

MATHEMATICAL MODEL FOR PLANAR MOTION OF THE HUMAN HAND

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A gesture in a broad sense is a form of non-verbal communication in which visible bodily actions communicate a particular message, either in place of speech or together and in parallel with spoken words. Hand gestures include movement of the fingers of the hand. The current trend in Virtual Environment (VE) applications is to use the human hand as a natural interface to communicate with the VE. There are several types of devices specially glove based devices to capture the hand gestures in VE applications. Most of the devices give the coordinates of the finger joints in the configuration space. For the use of hand gestures in VE applications, the captured positions should be converted into a usable format. To achieve this, developing a mathematical model of the human hand is very essential.

Therefore in this work, planar motion analysis of an index finger was carried out to develop the mathematical model. This mathematical model gives the flexion of angles of phalanges for a given orientation, if the coordinates at the ends of each phalanx are known, while knowing the length of each phalange. In this research, the kinematic analysis was performed using *homogeneous transformations*. To accomplish this, firstly, an equivalent structure of the index finger was developed by incorporating the biomechanical constraints of the index finger. Then the principle of *inverse kinematics* was applied to the derived equivalent structure of the finger to develop the set of equations which give the position and orientation of the human finger relative to the finger base.

Finally, attention has been given to develop a computer application by using the derived mathematical model with the expressions derived for flexion angles (the angle at which any phalanx is bent in the vertical plane with respect to the previous phalanx) in terms of the finger coordinates. In order to prove the accuracy of the developed mathematical model, arbitrary orientations with known length of phalanges of the index finger which are drawn using *AUTOCAD* software are considered. Comparison between the values taken from the computer application and the values obtain from the *AUTOCAD* drawings reflects that the developed mathematical model in this research is accurate enough to annotate the position and the orientation of the finger.