



# Augmentation of Articulate Data using 3D Image Analysis

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## Abstract

**Background:** Recently, the development of information and communication technology (ICT) has been remarkable utilizing artificial intelligence (AI) technology with deep learning. Three-dimension (3-D) image analysis technology has developed using computerized tomography (CT), magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA). Among them, SYNAPSE VINCENT system (Fujifilm, Japan) is known for its predominance.

**Patient and Method:** The patient is a 52-year-old female with type 2 diabetes mellitus (T2DM), who was suspected to have space occupying lesion (SOL) in the right kidney. Method included the investigation of enhanced abdominal CT with analysis of SYNAPSE VINCENT.

**Results:** The detail analysis showed some findings as follows: i) coronal view of bilateral kidney shows well-enhanced left adrenal tumour, no apparent of right renal tumour, and atrophy of renal cortex, ii) the image rotated 30 degrees showed same findings, iii) the image rotated 180 degrees also showed atrophy of reverse side of right kidney.

**Discussion:** In this case, the background of the atrophy of renal cortex has not been apparent, but it might be from diabetic nephropathy (DN). The application of VINCENT has expanded to various organs, such as liver, pancreas, biliary tract, and others, expecting augmentation of articulate data using 3D image analysis.

**Keywords:** *Three-dimension (3-D) image analysis; Synapse vincent; Artificial intelligence (AI); Deep learning; Atrophy of renal cortex*

## Introduction

In recent years, the development of information and communication technology (ICT) has been remarkable in all fields. Various applications utilizing artificial intelligence (AI) technology with deep learning have also been developed according to various purposes [1]. In this era, it has become possible to extract and analyse three-dimension (3-D) images with high resolution from tomographic data such as computerized tomography (CT) and magnetic resonance imaging (MRI) [2]. Historically, it began with a system initially targeted at the heart and liver, and became available for analysis in the neurology, respiratory and urological areas. Furthermore, in the field of orthopaedics, precise image analysis of knee joints can make it

possible to understand detailed situations before performing surgery. Regarding authors' clinical practice, various medical problems have been treated for years, including internal medicine, surgery and orthopaedic diseases [3]. Among them, we have treated especially patients with diabetes mellitus (DM), chronic kidney disease (CKD) and haemodialysis (HD) [4]. Furthermore, new technology of image analysis was continued so far [5]. We have recently have an impressive case who was evaluated with 3-D image analysis. In this article, these data and imaging analysis technology will be presented and discussed.

## Case Presentation

The patient is a 52-year-old female with type 2 diabetes mellitus (T2DM) for 15 years. She continued oral hypoglycaemic agents

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(OHAs) for Voglibose (0.3mg) 2 Tab and Ipragliflozin L-proline (50mg) 1 Tab per day. Furthermore, she has recently received insulin therapy, which is multiple daily injection (MDI). The content has been Apidra 16-18 units three times and insulin glargine 9 units once. Her current status has been stable for HbA1c 7.7-7.9%. Laboratory results showed Hb 13.5 g/dL, RBC  $4.45 \times 10^6/\mu\text{L}$ , WBC  $6300/\mu\text{L}$ , Plt  $26.2 \times 10^4/\mu\text{L}$ , GOT 21 U/mL, GPT 24 U/mL, GGT 25 U/mL, Cre 0.6 mg/dL, BUN 17 mg/dL, UA 5.5 mg/dL, LDL 102 mg/dL, HDL 39 mg/dL. There are unremarkable abnormalities in her complete blood count (CBC), liver function, renal function, lipids, chest X-P and electrocardiogram (ECG).

## Methods

Three-dimensional (3-D) image analysis method has been gradually prevalent in the medical practice and research region [6]. Among them, Fujifilm (Tokyo, Japan) has developed SYNAPSE VINCENT system [7]. It is for further investigation of diagnostic imaging of CT, MRI and magnetic resonance angiography (MRA) [8]. Currently, this system is also virtual endoscopic imaging. The mechanism includes the high-tech software to make acquired two-dimensional (2D) images into three-dimensional (3D) image [8,9]. The process of medical image analysis keeps going for further developing deep learning system [10].

