trolled through a personal computer or some other computing device separate from the display through a data cable. Each individual module **18** has individual connectors and wiring to connect each module **18** with either the neighboring modules **18** or the microcontroller **40** for signal, power, and, depending on actuation technique, a pneumatic supply line **12**. The modules **18** are mechanically attached to a housing **22** that will hold each individual module **18** and the supporting hardware: power conditioning **9**; potentially a compressor **6**; and, a coordinating microcontroller **40** which will control the individual modules **18** and communicate with the computer **4**. The use of module microcontrollers simplifies the overall control system, reduces the total computational power needed in a single processor, and allows the Braille dots to be operated at a rapid refresh rate. The refresh rate is the amount of time it takes for a Braille dot **20** to extend and retract. A high refresh rate is important for many computer based applications where rapid scrolling and moving through information is needed, such as a spreadsheet or other tabular data. For the pneumatically actuated Braille display systems, compressor **6** provides pneumatic pressure to each Braille dot **20** through tubing **12** and which provides pneumatic pressure to the plenums **32**. The compressor **6** can be any appropriate air pump but in the present invention a Medo linear compressor, ACO **102**, is used. In designs where the MEMS device **16** directly actuates the Braille dot **20**, no pneumatic force is needed and therefore, neither is a compressor **6**. Power is provided from a power source **42**, to the compressor **6** and the microcontroller **40** by power cables **7** and **8**, respectively. The power can be conditioned by power conditioning means **9** before connection to the microcontroller **40**. In another embodiment, the compressor **6** can be located inside of the housing **22** and one power cable can be used for both the compressor **6** and the microcontroller **40** with power provided from either the power conditioning means **9** or directly from 120 VAC **42**. The power conditioning means **9** can convert and condition either AC or DC power coming from batteries, standard wall receptacles, or other electrical power source. In still another embodiment, a pressure vessel (not shown) can be used to provide the pneumatic pressure and to reduce power consumption.

[**0045**] **FIG. 5** is a schematic representation of an example of an electronic addressing scheme for the Braille dots **20**. In **FIG. 5**, the Braille dots **20** are actuated based upon a row and column scanning mechanism. Although, only 4 rows and 5 columns are shown in **FIG. 5**, the scanning mechanism can be applied to any number of rows and columns. If at any time "t" both the row and column are at open electrode voltage (signified by "0") the microelectromechanical valve or device (piezoelectric or shape memory alloy) is open and the Braille dot **20** is extended. If either the row or the column is at close electrode voltage (signified by "1"), the microelectromechanical device **16** is closed and the Braille dot **20** is retracted. In this manner, at any time "t" a specific Braille dot **20** based upon its row and column location can be operated. For example, at t**1**, row **1** has open electrode voltage and column **1** has open electrode voltage. The Braille dot **20** is extended as shown by the X on the actuation scheme.

[**0046**] The microelectromechanical valves and devices (piezoelectric or shape memory alloy) of the present invention are preferably very small (sub-millimeter) in size, low cost and have low power requirements. Preferably, the microelectromechanical valves and devices (piezoelectric or shape memory alloy) are processed using micromachining technologies know to those skilled in the art. Further preferably, the microelectromechanical valves and devices (piezoelectric or shape memory alloy) are designed to be integrated with the electronic assembly requirements of the module **18** or for other uses as may be envisioned by those skilled in the art.

[**0047**] By way of example but not limitation some of types of microelectromechanical valves and devices (piezoelectric or shape memory alloy) which can be utilized in a number of embodiments of the present invention are shown in **FIGS. 6 through 10**. FIGS. 6-8 show examples of different types of microelectromechanical valves.

[**0048**] **FIG. 6** is a cross section of the module **18** as cut along lines **2-2** in **FIG. 2**. The Braille display **2** is enclosed in a housing **22**. **FIG. 6** shows four Braille dots **20***a, b, c, d.*, one-half of a Braille character **14** inside of the module **18**. The Braille dots **20** are shown alternately extended and retracted, **20***a* and **20***c* extended, **20***b* and **20***d* retracted. Each Braille dot **20** is operably attached to a microelectromechanical (herein also know as "MEMS") device **16***a, b, c, d*, respectively, this actuation can be either direct, or indirect utilizing pneumatic or hydraulic force. In this embodiment, the Braille dot **20** is attached and operates using pneumatic force. Additionally, the Braille dot **20** does not have to be a distinct, separate element but can also be a portion of the top surface **46** (see **FIGS. 7A and 7B**). The MEMS device **16** is comprised of a base **26** and frame **24**. The base **26** has a base aperture **34**, which provides a passage from the plenum **32** to the chamber **30**. The frame **24** has a port **36** opening from the chamber **30**. Actuator **28** (for illustrations purposes shown as a sliding element or boss in **FIG. 5**) operates to open and close the MEMS device **16**. The Braille dot **20** is made from a flexible, resilient polymer and is secured to the inside of the housing **22** juxtaposed between the port **36** and an opening **38** in the housing **22**. When the actuator **28** operates to open the MEMS device **16** air in the plenum **32** flows into and pressurizes the chamber **30**. The pressure is exerted on the Braille dot **20** through port **36**. The pressure on the Braille dot **20** forces the Braille dot **20** to expand through the opening **38** (**20***a* and **20***c*). The Braille dot **20** expands until it reaches a point of equilibrium where the resilient nature of the flexible, resilient polymer equals the pressure being applied. At that point, the Braille dot **20** remains expanded with the MEMS device **16** still open. When the actuator **28** operates to close the MEMS device **16**, it closes the base aperture **34** and the Braille dot **20** remains expanded until pressure is removed from the chamber **30** and vents therefrom. Venting is accomplished by any opening or passage from the chamber **30** to the atmosphere or even into the housing **22**. Because of the resilient nature of the polymer, the Braille dot **20** contracts forcing the air out through the vent and retracts back through the opening **38** (**20***b* and **20***d*). The opening or closing of the vent can be controlled by the MEMS device **16**; for instance, when such MEMS device **16** is a three-way valve. This is shown in **FIGS. 7A, 7B**, **8**A, and **8**B. The second valve position in a three-way valve opens the vent **33**. This will allow faster refresh rates. Venting also can be accomplished by leak holes (not shown) from the chamber **30**, including a leak hole in the flexible, resilient polymer of the Braille dot **20**. The Braille dot **20** will expand and remain expanded, as explained above, provided the air flow into the chamber **30**