## Executive summary

A biomimetic approach has been taken to develop a robotic finger that is capable of sensing touch, able to explore surfaces with artificial curiosity, discriminate different textures and assess their tactile pleasantness. The development of a biomimetic approach required a greater understanding of the subjective and neurological mechanisms involved with discriminative and affective touch for both healthy human volunteers and patients. This included (a) the role of the peripheral receptor response using microneurography that allowed the spike trains from a mechanoreceptor in a finger pad to be recorded when subjected to a tactile stimulus, (b) brain imaging using electroencephalography (EEG) and functional magnetic resonace imaging (fMRI) in conjunction with microsimulation of mechanoreceptors in the finger pads, (c) microstimulation of single, identified tactile nerve afferents, and evaluation of the sensations reported by the participants in order to explore the discrimination of both the stimulation frequency from a series of target frequencies, and the variability of neural signals, and (d) psychophysical studies of the pleasantness of materials in order to develop a unidimensional scale and also studies of autistic subjects and stroke patients to evaluate their tactile abilities for diagnostic and therapy purposes. To carry out these studies, a novel dynamic platform for tactile stimulation and temperature control was developed in order to provide a controlled tactile stimulus. Multi-scale multi-physics modelling of the finger pad was developed that was capable of describing the deformation when in static or sliding contact with a surface. It was coupled to micro model of two of the tactile afferents (Meissener corpuscle and Merkell cell) so that the deformation caused spike trains to be emitted by a further coupling with a micro-mechanical model of ion channel opening. The spike trains were of similar form to those recorded by microneurography measurements. Arificial touch sensors were developed that were incorporated in a biomimetic artificial finger. By exploiting machine learning algorithms, it was possible to use the finger to identify textures, assess pleasantness and provide the ability for the finger to explore unknown surfaces. A bio-hybrid tactile sensor was also developed that was based on encapsulated cells. The sensor was able to detect both static and sliding stimuli. A number of applications of the technology developed in the project were examined that included enhancements to the Cutometer for measuring the mechanical properties of skin *in vivo*. The idea is to investigate the aging of skin during space flights in a joint project with the European Space Agency. Other applications included the use of the artificial finger in a prosthetic hand with direct neural coupling, microstimulation of a sensory nerve in an upper limb amputee to evoke the sense of touch, design of security cards and packaging and the evaluation of packaging surfaces and cosmetic creams.