# 디지털 신호 처리 연구실 (DSPL)

## 김정태 교수님

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# Research areas of interest

- **Statistical signal processing**

  - ➢ Estimation / Detection

- **Image restoration / reconstruction**

- **Computational photography**

  - ➢ Plenoptic image processing, light field reconstruction

- **Machine learning based machine vision**

# Ongoing projects

- **Radar signal processing**

  - Radar signal processing for multiple object tracking – Top Engineering

- **Machine learning based machine vision algorithm**

  - Image based inspection of camera defects - Top Engineering

  - Image based inspection of display panel – KEIT

  - Image based recognition of banknote - Puloon Tech.

  - Intelligent machine vision system for smart factory - NRF

# What is Radar?

- **UWB radar (Ultra wideband radar)**

  ➢ UWB with high distance-resolution

    (transmits a very short pulse train less than 1 nanosecond)

- **UWB application**

  ➢ Occupancy detection with movement reduction

  ➢ People counting with movement pattern analysis

  ➢ Respiration detection of humans and animals

# Radar signal processing for multiple object tracking

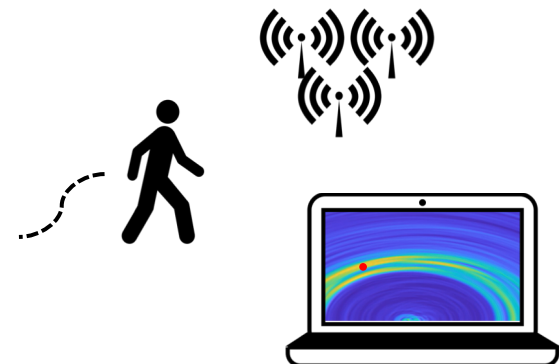- **Radar signal processing for multiple object tracking**

