

Zafrul Islam

Writing for Engineering

### Process of Touchscreen Feedback on an iPhone

The first touchscreen was invented in 1965 by Eric A. Johnson who worked at the Royal Radar Establishment in Malvern, England. His first article, "Touch display—a novel input/output device for computers" describes his work and features a diagram of the design [1]. In 1966, Johnson patented this design known as a capacitive touchscreen which features an insulator in the case glass, coated with a transparent conductor. The capacitive touchscreen uses a layer of capacitive material to hold an electrical charge; changing the amount of charge when touching the screen at a specific point of contact. Another design, the resistive touchscreen, came in the 1970s by American inventor, Dr. G. Samuel Hurst. In resistive screens, the pressure from your finger causes conductive and resistive layers of circuitry to touch each other, changing the circuits' resistance [1].

Tactile feedback, also known as haptic feedback, mechanisms respond to touch, simulating a sensation of tapping. The response is accomplished through the use of subtle and textured vibrations. Tactile feedback, however, does not interfere with the operation of the actual device [2]. The way tactile feedback works is an actuator, a small motor-like device, causes the vibration in equipment with tactile feedback. Software known as the haptic player actually controls how intense the actuator vibrates and when it vibrates [2]. These vibration patterns and waves are used to transmit information to a user or operator of an electronic device.

Tech companies were starting to take notice of this new way to interact with computers. Hewlett-Packard was the first to release a product that put touchscreens in the hands of everyday users. The first multi-touch overlay was developed in 1984 by Bob Boie of Bell Labs, creating a true capacitive screen that could detect multiple points of contact. At this time, IBM released the first cellphone with a touchscreen, the Simon Personal Communicator [1]. For Apple, they used the capacitive touchscreen along with the tactile feedback mechanisms to create products such as the iPhone. A process occurs to obtain information from the touchscreen.

- I. Screen registers touch.
  - i. Every point on the grid generates its own signal when touched and relays that signal to the iPhone's processor [3]. When touch is implemented upon the capacitive screen, signals travel from the touch screen to the processor as electrical impulses.
  - ii. In mutual capacitance, the capacitive circuitry requires two distinct layers of material. One houses driving lines, which carry current, and the other houses sensing lines, which detect the current at nodes [3]. Through mutual capacitance, the signal is being carried through the driving lanes until it reaches the self capacitance stage.
  - iii. The current is then traveled through self capacitance where one layer of individual electrodes is connected with capacitance-sensing circuitry to be sent as raw data to be rendered.
- II. Raw data is captured.

The processor uses software to analyze the data and determine the features of each touch. This includes size, shape and location of the affected area on the screen. If necessary, the processor arranges touches with similar features into groups. If you move your finger, the processor calculates the difference between the starting point and ending point of your touch [3].

III. Background noise removed.

If any part of the raw data doesn't match any applicable gestures or commands, the iPhone disregards it as an extraneous touch. This is done to provide a more precise location of where touch was applied.

IV. Pressure points are measured.

Calculations are made to determine whether the touch is made from a source that matches the features of human touch based on the pressure applied on the capacitive screen. This part of the process further yields a more exact image of the touch.

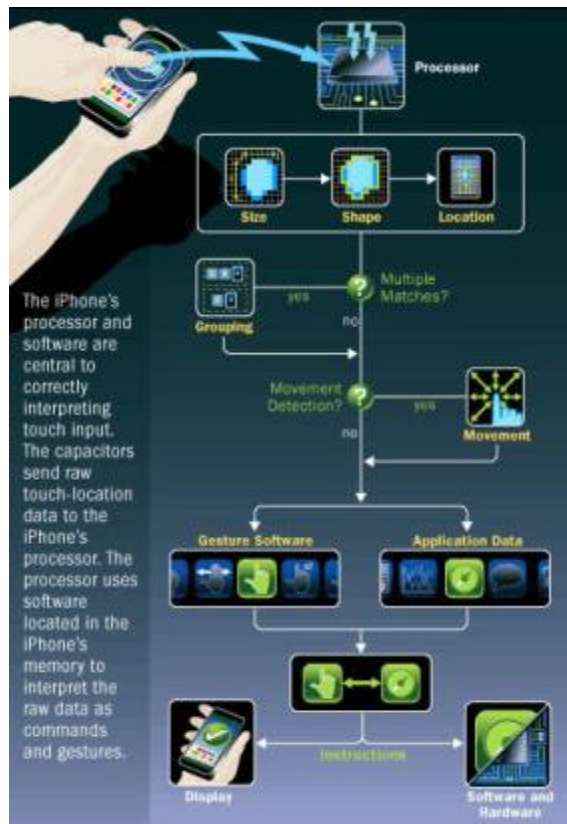
V. Touch areas are established

The processor uses its gesture-interpretation software to determine which gesture you made. It combines your physical movement with information about which application you were using and what the application was doing when you touched the screen [3].

VI. Exact Coordinates are calculated.

The processor uses software located in the iPhone's memory to interpret the raw data as commands and gestures [3]. The processor relays these commands to the program in use and, if necessary, sends commands to the

iPhone's screen and other hardware. This allows the phone to determine the location and movement of simultaneous touches in multiple locations [3].



[4]

*The figure depicts how the phone's processor and software determine the location of the area on the screen that was touched and how that location can be used for the phone.*

In conclusion, the whole process of touchscreen feedback on an iPhone occurs in a nanosecond. From touching the screen, several calculations and signals are sent from the screen to the software. These calculations and signals determine the exact coordinates of where you touched through a complex process. The translation of raw data from the touch input is used to determine where the area on the screen was touched so that instructions are sent to the phone to perform certain commands. Other phones have a similar

touchscreen feedback process like the iPhone but can vary in different stages since each phone has a different processor and software to interpret touch.

## Reference List

- [1] "Making Touchscreens live up to their name: touch feedback as the essential element to human-computer interface" *TACTAI*, 2019. [Online]. Available: <https://www.tactai.com/2019/07/13/448/>. Accessed: March 9, 2020
- [2] "What Is Tactile Feedback?" *itstillworks*, 2010. [Online] Available: <https://itstillworks.com/tactile-feedback-7557599.html/>. Accessed: March 9, 2020
- [3] "How the iPhone Works" *howstuffworks*, 2013. [Online]. Available: <https://electronics.howstuffworks.com/iphone.htm/>. Accessed: March 9, 2020
- [4] "iPhone Processor Diagram" *howstuffworks*, 2013 [Photograph] Available: <https://electronics.howstuffworks.com/iphone3.htm/>. Accessed: March 9, 2020