EFFICIENT SATELLITE IMAGE REPRESENTATION USING DEEP AUTOENCODERS

By Group 28 :

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Importance of Satellite Images

Satellite images give a smooth **representation** of happenings around the **globe** and the **opening** of different **events** in the sky. **Satellite** data consists of **high-resolution** images, hence the data is **high** in **volume**, and needs a **high amount** of **storage**.

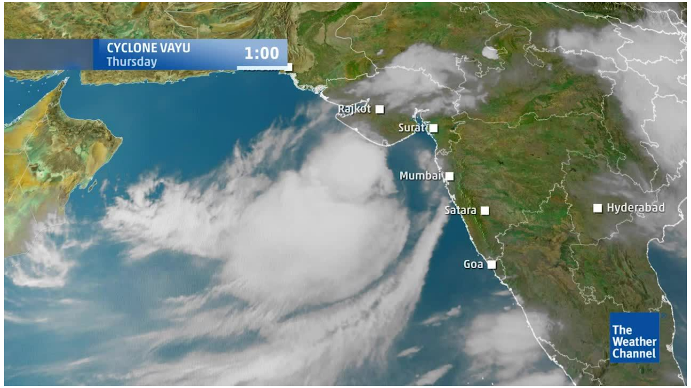
How **IMPORTANT** are satellite images for the world ?

- **Weather Forecasting :**
  Monitor weather conditions and **parameters** such as **low clouds**, **thunderstorms** and even **track** the **evolution** of **dust plumes** in the atmosphere.

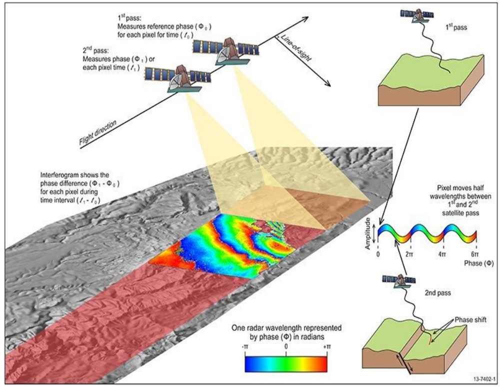
- **Geographic Information System (GIS) :**
  GIS gathers lots of satellite image data to **analyze** and **extract** useful information from this data like **population characteristics**, **economic development**, etc.

- **InSAR (Interferometric Synthetic Aperture radar) :**
  It **predicts** and **measures** the length of the **displacement** of **potential landslides**, **irrigation**, and **soil moisture** tracking and management.

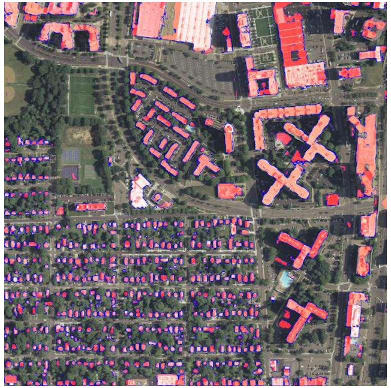
- **Urban Planning, Crop Prediction, Military Surveillance, Disaster Management** and **Natural Resource Utilization.**