  - Statistical property analysis of radar signal

  - Noise and clutter reduction based on statistical signal processing

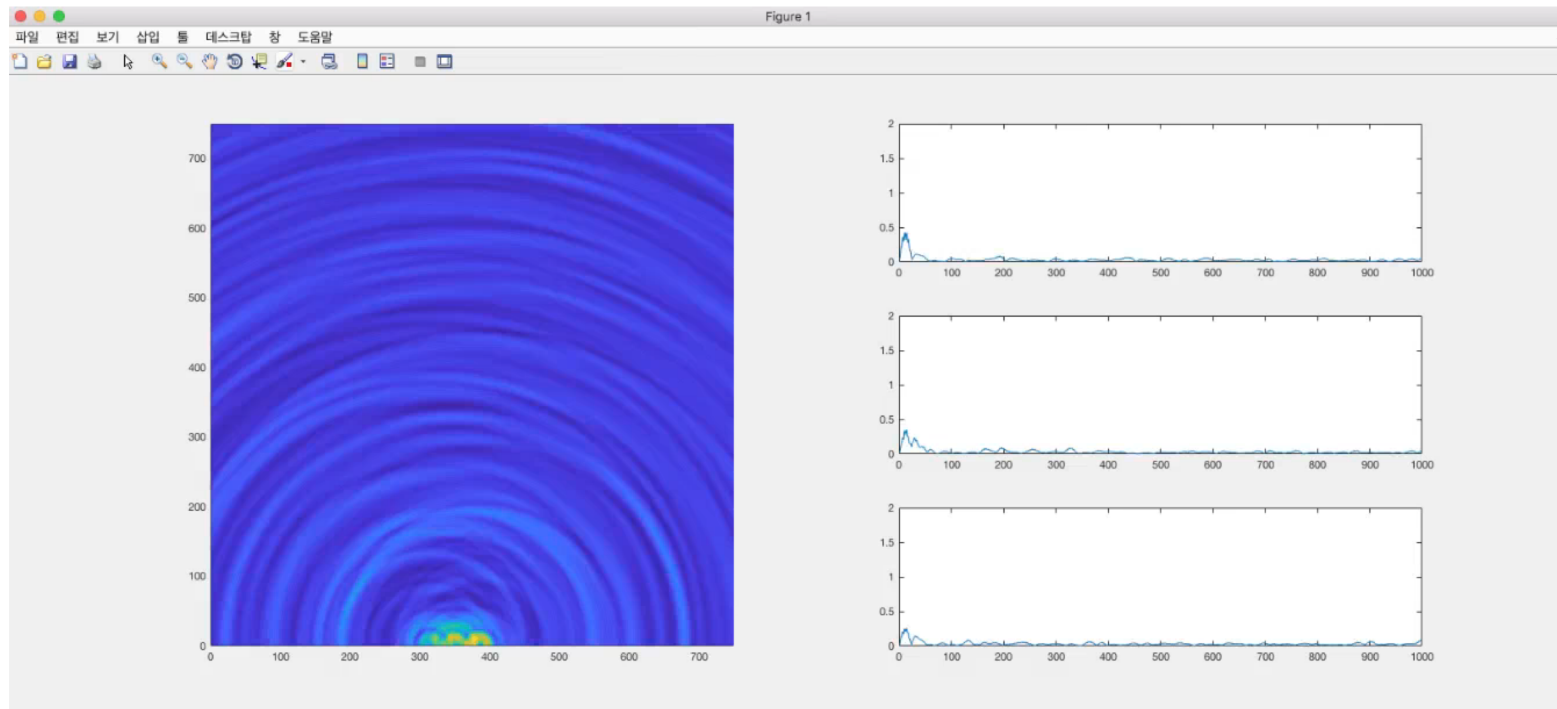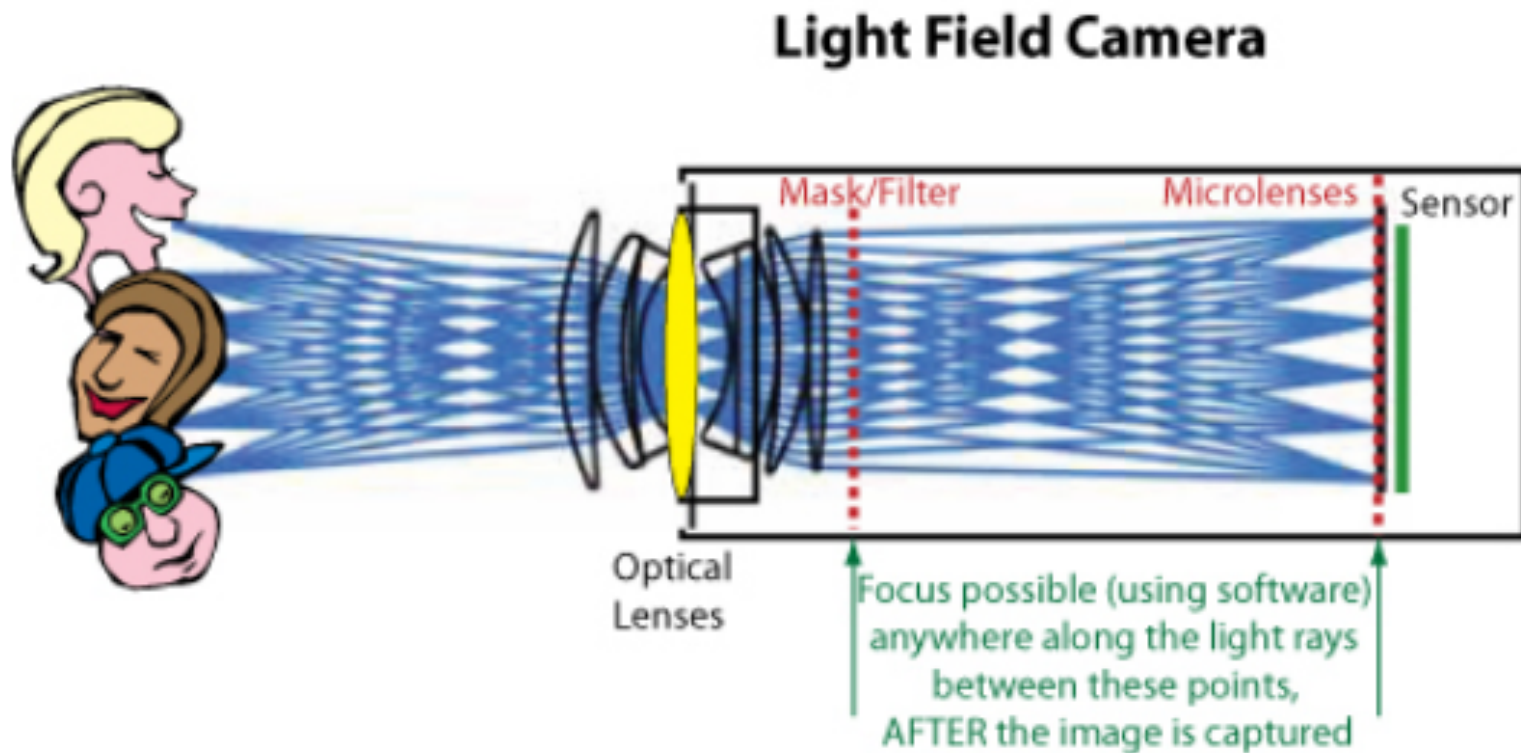  - Multiple radar-based 2D multiple target localization
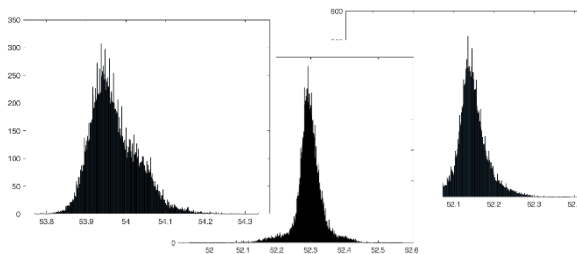


