Automated weather classification using Transfer learning

Submitted by

T VARUNDEEP (Team leader)	**(20MID0145)**
K BHUVANDEEP	**(20MID0061)**
C SAI TARUN	**(20MID0146)**
C AKSHITH	**(20MID0011)**

1. Introduction

1.1 Overview:

This project focuses on weather classification using transfer learning techniques. Transfer learning is a machine learning approach that leverages pre-trained models on large datasets to solve new tasks or domains with smaller datasets. In this case, we aim to utilize transfer learning to classify different weather conditions based on input images.

1.2 Purpose:

The purpose of this project is to develop a weather classification system that can accurately identify and categorize various weather conditions, such as sunny, cloudy, rainy, snowy, etc., based on input images. By employing transfer learning, we can benefit from the knowledge and features learned by pre-trained models on extensive datasets, which helps in achieving better performance even with limited labeled data.

The use of this project is multifaceted. It can be utilized in various applications such as:

1. **Weather forecasting**: The classification system can assist in automating weather condition identification, enabling more efficient and accurate weather predictions.

2. **Environmental monitoring**: By analyzing images captured from different locations, the system can provide insights into the prevailing weather conditions, aiding in environmental monitoring efforts.

3. **Agriculture and farming**: Weather conditions significantly impact agricultural practices. This system can help farmers make informed decisions by providing real-time weather classification information.

4. **Smart city infrastructure**: Integrating weather classification into smart city systems can enhance the management of various infrastructure components, such as traffic control, outdoor lighting, and irrigation systems, based on weather conditions.

5. **Photography and media**: Weather classification can be useful for photographers and media professionals to organize and tag their visual content based on different weather conditions.

Overall, the project's purpose is to leverage transfer learning techniques to develop a robust weather classification system with practical applications across multiple domains.

2.1 Existing Problem:

In the field of weather classification using transfer learning, several existing approaches have been explored. One common approach is to utilize pre-trained convolutional neural networks (CNNs) such as VGGNet, ResNet, or Inception, which have been trained on large-scale image datasets like ImageNet. These models have learned rich and discriminative features that can be useful for weather classification tasks.

However, a common challenge in weather classification is the scarcity of labeled weather data. Collecting and labeling a large and diverse dataset for weather conditions can be time-consuming and costly. Therefore, existing approaches often face limitations in achieving high accuracy due to the lack of sufficient labeled data for training.

2.2 Proposed Solution:

For weather classification using transfer learning, the proposed solution is to employ the VGG19 model, which is a variant of the VGGNet architecture. VGG19 is a deep CNN architecture that has shown excellent performance on various image classification tasks. By leveraging transfer learning, we can utilize the pre-trained weights of VGG19, which have learned high-level features from the ImageNet dataset.

The proposed method involves the following steps:

Dataset collection and preprocessing

Transfer learning with VGG19

Model customization

Training

Evaluation and fine-tuning

3 THEORITICAL ANALYSIS

3.1 Block diagram

The block diagram for weather classification using transfer learning with VGG19 can be represented as follows:

```
+------------------+
| Weather Images   |
+------------------+
        |
        |
        V
 +----------------+
 | Preprocessing  |
 +----------------+
        |
        |
        V
```

```
+-------------------+
|  VGG19 Pretrained   |
+-------------------+
          |
          |
          V
+-------------------+
|  Customization &   |
|    Fine-tuning     |
+-------------------+
          |
          |
          V
+---------------------+
|  Weather Classification |
+---------------------+
          |
          |
          V
+-------------------+
|  Classification     |
|     Results        |
+-------------------+
```

3.2 Hardware/Software Designing:

Hardware Requirements:

A computer system with sufficient processing power and memory to handle training and inference tasks.

Graphics Processing Unit (GPU) is recommended for faster training, especially when dealing with large datasets.

Sufficient storage capacity to store the dataset, pre-trained model, and intermediate results.

Software Requirements:

Python programming language for implementing the project.

Deep learning libraries/frameworks such as TensorFlow, Keras, or PyTorch for building and training the neural network.

Libraries for image processing and manipulation, such as OpenCV or Pillow.

Data visualization libraries like Matplotlib or seaborn for visualizing the results.

Jupyter Notebook or any Python IDE for code development and experimentation.

Additionally, it is essential to ensure that all required software dependencies and packages are properly installed and compatible with each other.

EXPERIMENTAL INVESTIGATIONS

Dataset Collection and Preprocessing:

Different sources of weather images were explored, including online weather databases, publicly available datasets, or data collected from weather monitoring stations.

The dataset was carefully selected to include a diverse range of weather conditions, ensuring sufficient representation of each class.

