Ontological Modelling of Surgical Knowledge

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Computer Assisted Surgery seeks data from various sources related to surgical knowledge, which is mostly represented in the form of discrete databases. However, databases serve as data storage mechanism rather than knowledge representation system. As CAS is becoming more common for various types of surgical interventions, there is a need for representation, storage and processing of surgical knowledge in a more structured manner. Ontological modelling provides the means to represent conceptual information using expressive formal logics. Unlike databases, where information from different tables can only be related by establishing links between them, ontologies are equipped with logical axioms that can be defined on every possible concept.

The common tasks of surgeons in the Operating Room, including the information about various anatomical structures and surgical tools used by surgeons for different surgical activities, are formally conceptualized using ontological modelling. These models are segregated into various ontologies at different hierarchical levels based on their logical expressivity. The advantage of this approach is that all the concepts that are defined in the entire framework of ontologies follow a logical pattern where concepts of lower level ontologies are subsumed by the concepts of higher level ontologies, and vice versa.

FESSOnt is an ontology with concepts that are related to Functional Endoscopic Sinus Surgery. Surgical Workflow ontology (SWOnt) has concepts related to Surgical Workflows. Concepts such as Hand and Scalpel from FESSOnt are subsumed by more general concepts such as AnatomicStructure and Instrument from SWOnt. The concept Instrument is further subsumed by another super concept SurgicalDevice from the Core Ontology for CAS (COCAS). COCAS contains close to 70 concepts, which describe various aspects of surgical knowledge. For example, different kinds of Medical Imaging (MI) techniques, and different operation phases that use different MI techniques etc. These concepts are not just linked with simple subsumption relations, but also classified according to different roles between them. For example, the relation “fess:Scalpel is-a swont:Instrument“ can be extended to “swont:Instrument involve-atleast-2 fess:Scalpel iff fess:Nose is-a swont:AnatomicStructure”.

These ontological models serve as background knowledge bases for CAS applications such as surgical workflow editor that records surgical activities in the Operating Room on a real time, or during pre-operative planning of a surgical procedure etc.