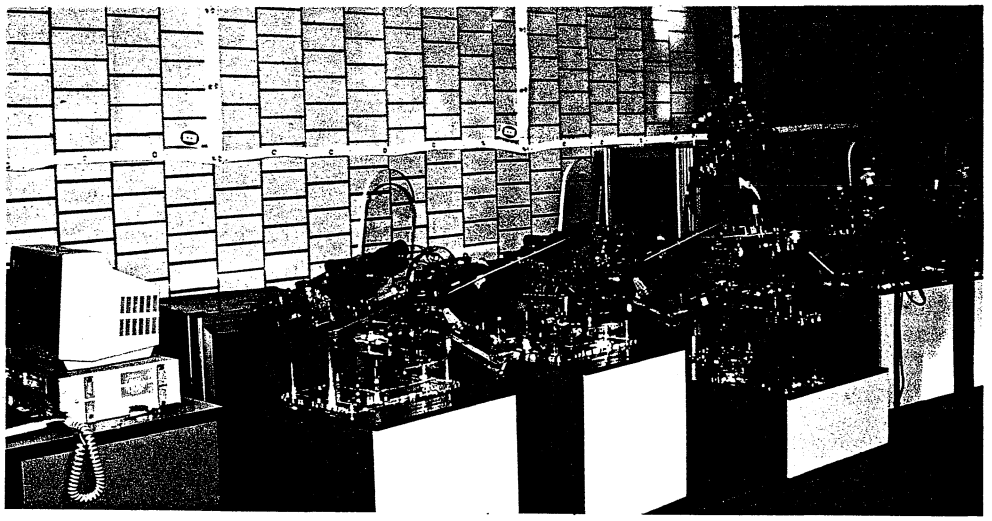

Fig.6
Concert by MUBOT