< UWB radar chip>

< Statistical modeling of radar signal >
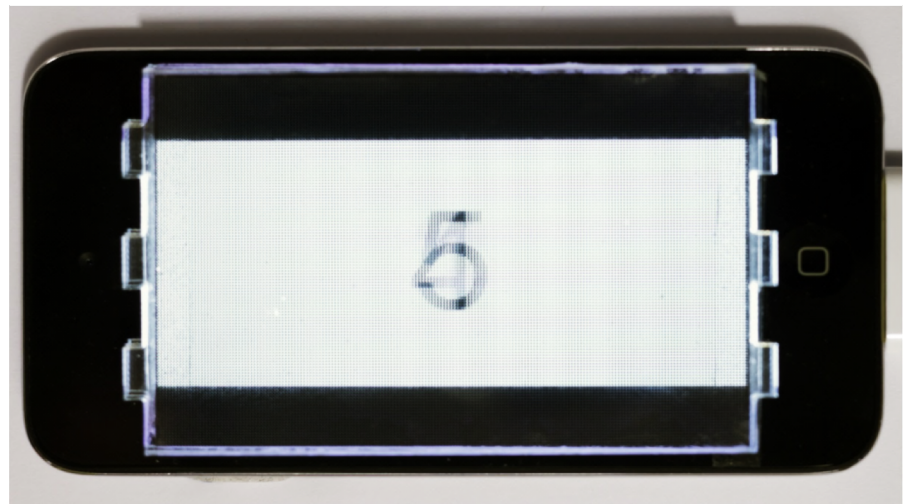
< Multiple radar basd 2D image generation>

# Demo

# Light field



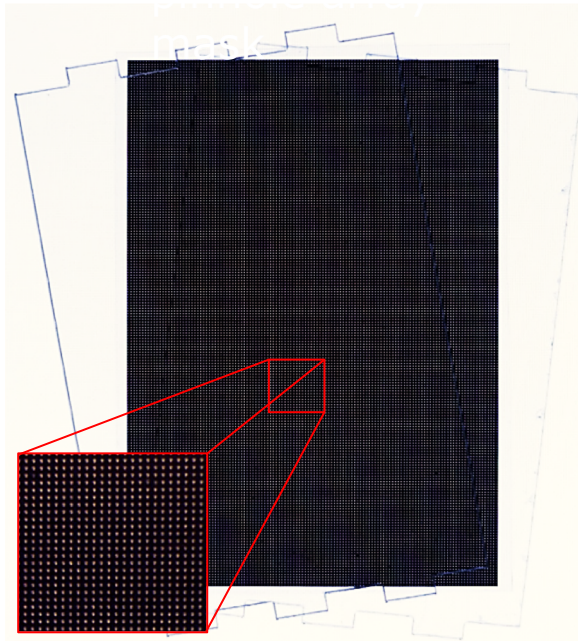**<Light field and light field camera architecture>**

