to identify the null space of the signal. Thus, if sensor signals defined within this null space are used to define one or more commands for a system, the commands may not be mistaken with the signals detected during normal execution of a task.

[0057] Using the above concept, it is possible for a user to express and communicate a rich variety of commands while both hands are busy holding a tool and, thereby, not available for operating switches and joysticks. Thus, "Finger Code Communication" may be implemented in a system by a user using wearable finger force sensors. Specifically, a user may issue a command to a system with a special combination of individual finger forces, but those finger force signals may need to be distinguished from the forces of unintended signals from performance of a task in which the user is engaged. While the user is executing their task, the user typically interacts with one or more objects (e.g., holds a tool with both hands), generating finger forces. In order to distinguish those forces from intended signals as well as to design a "command code" of finger forces, a data-driven approach is proposed by using data taken from the user performing the task(s).

[0058] Suppose that fingertip force sensors can measure fingertip forces at m fingers. Let f_i be force at the i^{th} finger. Collectively, m fingertip forces are represented as:

$$\mathbf{f} = \begin{pmatrix} f_1 & \cdots & f_m \end{pmatrix}^T \in \Re^m.$$

[0059] Suppose that a user demonstrates a task to be performed by using a tool. Finger forces are measured and labeled as $\mathbf{f}^{(1)} \cdots \mathbf{f}^{(N)}$. The covariance matrix of the data may then be computed:

$$C = \sum_{i=1}^{N} (\mathbf{f}^{(i)} - \overline{\mathbf{f}})(\mathbf{f}^{(i)} - \overline{\mathbf{f}})^T \in \Re^{m \times m}$$

[0060] The principal component analysis of the covariance gives a series of eigenvalues and associated eigenvectors in the descending order of magnitude:

$$\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_k > 0, \quad \lambda_{k+1} = \cdots = \lambda_m = 0, \quad 1 < k < m$$

[0061] where integer k is the number of positive eigenvalues. Using the first k eigenvectors, the range space of the fingertip forces can be formed:

$$\mathbf{R} = < \mathbf{v}_1, \cdots, \mathbf{v}_k >$$