<Aeio>

The first bowed instrument robot we designed was <Hurdy>, an automated hurdy gurdy, built between 2004 and 2007. The building of that robot had many problems and our attempts to solve these have lead to many new ideas and experiments regarding acoustic sound production from bowed strings. The problems with <Hurdy> were all related to the very complicated controls required for the bowing mechanism: a system with so many degrees of freedom that handling it became far from 'automatic' and the users were left with a very complicated command set in order to make <Hurdy> play the notes he wanted. Bow pressure curve in time, bowing speed, finger pressure, bowing angle all in function of the note to be played and the required dynamic had to be send to the robot. To avoid this we provided the users an alternative way of producing bowed sound from the string: magnetic drive. This worked very well and many aspects of bowing technique in <Hurdy> could be automated in a more user friendly way.
These experiments made us dream of an instrument using twelve strings, in a chromatic arrangement, that would all individually be bowed with our electromagnetic system. So on the drawing table we envisaged an instrument with twelve strings tuned from 36 to 47 and equipped with felt covered solenoid driven dampers. The soundboard could be made from either hardened brass, titanium or Styrofoam mounted in a steel frame. Now one would think the instrument could only play twelve notes, but that's wrong since on each string we can sound the fundamental as well as the entire series of slightly inharmonic partials. In fact the range is extremely extended and covers at least the ambitus of the classical cello. The name of this robot was derived from its working principle, showing some similarity to the aeolian harp, where the strings are struck by the passing wind. <Aeio> lends itself not only as a robotic instrument in the context of our robot orchestra, but can also stand very well on its own as an interactive audio art installation.

When the instrument is used monophonically, there are no limitations. However, when you want to play double strings, these can only be played if the requested notes can be produced on two different strings. That's quite the same with all usual bowed string instruments. The driver software will arbitrate for you but there is an obvious possibility that certain chords will not be sounded in full. All strings can be made to sound simultaneously, if required. Vibrato, as common on bowed instruments, as well as glissando playing, is impossible with <Aeio>.
A scheme for playing string spectra using midi has been worked out. Unfortunately, standard midi has no codification for fractional midi notes nor for 'just' intoned intervals. So the best alternative seemed to implement continuous controllers (nrs. 36-47) for each string, whereby the parameter value corresponds to the number of the overtone to be sounded. To also control the volume or excitation level of the string, we implemented another series of controllers, in the range 49-60.

The constructional parts for this robot are all made from welded stainless steel. The instrument is mounted on a wheel base, as most of our music robots.

The strings are driven by the electromagnets in two phases. By extending the duration of one of the phases the excitation characteristics of the string can be modified to a great extend. The waveform thus obtained comes closer to that of a real bowed string. The firmware in each of the twelve PIC controllers has two cascaded 16 bit timers. Using the thus obtained 32 bit timer, a period time can be programmed with great precision. To make research and development easier, we designed the firmware for the string drivers such that each dsPIC processor responds to its own midi channel, thus using up 12 midi channels. In normal use, the parser microcontroller takes care of string arbitration and the user sends all his commands on the <Aeio> channel solely.