This thesis discusses a number of robot touch perception systems. All these systems are self-organizing and model different aspects of human touch perception. The thesis starts out with introductions to the anatomy and the physiology of the human hand. It proceeds with an overview of the human touch perception from both a neurophysiological and a behavioural perspective. Then related robotic research is reviewed and artificial neural networks are introduced.

The thesis proceeds by describing the robot platforms developed for the research. These platforms consist of three robot hands, the LUCS Haptic Hands I-III, together with texture and hardness sensors. The thesis discusses both touch sensor based and proprioception based systems. Both kinds of systems successfully learned to separate objects of different size and shape as well as individual objects. Several texture and hardness sensor based systems are also discussed. Some of the systems are bimodal, i.e. they merge texture/hardness or touch/proprioception for improved performance. Two novel variants of the Self-Organizing Map that have been developed and used in some of the systems are discussed.

All systems have been tested and evaluated with different test objects. The systems based on the LUCS Haptic Hand I successfully learned to separate objects of different size. The systems based on the LUCS Haptic Hand II successfully learned to separate objects of different shapes and to discriminate individual objects. The systems based on the anthropomorphic robot hand, the LUCS Haptic Hand III, were all based on proprioceptive information. These systems successfully learned to separate objects of different shapes and sizes. They were also able to discriminate individual objects. The texture and hardness based systems were able to discriminate individual objects and to categorize them as hard or soft. The hardness and texture sensors were also used in a system that successfully developed associated representations of these two submodalities.