# Light field display

- **Eyeglasses-free display**

  ➤ Emit a light field with a high angular resolution

  ➤ Create an average of multiple different views on the retina

# Light field data processing
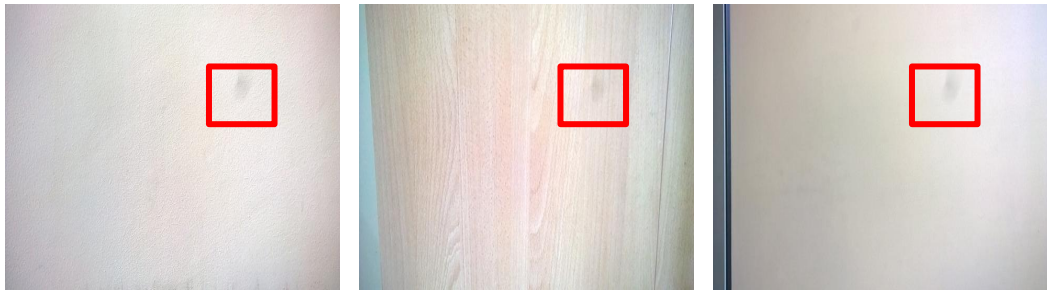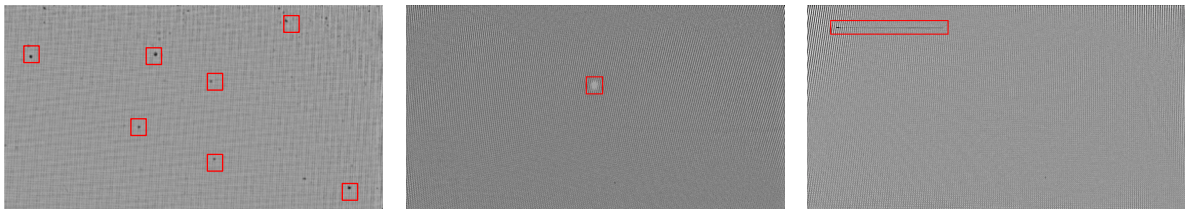
- **Eyeglasses-free display algorithm**

  ➢ Design the model ('P') mapping between rays incident on the retina and those emitted by the screen ('I')

  ➢ Optimize some objective function to find the emitted light field



$$\mathbf{P} \cdot \mathbf{L}^d = \mathbf{P}^{-1} \mathbf{I}$$
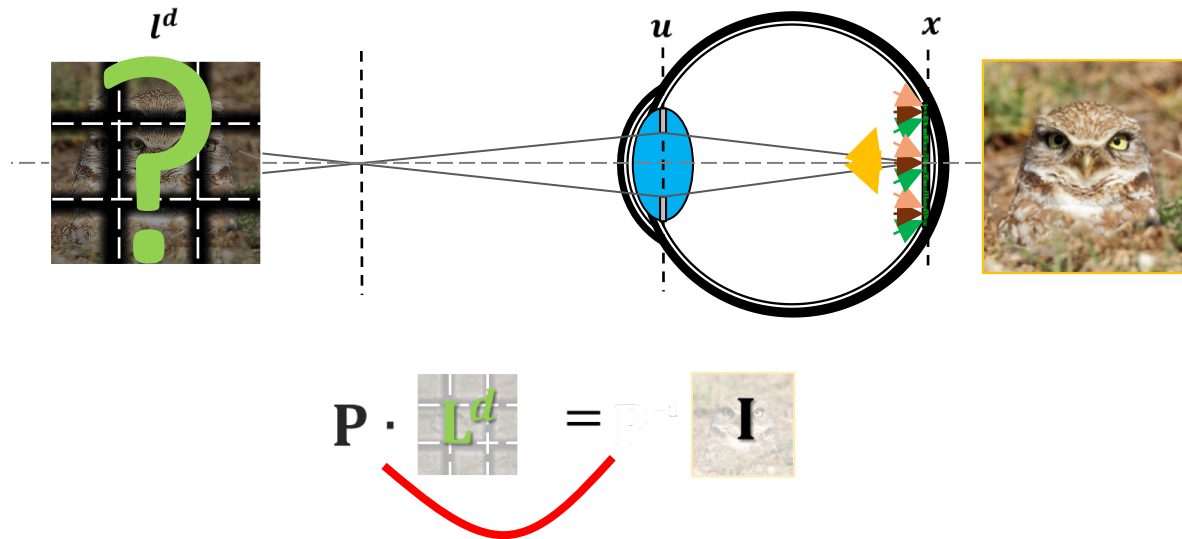
# What is Machine Learning (ML) ?

