[0015] Each strain gauge sensor can be provided with a pair of sensor wires for measuring changes in resistance from the strain gauge sensor resulting from a single touch and pressure or a plurality of touches and pressures at locations across the pad. The pair of sensor wires from each strain gauge of the strain gauge matrix are preferably connected through a single signal cable to a Digital Signal Processor (DSP). The DSP is preferably constructed to measure the current (and/or voltage) change across each strain gauge sensor as a measure of strain and uses this information relating to strain to calculate the exact positions and the relative pressures of the touch points based on a pre-programmed mathematical algorithm contained in the DSP. The calculated results from the DSP algorithm can be sent to an application board, where the locations of the touch points, and/or the sensed pressure, are used by the desired applications.

[0016] Referring now to the drawings in detail, the various embodiments of the present invention will now be discussed. With reference first to FIGS. **1-3**, a multi-point touch pad device constructed in accordance with an embodiment of the present invention is depicted and generally designated by reference numeral **10**. Multi-point touch pad **10** is preferably unitarily formed and includes a base **20** having a top surface **38** that defines a plane. A wall **14** extends generally perpendicular to and away from the plane of top surface **38** at an edge of base **20**. Base **20** combined with at least one wall **14** serves to form a touch pad enclosure **12**.

[0017] Referring now to **FIG. 3**, with continued reference to **FIGS. 1 and 2**, a support layer **26** having a top surface **32** and a bottom surface **28** may be approximately the same size and shape as the touch pad enclosure **12**. Support layer **26**, which can be formed of a soft foam-like material having shock absorbency properties, is disposed within touch pad enclosure **12**. In a preferred embodiment of the invention, the support layer bottom surface **28** is seated adjacent and parallel to top surface **38**. A plurality of sensors, preferably strain gauges **16**, are placed adjacent to the support layer top surface **32**, preferably in a matrix configuration.

[0018] Various types of sensors known to those skilled in the art such as, for example, Force Sensing Resistors™ (FSRs), piezoelectric sensors and capacitive touch sensors may be used in the present invention. However, strain gauges **16** can offer more precise response properties and can be more cost effective as compared to the other sensors known by those skilled in the art. Strain gauges **16** are the preferred sensors for use in the present invention.

[0019] With continued reference to **FIG. 3**, as well as with continued reference to **FIGS. 1 and 2**, a touch layer **24** is disposed on strain gauges **16** and is adhesively bonded thereto with strain gauges **16** forming a matrix configuration to effectuate an acceptable degree of coverage and responsiveness for multi-point touch pad **10**. In practice, strain gauges **16** will sense a deformity of the strain gauge **16** and touch layer **24** combination which will cause a proportional change in the strain gauge **16** resistance. With a voltage placed on the strain gauge **16**, the deformation and hence, the change in resistance, will result in a change in current flowing through (or voltage across) the strain gauge **16**; a change in current (or voltage) which is measurable.

[0020] As illustrated in FIGS. **1-3**, touch layer **24** having a touch layer top surface **18** and a touch layer bottom surface **34**, touch layer **24** being advantageously formed of an elastic material such as spring steel or bronze and touch layer **24** further having properties to insulate strain gauges **16** from moisture and dust infiltration while also being sensitive and precise to the touch. Disposed adjacent to strain gauges **16** is support layer **26** which keeps strain gauges **16** flat when no pressure is exerted on them, thereby preventing erroneous readings from multi-point touchpad **10**.

[0021] With reference now to **FIG. 2**, strain gauges **16** each contain a pair of sensor wires **36**. Sensor wires **36** are further connected to a digital signal processor (DSP) **50**. The sensor wires **36** are encapsulated within signal cable **22**, signal cable **22** being connected to touch pad enclosure **12** and to DSP **50**. The DSP **50**, processes signals received from strain gauges **16** through sensor wires **36** with the assistance of an algorithm (e.g. software programmed) contained within DSP **50**.

[0022] With reference now to **FIG. 4**, and continued reference to **FIG. 2**, DSP **50** is constructed to implement the algorithm represented by the flowchart depicted in **FIG. 4**. The software that controls the algorithm of DSP **50** may be programmed by different programmers in various forms or programming languages. However, the functionality should remain consistent with the mathematical formulas for the multi-point touch pad **10** to function according to its design.

[0023] A flow chart **112** illustrated in **FIG. 4** depicts the operation and performance of multi-point touch pad **10** having the DSP **50** which contains a software programmed algorithm therein. Flow Chart **112** contains a touch module **100** which illustrates a user touching the touch pad with a single position and pressure or with simultaneous positions and pressures. With reference to sensing module **102** the touch by the user causes a change in the resistances of one or more of strain gauges **16**. The resistance changes are registered on strain gauges **16** which are then transmitted through sensor wires **36** to DSP **50**. DSP **50** then samples the signal as illustrated in DSP sampling module **104**.

[0024] DSP **50** is programmed with a software algorithm which contains the known positions of strain gauges **16** on multi-point touch pad **10**. These positions are identified with the following formula: (a_i, b_i), i=1, 2, . . . , N, where N is the number of strain gauges **16**, and the measured pressures of strain gauges **16** are p_i, i=1, 2, . . . , N. For purposes of illustration, assume the positions of the touch points on multi-point touch pad **10** are: (x_j, y_j), j=1, 2, . . . , M, where M is a known number of the touch points (less than N), but x_j and y_j are unknown and will be determined by the calculations of the formula. In addition, assume that the pressures of the touch points are: z_j, j=1, 2, . . . , M, which are also to be calculated using the software algorithm.

[0025] The software algorithm programmed in DSP **50** then transfers the sampling data from DSP sampling module **104** to DSP calculation module **106** where the software algorithm calculates the position and pressure of the touch points using the following mathematical formula: p_i= w(|(x_1, y_1)−(a_i, b_i)|)z_1+w(|(x_2, y_2)−(a_i, b_i)|)z_2+. . . +w(|(x_M, y_M)−(a_i, b_i)|)z_M, i=1, . . . , N; where w(|(x_i, y_j)−(a_i, b_i)|) is a weighting factor that reflects the effect of pressure z_j on p_i. The software algorithm of DSP **50** further calculates that: w(|(x_i, y_j)−(a_i, b_i)|) is a function of the distance between the touch point (x_j, y_j) and the sensor location (a_i, b_i). The software algorithm