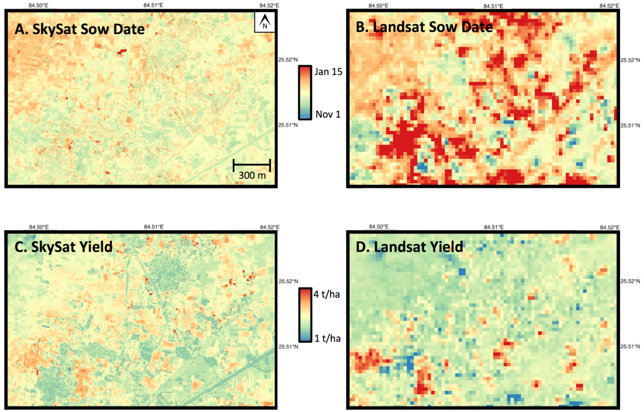
Weather Forecasting



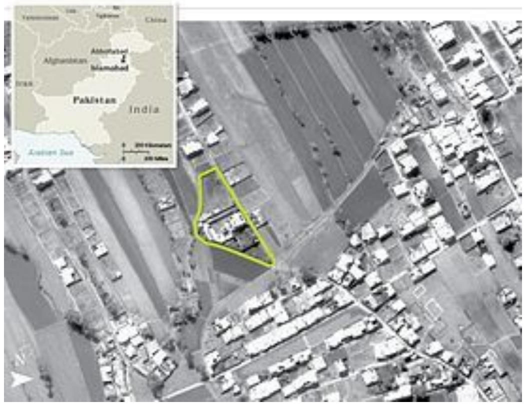
InSAR



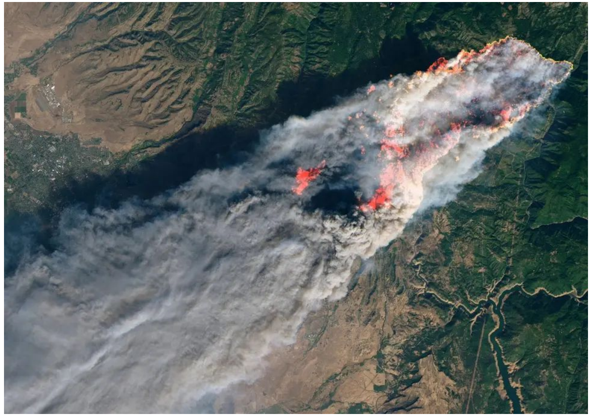
Urban Planning



Crop Prediction



Military Surveillance



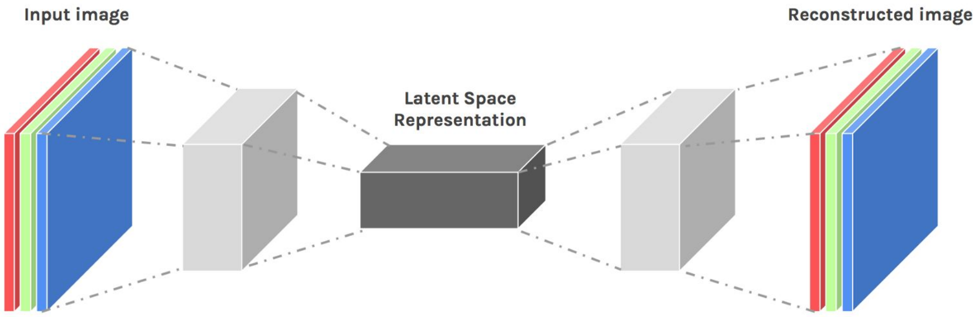
Disaster Management

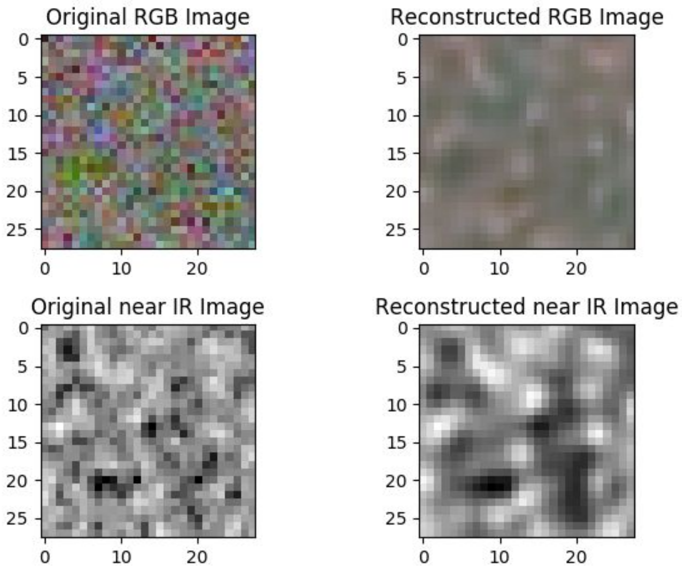
Autoencoder Theory

Autoencoder : **ANN** in which the **input** and **output** are the **same.**

Uses :