# Applications of our project

| | |
|---|---|
| **Defect of Mobile camera** |  |
| **Defect of Display panel** |  |
| **Banknote** | <br>< Counterfeit >　　　　< Classification > |

# ML based stain detection

- **Stain detection algorithm implementation**

  ➢ Region of interest (ROI) extraction

  ➢ Classification

- **Deep learning structure optimization**

  ➢ hyper-parameter optimization based on Bayesian optimization
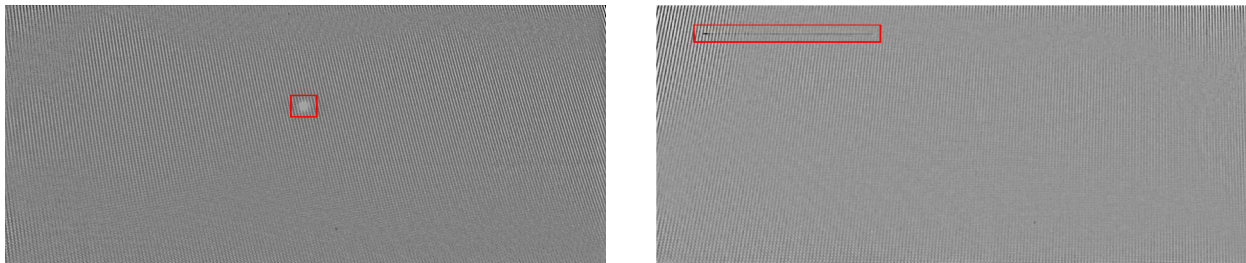
- **High speed and high performance**



**&lt;Stain image&gt;**
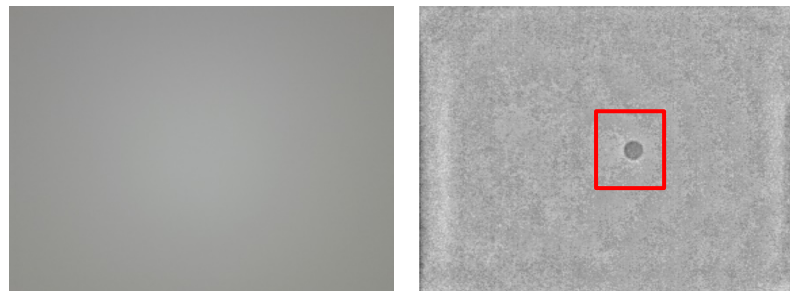
# ML based display panel inspection

- **Display panel inspection algorithm implementation**

  - ➢ Remove background pattern

  - ➢ Detection of defective part

  - ➢ Quantification and classification of defect
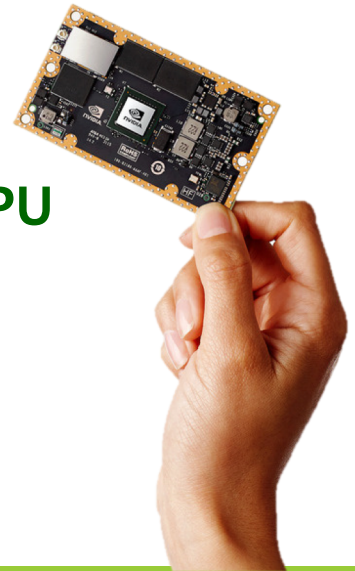
- **High speed and high performance**