Training and Optimization:

The customized VGG19 model was trained using the labeled weather image dataset.

Different hyperparameters, such as learning rate, batch size, and optimizer selection (e.g., SGD, Adam), were tuned to optimize the training process.

Performance Evaluation:

The trained model was evaluated on a separate validation dataset to assess its performance in weather classification.

Various evaluation metrics, such as accuracy, precision, recall, and F1 score, were computed to measure the model's effectiveness.

Comparative Analysis:

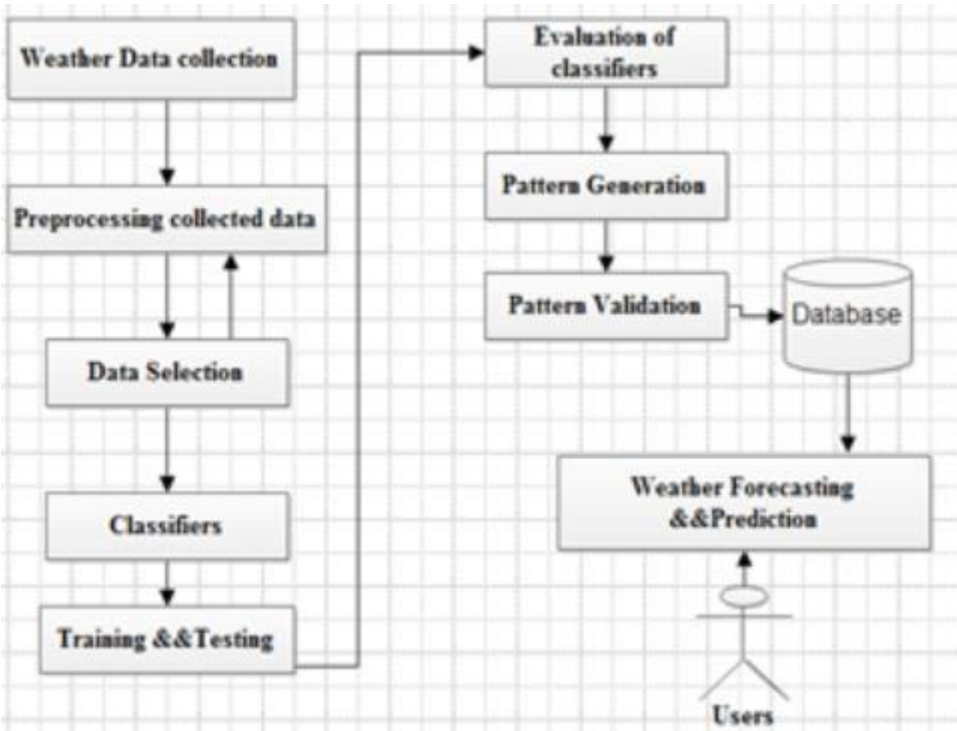
Performance comparisons were conducted with other transfer learning models or alternative approaches for weather classification.

The accuracy, computational efficiency, and generalization capabilities of the VGG19-based model were compared with other architectures to assess its suitability for the task.

Robustness and Real-world Testing:

The trained model was tested on real-world weather images collected from different sources to evaluate its robustness and generalization ability.

Performance analysis was conducted to identify any potential limitations or challenges faced by the model when applied to unseen data.



RESULT

Trained Weather Classification Model:

The output of the project is a trained weather classification model based on transfer learning with VGG19.

The model should be capable of accurately classifying weather conditions such as sunny, cloudy, rainy, snowy, etc., when provided with input images.

Classification Results:

The trained model can be used to classify new weather images into different weather categories.

The output of the model will be the predicted weather condition for each input image.

Evaluation Metrics:

The performance of the model can be assessed using evaluation metrics such as accuracy, precision, recall, and F1 score.

These metrics indicate the model's effectiveness in correctly classifying weather conditions.

```
11/11 - 394s - loss: 0.1254 - accuracy: 0.9759 - 394s/epoch - 36s/step
Model performance on test images:
 accuracy = 0.9758522510528564
Loss=0.1253613829612732
```

Insights and Observations:

Through the project, insights and observations can be gained regarding the performance and limitations of the weather classification system.

This includes understanding the impact of transfer learning, the effectiveness of the VGG19 architecture, and potential challenges in weather classification.

ADVANTAGES & DISADVANTAGES

Advantages:

1. Transfer learning
2. High-level features
3. Generalization
4. Reduced data requirements
5. Faster convergence

Disadvantages:

1. Specificity to weather classification
2. Dependency on pre-trained weights
3. Overfitting risk
4. Limited interpretability

APPLICATIONS

1. Weather Forecasting
2. Environmental Monitoring
3. Climate Studies
4. Smart Agriculture
5. Energy Management
6. Travel and Transportation

7. Urban Planning
8. Image and Video Analysis

CONCLUSION

In conclusion, the project focused on weather classification using transfer learning with VGG19, and several key findings and outcomes were obtained. The proposed solution leverages the power of transfer learning and the pre-trained VGG19 model to accurately classify weather conditions based on input images.