1. Finding compressed representation of data
2. Dimensionality Reduction
3. Denoising data
4. Data Generation





Model Architecture

Hyperparameters :

Number of Epochs: **30**

Loss Used: **Mean Square Error**

Metrics Used: **PSNR, R^2**

Batch Size: **32**

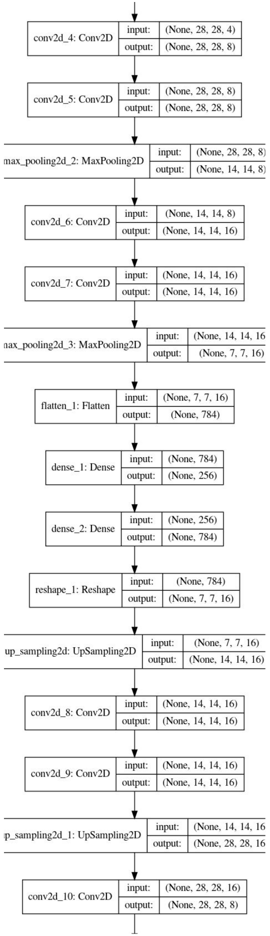
Optimizer Used: **Adam**

Table - I : Variation of Test Loss, Accuracy and PSNR with size of Latent Space

S.No.	Size of latent space	Test Loss	Test accuracy	PSNR
1.	64	0.0035	91.62%	30.112
2.	128	0.0028	92.73%	31.198
3.	**256**	**0.0023**	**93.57%**	**31.933**
4.	512	0.0023	92.93%	31.70
5.	1024	0.0022	93.15	31.

Table - II : Performance of Models for Image Classification

S.No.	Model Used	Accuracy
1.	Autoencoder+Logistic Regression	91%
2.	Autoencoder+Support Vector Classifier	97%
3.	**Autoencoder+Dense Neural Network**	**99%**
4.	Autoencoder+K-Nearest Neighbor	70%
5.	Dense Neural Network	72%
6.	**Deep Convolutional Neural Network**	**99%**



Source Code : https://github.com/vaibagga/Satellite-Image-Similarity

Demonstration Using Grayscale Images

Source Code : https://github.com/tanishq9/Unsupervised-Image-Retrieval-API

For demonstration purposes we have used 28*28 **single** channel **grayscale** images to easily convey the idea of finding **K-most** similar images to a **given** image by building a **Image Retrieval System** by using **Convolutional Autoencoder** and **Nearest Neighbor** technique. The dataset that which we used was **MNIST dataset,** it had **70,000** images out of which **60,000** images were used for **training** and **10,000** images were used for **validation** purposes. The **model** has been **trained** for 2 epochs having a batch size of 32. **Adam optimizer** was used for optimization.

autoencoder.py

```
input_img = Input(shape=(28,28,1))
x = Conv2D(16,(3,3), activation='relu', padding='same')(input_img)
x = MaxPooling2D((2,2), padding='same')(x)
x = Conv2D(8,(3,3), activation='relu', padding='same')(x)
x = MaxPooling2D((2,2), padding='same')(x)
x = Conv2D(8,(3,3), activation='relu', padding='same')(x)
encoded = MaxPooling2D((2,2), padding='same', name='encoder')(x)

x = Conv2D(8, (3, 3), activation='relu', padding='same')(encoded)
x = UpSampling2D((2, 2))(x)
x = Conv2D(8, (3, 3), activation='relu', padding='same')(x)
x = UpSampling2D((2, 2))(x)
x = Conv2D(16, (3, 3), activation='relu')(x)
x = UpSampling2D((2, 2))(x)
decoded = Conv2D(1, (3, 3), activation='sigmoid', padding='same')(x)

autoencoder = Model(input_img, decoded)
autoencoder.compile(optimizer='adam', loss='mse')
```

