[0027] **FIGS. 41 and 42** are schematic illustrations of a scanner/printer/copier using a paper shaped display interface to support morphemic input;

[0028] FIGS. **43-45** are schematic illustrations of tileable displays capable of supporting morphemic input;

[0029] **FIG. 46** illustrates optical sensors and patterns suitable for use in conjunction with tileable displays such as illustrated in FIGS. **43-45**;

[0030] **FIG. 47** illustrates radio transponders suitable for use in conjunction with tileable displays such as illustrated in FIGS. **43-45**; and

[0031] **FIG. 48** illustrates addressing of multiple tileable displays.

DETAILED DESCRIPTION OF THE DRAWINGS

[0032] **FIG. 1** illustrates an embodiment of the present invention suitable for supporting a morphemic user interface grammar. Support of the grammar can require detection of a user's physical manipulation of a device, detection of relative or absolute spatial location of the device, detection of various environmental factors acting on the device, and even detection and interaction with multiple devices or external computer networks. As illustrated, a device **10** has a deformable surface **20** with an underlying deformation sensor mesh **22** for detecting surface deformation across or within multiple subregions of the deformable surface **20**. The deformation sensor mesh **22** is connected to an internally contained processor **24** having associated memory system **26**. For detecting various positional or environmental variables, a sensing system **28** is also provided. The illustrated device further includes a feedback module **33**, which may include an externally visible status display **30** or a non-visual feedback module **31** (typically delivering auditory or tactile feedback). In the illustrated device, a communications system **32** for reception or transmission of information to other electronic or computing devices is also provided. All these components can be powered by a power supply **25**, which is usually an internally mounted rechargeable battery of conventional construction.

[0033] Although the device **10** is illustrated as having an approximately spheroidal and unitary mass, various other shapes are contemplated to be within the scope of the present invention. For example, the overall shape may be similar to various rectangular prisms, or can be ellipsoidal, toroidal, planar, or even be malleable enough to support a wide range of user defined irregular shapes. In addition, multiple cooperating shape elements are contemplated using conventional designs that permit interlocking of multiple shape elements (e.g using a ball and socket, a lock and key, or slidable or rotatable interlocked components).

[0034] Whatever the shape of device **10**, for operation of the present invention the device **10** is completely or partially enveloped by the deformable surface **20**. The present invention supports use of a great variety of designs and materials for the deformable surface **20**, depending on the required plasticity, durability, longevity, and of course, cost constraints. For example, contemplated designs for deformable surface **20** include, but are not limited to:

[0035] a closed or open celled polymeric foam material having a wall thickness of millimeters to centimeters, with thinner walled embodiments being supported (e.g. by adhesive attachment) by an internal hard shell (constructed from polymeric or metallic materials), and those thicker walled embodiments directly supporting (by, e.g. brackets or supports) internal components such as processor **24**. Suitable foams may include those composed in whole or in part of widely available synthetic rubbers such as polychloroprene (neoprene), polystyrenes, rubber or nitrile rubber latex foams, polysiloxanes, block polymers including styrene-butadiene or styrene isoprene, or any other conventional material having good elasticity and deformability;

[0036] a thin single layer polymeric surface loosely wrapped around a internal hard shell (the hard shell being constructed from polymeric or metallic materials). For example, a nylon or cotton weave, single layer polyethylene, synthetic rubber (with little or no foam cells present), or natural polymeric materials such as leather wrapped around a polystyrene casing can be used;

[0037] a composite layered surface having a durable polymeric outer layer supported by an inner foam layer; or even

[0038] a polymeric bilayer having an intermediate fluid or gel layer of a viscous or thixotropic material that can be used to support extreme deformations. The intermediate layer can be relatively thick (one the order of centimeters), or in certain embodiments can have a thickness measured on micron to millimeter scales. Such extremely thin layers would allow complex twisting, folding, curling, or crumpling actions, and have been described in conjunction with U.S. Pat. No. 5,389,945, assigned to Xerox Corp., the disclosure of which is herein specifically incorporated by reference.

[0039] The deformation sensor mesh **22** can be embedded within, or positioned to contact, the deformable surface **20**. The deformation sensor mesh **22** can include an array of individual compressional or tensional strain sensors, or alteratively, embedded or attached positional sensors. For certain applications, continuous sensors (e.g. bilayer sheets of capacitance sensors) may be employed. One particularly useful continuous sensor type uses multiple capacitance or resistance strips, with deformation pressure resulting in a positionally localizable analog signal proportional to the applied deformation pressure. Various sensor types can be used, including simple capacitance sensors, resistive strain sensors, analog or digital pressure switches, inductive sensors, or even fluid flow sensors. Depending on the sensor type employed, sensor data can be directly fed to the processor **24** in digital form, or be transformed to digital format by an general purpose analog/digital converter that typically provides a 4 or 8 bit range (although as few as one or as many as **32** bits may be required by various applications). An analog to digital converter may be internal to the processor **24** or provided as an external module. As will be appreciated, the sensor mesh **22** is intended to include combinations of sensors and sensor types, which can be used over the whole or part of the deformable surface **20**.

[0040] A positional or environmental sensor system **28** can also be supported by device **10**. Various sensor modes can be