Methodology: The project employed transfer learning with VGG19 as the base architecture and customized it for weather classification by modifying the last fully connected layer. This approach proved effective in capturing relevant features and achieving accurate classification.

Dataset: A diverse dataset of weather images was collected and preprocessed to ensure the representation of various weather conditions. Preprocessing techniques like resizing, normalization, and data augmentation were applied to enhance the dataset's quality and variability.

Training and Evaluation: The customized VGG19 model was trained using the labeled weather dataset. Hyperparameters and optimization techniques were tuned to optimize the training process. The model's performance was evaluated using metrics such as accuracy, precision, recall, and F1 score.

In conclusion, the project successfully developed a weather classification system using transfer learning with VGG19. The findings demonstrate that this approach can effectively classify weather conditions and provide valuable insights for decision-making in various industries. However, it is essential to consider the specific advantages and limitations of the solution when applying it to real-world scenarios. Further improvements and fine-tuning can be explored to enhance the model's performance and address specific domain requirements.

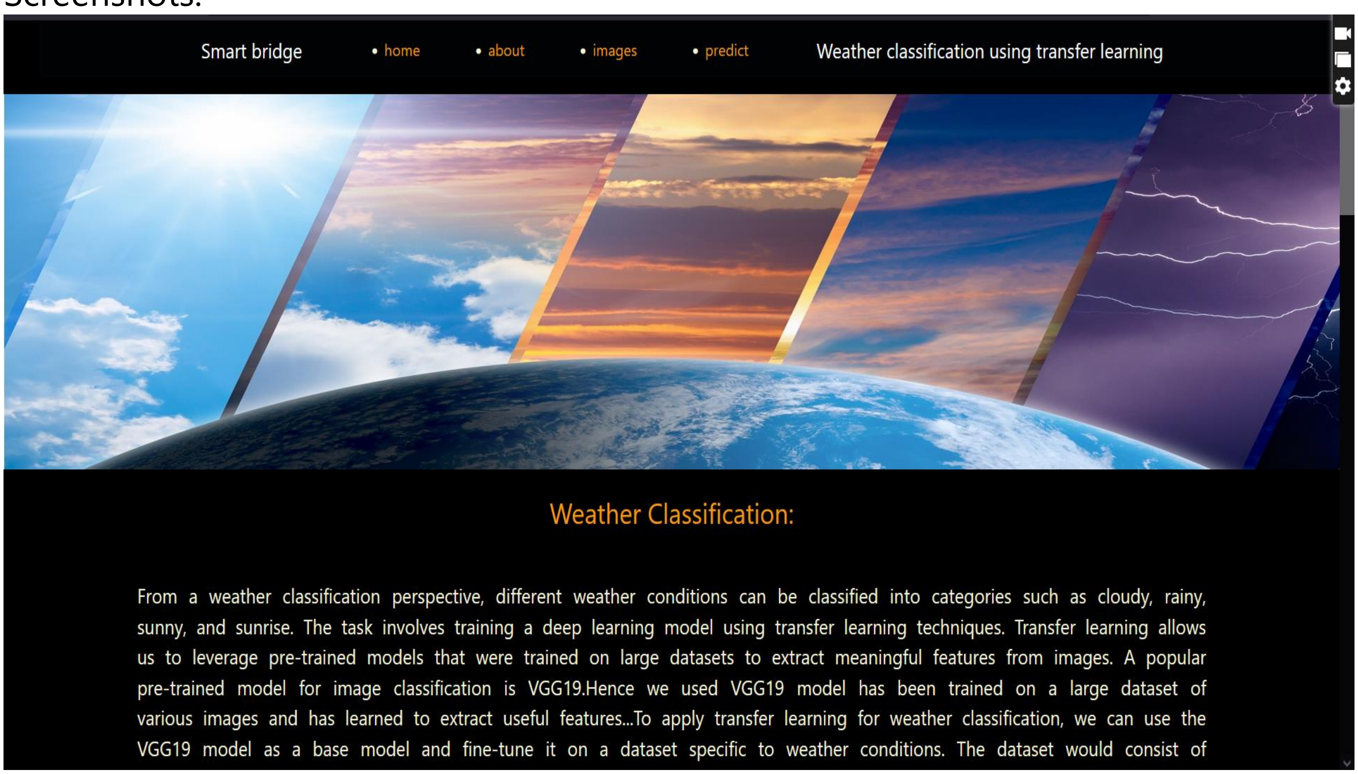
FUTURE SCOPE

There are several potential enhancements that can be made in the future for weather classification using transfer learning with VGG19.