  - ➢ GPU based CUDA, parallel processing algorithm



**<Display panel image>**

# ML based banknote recognition

- **Banknote recognition algorithm implementation**

  ➢ Serial number recognition

  ➢ Counterfeit authentication

  ➢ Banknote edition classification

- **High speed and high performance**

  ➢ Algorithms using tensorflow, python, CUDA

- **Banknote recognition algorithms using Embedded GPU**

# ML based banknote recognition

## Serial number recognition
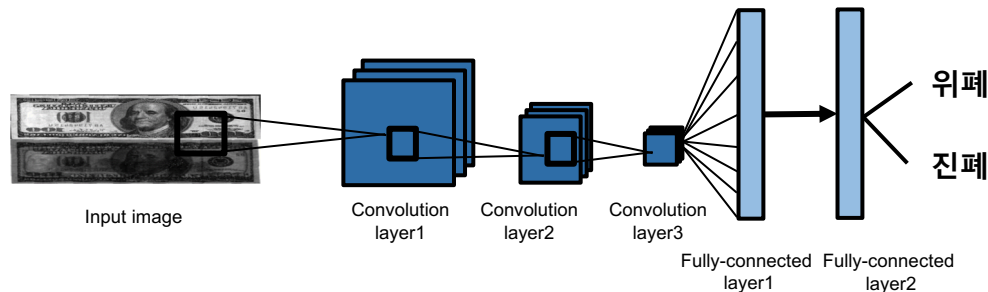


< Serial number image>

## Counterfeit authentication



< Counterfeit / Genuine image>

## Banknote edition classification



< Multinational banknote image>



Input image | Convolution layer1 | Convolution layer2 | Convolution layer3 | Fully-connected layer1 | Fully-connected layer2

위폐

진폐
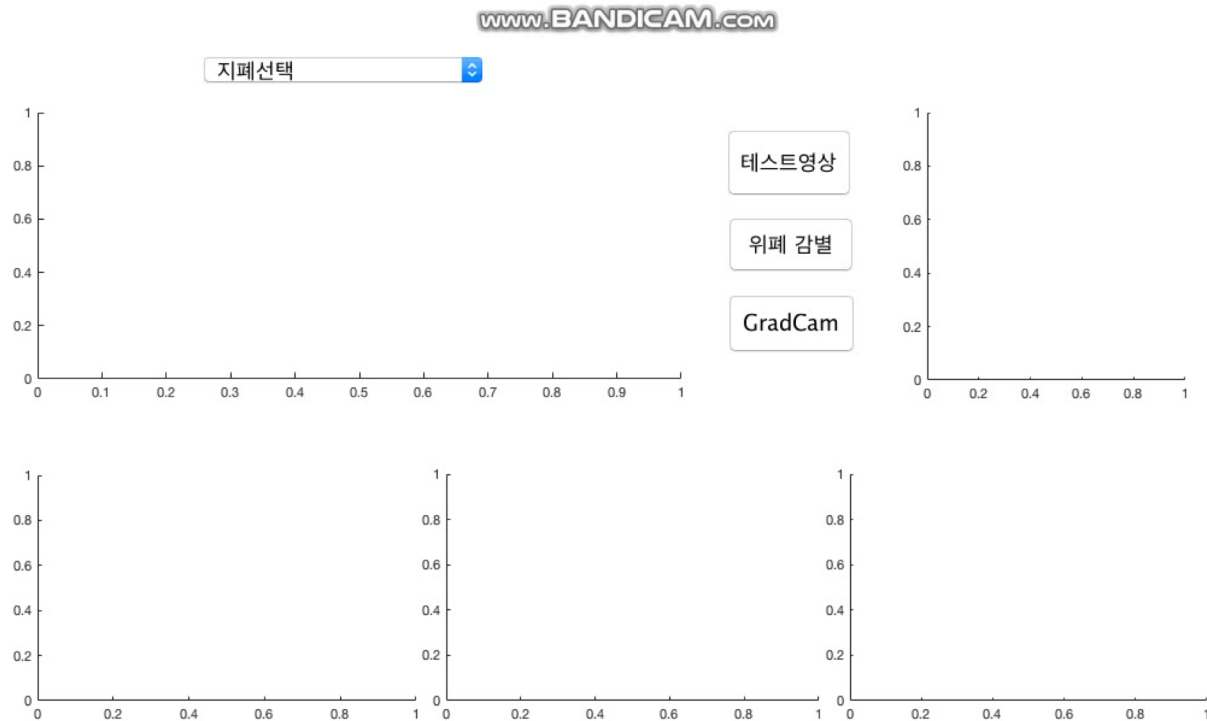
<Counterfeit authentication Deep learning Network >

# Result - Counterfeit authentication

# Future works

- **Radar signal processing**
  - ➤ Advanced statistical model-based filtering for radar signal
  - ➤ Design multiple object tracking algorithm
- **Light field**
  - ➤ Design the precision system for light field display
  - ➤ Rendering optimization for light field dioptric images
- **Machine learning based inspection system**
  - ➤ High speed and high performance inspection system based on deep learning
- **Machine learning based banknote recognition**
  - ➤ Banknote recognition algorithms using Embedded GPU
  - ➤ Integrated banknote recognition system optimization

# 디지털 신호 처리 연구실 (DSPL)

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대학원 생활에 대해 궁금한 점

있으면 질문해주세요 ☺

감사합니다 ^.^