Autoencoder Architecture

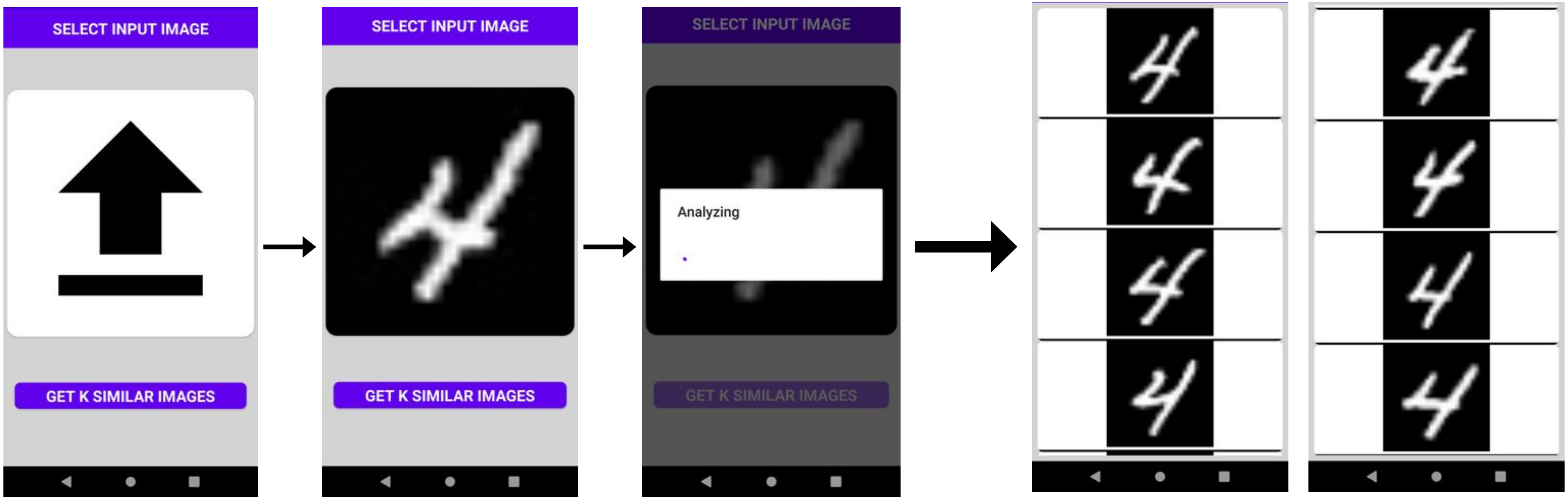
```
autoencoder.summary()
```

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	(None, 28, 28, 1)	0
conv2d_1 (Conv2D)	(None, 28, 28, 16)	160
max_pooling2d_1 (MaxPooling2	(None, 14, 14, 16)	0
conv2d_2 (Conv2D)	(None, 14, 14, 8)	1160
max_pooling2d_2 (MaxPooling2	(None, 7, 7, 8)	0
conv2d_3 (Conv2D)	(None, 7, 7, 8)	584
encoder (MaxPooling2D)	(None, 4, 4, 8)	0
conv2d_4 (Conv2D)	(None, 4, 4, 8)	584
up_sampling2d_1 (UpSampling2	(None, 8, 8, 8)	0
conv2d_5 (Conv2D)	(None, 8, 8, 8)	584
up_sampling2d_2 (UpSampling2	(None, 16, 16, 8)	0
conv2d_6 (Conv2D)	(None, 14, 14, 16)	1168
up_sampling2d_3 (UpSampling2	(None, 28, 28, 16)	0
conv2d_7 (Conv2D)	(None, 28, 28, 1)	145

