UGC/FDS11/E02/24

Title of Project:

(English) A transformer-based method for refining and abstracting sketches at different levels of details

(Chinese) 基於轉換器網絡的多細節層級的線條圖細化與簡化方法

**Abstract of Research Comprehensible to a Non-specialist**

A sketch is a rough line drawing that is done quickly by an artist to represent the chief features of an object or a scene and is frequently used as a preliminary form of the final drawing in the field of design, such as urban design, architectural design, product design, and character design. After the preliminary sketching for conveying the idea, the artists commonly still need to abstract the sketchy lines or flesh out the details for different design and presentation purposes. For example, different levels of details are encouraged when the sketch is displayed on displays of different resolutions. Moreover, different scenes or objects may be designed at different levels of details by different artists, obtaining a visually consistent level of detail is important when a new sketch image is composed with different sketch components (Figure 1, pp. 20).

Unfortunately, despite the highly desired use of multi-level-of-detail sketch drawings, either refining or abstracting sketches due to the lack of precise definition in defining the level of details for a specific sketch drawing. That is, it is subjective to define whether two sketch drawings are of the same level of details. Without a specific metric for defining the level of details, the existing multi-level sketch generation methods mainly fall into two categories, raster solutions and vector solutions. The raster solutions take the raster sketch (a grid of pixels) as input and usually define the level of details as the style of the sketch drawing. Therefore, the raster solutions are usually lacking the capability of generating sketch drawings at infinite number of levels of details. Besides, the raster solutions may lead to blurred results with inconsecutive strokes. On the other hand, the vector solutions take the vector sketch (a list of strokes) as input and generally build a hierarchical tree or graph structure where the end nodes are the strokes or the graphical components. By progressively removing a node, the level of details of the sketches can be adjusted. However, these methods generally cannot be applied for refining the input sketch but can only be applied for sketch abstraction where the hierarchy of the original sketch is built on the input sketch. What's more, the abstraction of the sketch is usually not semantic-based and is lack of the flexibility in abstract different types of components differently based on semantics. For example, a long wavy line could be abstracted into either a long straight line or a short wavy line (Figure 2, pp. 20).

We propose that semantic information should be adopted to guide the refinement or abstraction of the main structures, i.e., structural components, of the sketch so that the semantics of the sketch can remain unchanged. At the same time, the decorative components should be summarized or repeated directly based on its shape, without the need of semantic awareness for changing the structures. Motivated by this observation, it

is expected to first classify structural strokes and decorative strokes in a sketch (Figure 3, pp. 20), and then apply different schemes for refining or abstracting the sketch. Specifically, we propose to encode a sketch into a vector form via a transformer-based representation. Then we decompose the sketch into structural components and decorative components by refining the network based on adversarial latent space stroke manipulation. The performance of the network could be improved by introducing contrastive learning and adversarial discriminator. Finally, we develop the abstraction operator and refinement operator to be used in the embedding space for manipulating the sketch.

The tangible research outputs of the proposed project would directly benefit the industry and the research society. The research project would also provide invaluable chance in developing the knowledge and skills of the teachers and the students in artificial intelligence and digital entertainment technology, which is also part of the curriculums and programmes offered by the school and the institute.