[0062] FIG. **15** is an example proximity image of a hand in the pen grip configuration with thumb and index fingers pinched;

[0063] FIG. **16** is a data flow diagram of the hand tracking and contact identification system;

[0064] FIG. **17** is a flow chart of hand position estimation:

[0065] FIG. **18** is a data flow diagram of proximity image segmentation;

[0066] FIG. **19** is a diagram of the boundary search pattern during construction of an electrode group;

[0067] FIG. **20**A is a diagram of the segmentation strictness regions with both hands in their neutral, default position on surface;

[0068] FIG. **20**B is a diagram of the segmentation strictness regions when the hands are in asymmetric positions on surface;

[0069] FIG. **20**C is a diagram of the segmentation strictness regions when the right hand crosses to the left half of the surface and the left hand is off the surface;

[0070] FIG. **21** is a flow chart of segmentation edge testing;

[0071] FIG. **22** is a flow chart of persistent path tracking;

[0072] FIG. **23** is a flow chart of the hand part identification algorithm;

[0073] FIG. **24** is a Voronoi cell diagram constructed around hand part attractor points;

[0074] FIG. **25**A is a plot of orientation weighting factor for right thumb, right inner palm, and left outer palm versus contact orientation;

[0075] FIG. **25**B is a plot of thumb size factor versus contact size;

[0076] FIG. **25**C is a plot of palm size factor versus ratio of total contact proximity to contact eccentricity;

[0077] FIG. **25**D is a plot of palm separation factor versus distance between a contact and it nearest neighbor contact;

[0078] FIG. **26** is a flow chart of the thumb presence verification algorithm;

[0079] FIG. **27** is a flow chart of an alternative hand part identification algorithm;

[0080] FIG. **28** is a flow chart of the pen grip detection process:

[0081] FIG. **29** is a flow chart of the hand identification algorithm:

[0082] FIGS. **30**A-C show three different hand partition hypotheses for a fixed arrangement of surface contacts;

[0083] FIG. **31**A is a plot of the hand clutching direction factor versus horizontal hand velocity;

[0084] FIG. **31**B is a plot of the handedness factor versus vertical position of outermost finger relative to next outermost;

[0085] FIG. **31**C is a plot of the palm cohesion factor versus maximum horizontal separation between palm contacts within a hand;

[0086] FIG. **32** is a plot of the inner finger angle factor versus the angle between the innermost and next innermost finger contacts;

[0087] FIG. **33** is a plot of the inter-hand separation factor versus the estimated distance between the right thumb and left thumb;

[0088] FIG. **34** is a flow chart of hand motion component extraction;

[0089] FIG. **35** is a diagram of typical finger trajectories when hand is contracting;

[0090] FIG. **36** is a flow chart of radial and angular hand velocity extraction;

[0091] FIG. **37** is a flow chart showing extraction of translational hand velocity components;

[0092] FIG. **38** is a flow chart of differential hand pressure extraction;

[0093] FIG. **39**A is a flow chart of the finger synchronization detection loop;

[0094] FIG. **39**B is a flow chart of chord tap detection;

[0095] FIG. **40**A is a flow chart of the chord motion recognition loop;

[0096] FIG. **40**B is a flow chart of chord motion event generation;

[0097] FIG. **41** is a flow chart of key layout morphing;

[0098] FIG. **42** is a flow chart of the keypress detection loop;

[0099] FIG. **43**A is a flow chart of the keypress acceptance and transmission loop; and

[0100] FIG. **43**B is a flow chart of typematic emulation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0101] Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0102] FIG. **1** is a system block diagram of the entire, integrated manual input apparatus. Sensor embedded in the multi-touch surface **2** detect proximity of entire flattened hands **4**, fingertips thumbs, palms, and other conductive touch devices to the surface **2**. In a preferred embodiment, the surface is large enough to comfortably accommodate both hands **4** and is arched to reduce forearm pronation.

[0103] In alternative embodiments the multi-touch surface **2** may be large enough to accommodate motion of one hand, but may be flexible so it can be fitted to an armrest or clothing.

[0104] Electronic scanning hardware **6** controls and reads from each proximity sensor of a sensor array. A calibration module **8** constructs a raw proximity image from a complete scan of the sensor array and subtracts off any background sensor offsets. The background sensor offsets can simply be a proximity image taken when nothing is touching the surface.