## Results

### Abdominal CT

She received abdominal computerized tomography (CT) scan in June, 2021. The findings were as follows: liver is unremarkable, gall bladder has small gall stones, pancreas is unremarkable, left adrenal gland shows to have adrenal tumour, left kidney has small renal stone, right kidney shows to have atrophy and possible space occupying lesion (SOL) about 30 mm size. At this point, SOL in right kidney could not be diagnosed or judged clearly. Due to this result of simple abdominal CT, enhanced CT was conducted 2 weeks later. The results were shown in Fig. 1. The findings were that i) left adrenal gland showed well-enhanced lesion, ii) right kidney did not have apparent or significant SOL or tumour image, iii) right kidney showed the atrophy of renal cortex (Figure 1).

### 3-D image analysis

Using the data obtained from enhanced CT, three-dimensional (3-D) image analysis was performed by SYNAPSE VINCENT system. The results are shown in (Figure 2). They are i) coronal view of bilateral kidney shows well-enhanced left adrenal tumour, no apparent of right renal tumour, and atrophy of renal cortex (Figure 2a), ii) (Figure 2b) shows about 30 degrees rotation from

Figure 2a, in which the findings are same, and iii) (Figure 2c) shows about 180 degrees rotation from (Figure 2a), in which atrophy of reverse side of right kidney was observed.



*Figure 1: Enhanced abdominal CT scan.*



*Figure 2: Three-dimensional (3-D) image analysis on CT.*

*2a: frontal aspect of bilateral kidneys.*

*2b: 30 degree rotation from 2a.*

*2c: 180 degree rotation from 2a.*

## Discussion

During decades, diagnostic imaging technology has made great strides. "SYNAPSE VINCENT" has been computer software that draws high-precision 3D images from tomographic images of CT and MRI [8]. This technology initially began in 2008 with the analysis of heart and liver analysis functions in Japan. After that, the application areas were gradually expanded such as respiratory organs, head, and urinary organs. Orthopaedic area was also included in 2018 for knee joint. Currently, it is widely used in diagnostic imaging and surgical treatment for responding to the diversifying needs in medical practice. It is possible to segment the pancreas, which has been difficult to extract for imaging, before surgical operations in digestive, hepatobiliary, pancreatic and renal region. Formerly, such judgement was depended on manual operation, skill and experience. However, possible segmentation using AI technology seemed to change the

operation. From historical point of view, the application area has been developed from liver diseases and treatment [11]. Regarding 3D image visualization technologies, it was named as "Image-supported navigation in hepatectomy" as part of advanced medical techniques, by the Ministry of Health, Labour and Welfare, Japan. SYNAPSE VINCENT was used for Preoperative liver functional evaluation by scintigraphy and vascular fusion embolization area prediction after Tran's catheter arterial chemoembolization for hepatocellular carcinoma (HCC) and surgical planning for liver diseases [12-14].

This case showed impressive results in the light of diagnostic imaging. As to the tumour of left adrenal gland, it was proved to be an incidentaloma with non-functioning endocrinological tumor, such as Cushing disease, hyperaldosteronism or pheochromocytoma. During clinical progress for this case, the possible presence of SOL in the right kidney was not apparent. From the result of 3D image analysis system, the atrophy of right renal cortex was diagnosed clearly. Atrophy of renal cortex was observed in this case. Is there any possibility of the relationship between renal atrophy and diabetes? Tubulointerstitial fibrosis and glomerulosclerosis would lead to lower renal parenchymal resilience [15]. For influencing renal resilience of diabetic nephropathy (DN), 187 DN patients were enrolled for a study. As a result, stiffness of renal parenchyma was influenced by disease stage, diabetes duration, and creatinine [15]. A characteristic change is observed for tubular atrophy at the late stage of diabetes. However, early changes in diabetic kidney show usually thickening tubular basement membrane. Successively, deterioration rate of renal function brings a strong relationship with the degree of tubulointerstitial fibrosis [16]. In contrast, this case did not show DN, then the cause of the atrophy is not apparent at present. The case will be carefully followed up.

Finally, clinical application of SYNAPSE VINCENT is now more widespread. Formerly, the area of liver and biliary tract has been often used and reported. Recent trends include the liver and pancreas biliary tract and pancreas various operation of the pancreas fat accumulation in the pancreas and lumbosacral vascular anatomy [17-21]. Consequently, augmentation of articulate data using 3D image analysis will be expected to develop more in the future.

## Conflict of Interest

The authors have read and approved the final version of the manuscript. The authors have no conflicts of interest to declare.

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