RESEARCH INTEREST

Mid-air Interaction + Gesture Recognition (Mouse alternative and more)

I am Anantha Krishna Pillai, a Computer Science undergraduate from Cochin University of Science and Technology (CUSAT), India. I have been working as a Java Developer in a US based company and simultaneously been developing and prototyping ideas to implement next-gen interaction mechanisms. I developed a prototype to supplant keyboards and tried testing it efficacy. I am interested in UI/UX research, interaction and haptics, and try to conceptualize ideas that could transform human-machine interaction and also become perspective business ventures. I have a couple of promising prospective business ideas; one focuses on enabling haptic cues that help navigation and another that aims to invent a novel interaction mechanism. The latter interaction mechanism seeks to supplant the traditional mouse and also enable gesture recognition by tapping into the biomechanical movement in human hands. This interaction mechanism will be discussed in more detail below.

Background

A computer mouse developed in 1950 is more or less stagnant compared to the developments in other facets of technology. Numerous devices have been invented since but almost all of them failed to deliver. With advances in technology it is necessary to change the way we interact with it. Today we have sophisticated devices (Google Glass) that are smaller than the interaction tool (keyboard and mouse) we currently use. This concept addresses the stagnant interaction domain and comes up with an inspiring product that will revolutionize interaction.

The Product

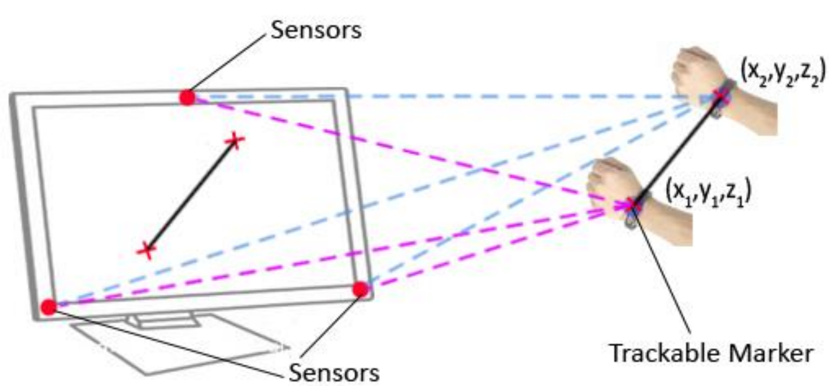
A wearable bracelet, whose relative position will be calculated in 3D-space. The change in position relative to a set of fixed points will be translated to mouse movements and used to interact with a computer. The concept makes the interaction device user-centric (ability to interact with multiple devices) unlike the computer dedicated tools like mouse and keyboard. The user can use the wearable like a mouse, placing the wrist on a table or else can also choose to interact with mid-air movements.

The Principle - How does it work?

The product henceforth referred to as '*wearable*' basically would work on the principle of triangulation to calculate the position in 3D space and use biomechanical cues to understand gestures.

- Position Locator

  With the help of a transmitter-receiver mechanism, distance between two points can be calculated. The same idea will be employed to calculate the position P in space. We fix 3 receivers at three different points on the edges of a display or the intended interaction medium. These 3 receivers are aware of their position with respect to each other. Our wearable equipped with a transmitter is located at point P and transmits signals in space. Multiple receivers ensure that the location P (x_1,y_1,z_1) is accurately determined. Any change in the location of the device will be determined as Q (x_2,y_2,z_2). This change in position of the device will be translated as cursor movement.



Speed of motion of the wearable will be translated to degree of cursor movement on a computer. As movement along all 3 coordinate axes can be captured using this mechanism can be exploited to interact with 3D systems.

- Button Emulation (Contemplating on using surface electromyography)
  Each finger on human hand is attached to different set of bones and muscles and hence triggers a unique movement in forearm muscle. Theoretically, at least 125 (=5!) combinations should be possible. To emulate a mouse we would tap into just 4. Pressure sensitive bands will be placed on the underside of the wearable that would detect any change in muscular movement when the wearable is actively engaged for interaction. When a certain movement is made the corresponding pressure points will understand the pattern and respond accordingly. The wearable will train itself overtime to recognize user specific muscle movement pattern and improve accuracy.
  1. **Full-flex**: A noticeable contraction is felt in wrist area and this will be used to engage/disengage interaction with a computer system.
  2. **Index-flex**: This causes a prominent depression towards the opposite end of the wrist.
  3. **Middle-flex**: This causes a discernable movement at the center of the wrist.
  4. **Thumb-flex**: Motion triggered towards the side of the wrist.

Engage/disengage interaction
Gesture 1:
Full flexed position, overall contraction

Mouse left button
Gesture 2:
Index finger flexed, prominent depression towards opposite side

Mouse right button
Gesture 3:
Middle finger flexed, prominent pressure area towards center

Auxiliary button
Gesture 4:
Thumb flexed, prominent pressure area towards side.

Why this is better than the existing interaction methods?

- Vs. Mouse: Mouse enables interaction with the help of motion over an even surface. The wearable will enable mid-air interaction. The wearable can also be dragged over a surface to work like a mouse. Wearable is an ergonomic approach to interaction where the interaction would be natural, according to inherent human motion, and not dictated by an interaction tool.
- Vs. Touch: Touching blocks a considerable amount of information area from sight. Moreover, the user needs to clear his hand off the display to comprehend the refreshed area and bring it back to further interact. Wearable will have no such sight blockage issue, presentation area always in visual sight. (Increased efficiency according to Gilbreth's 'time and motion study').
  Touch is not ergonomically scalable, touchscreen larger than 30" would be very tedious to navigate and interact tangibly. Wearable would provide scalability to interact with huge displays.

Hardware and software adaptions required?

Hardware for sensing and processing distance would need to be integrated into the existing system. Add-on hardware modules can be developed.

Existing softwares have visual cues (cursor) that indicate the point of interaction on both touch based and mouse controlled devices. The same visual cue can be reused with trivial adaptations, if any.

How it is different from similar prototypes/products?

Other products developed use a glove/glove-like wearable which is cumbersome. Few mouse emulators work using cameras and color markers, requiring the hand to be in the camera's angle of view. Few other similar products in the market either implement mid-air interaction using pens or else capture gestures. Our wearable incorporates both these ideas (tracking + gesture) into a single product.

Why this will be effective?

- Works in mid-air unlike the mouse which needs an even surface. Works on even surface too!
- One wearable to control them all.
- <u>Security</u>: Unauthorized wearable cannot be used to operate a device.
- Uniqueness in user muscle movement pattern and could act as <u>*biometric security*</u> in future.
- <u>Scalability</u>: Interaction with device and displays of any size (Google glass, Smartwatch & Heliodisplay).
- No need to touch or physically hold a device.
- Interact with user's comfortable range of motion.

Limitations

- Line of sight necessary to accurately measure the distance & movement.
- Technical feasibility to accurately locate a point in space.

Practical Use-cases

- Meetings and presentations where minimal yet vital interaction with a system is required.
- Switch and interact with multiple devices. (Universal controller)
- Enjoy mouse-like interaction without using a dedicated mouse.
- Seemingly innocuous gestures to control flow of presentation in TED talks, CHI etc.

Scope of Product *(around 2billion+ devices)*

- 700 million tablets, laptops and PCs sold each year could implement this mode of interaction.
- Existing 1.6 billion PCs could do with addition of a next-gen interaction solution.
- Almost all consumer electronics can be configured to exploit this interaction method.

Prospective Future Developments

Gesture control can be explored further as a completely different interaction mechanism. The basic principle would be same (tapping into biomechanical cue) as that used for button emulation in the wearable discussed above.