Total params: 4,385
Trainable params: 4,385
Non-trainable params: 0

Model Summary

Workflow of the application

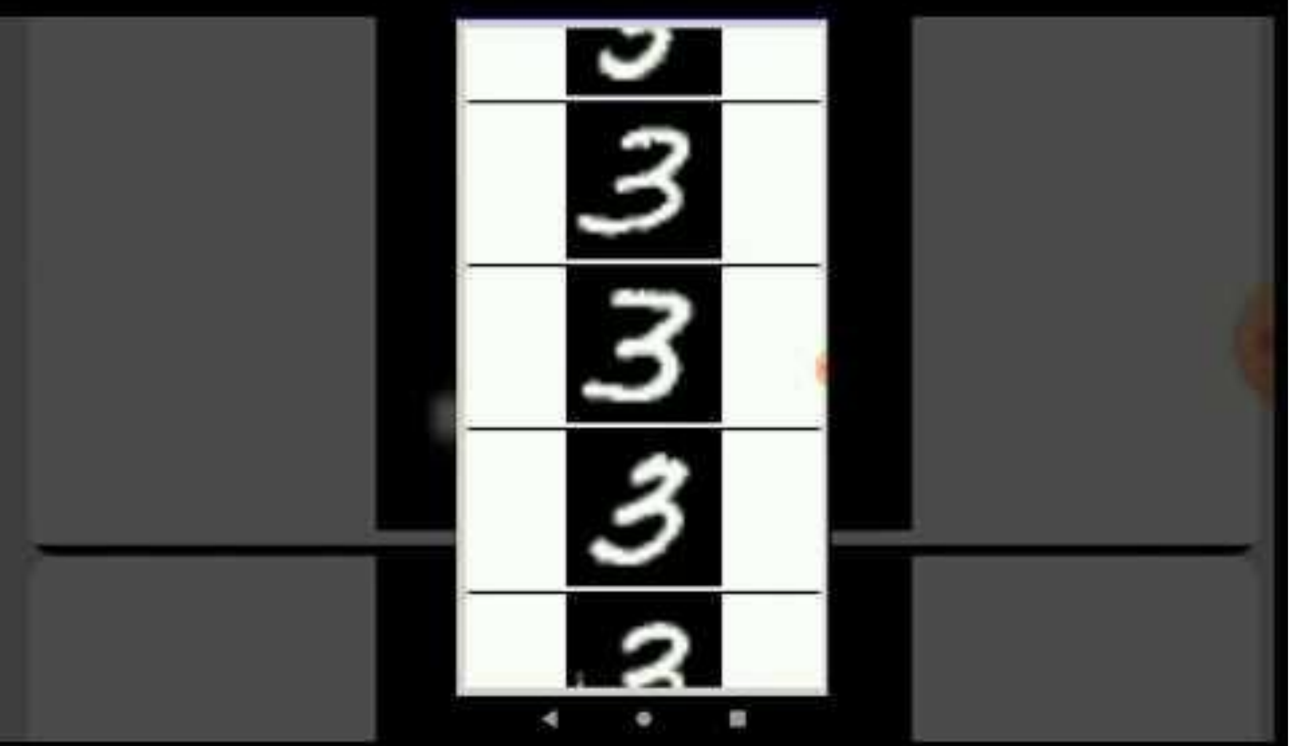


Select the input image and let the API analyze it

Get K=9 similar images in output

Fig. Screenshots of the Android Application

Demonstration Video & Tech Stack



TECH STACK

Languages :

- Java
- JavaScript
- Python

Tools :

- Visual Studio Code
- Jupyter Notebook
- Android Studio
- Git
- Node.js
- Heroku

Frameworks :

- Express.js
- Tensorflow

Libraries :

- Scikit-Learn
- Keras
- OkHttp
- Glide
- Formidable
- Material.io

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