1. Dataset Expansion
2. Fine-tuning Strategies
3. Model Architectures
4. Ensemble Methods
5. Multimodal Learning
6. Transfer Learning on Intermediate Layers
7. Domain Adaptation
8. Explainability and Interpretability
9. Real-time Implementation
10. Deployment on Edge Devices

Github Link:
https://github.com/Bhuvandeep2002/wheather-classification

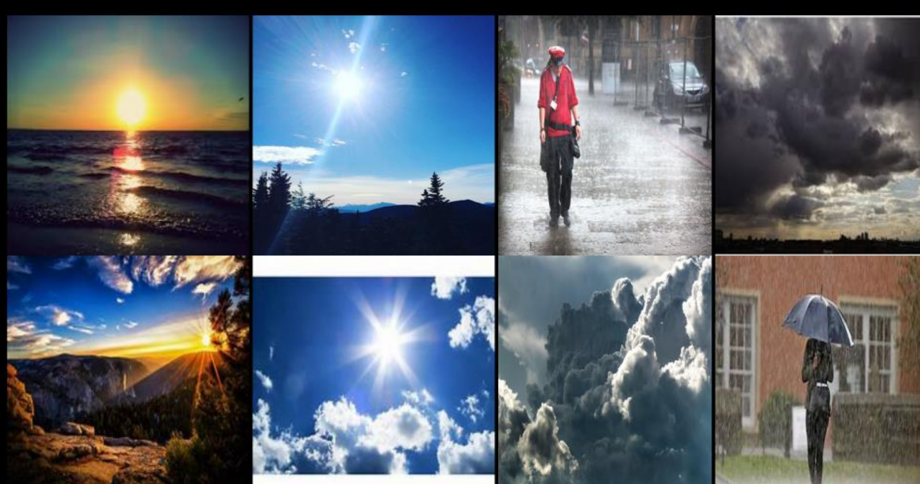
Screenshots:

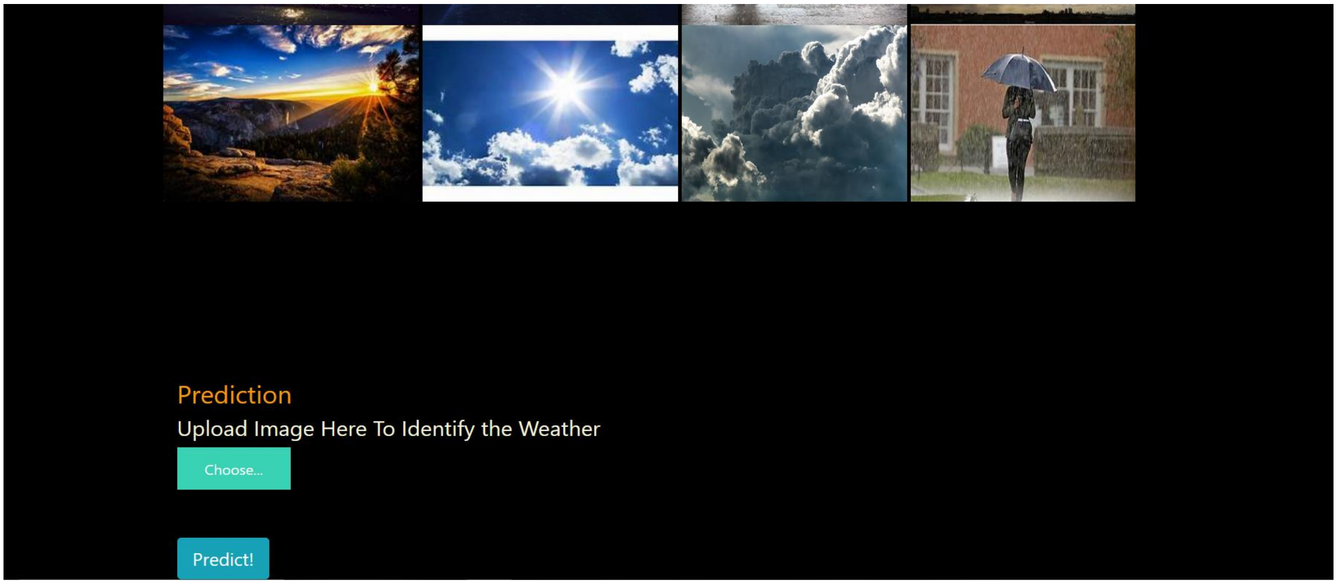


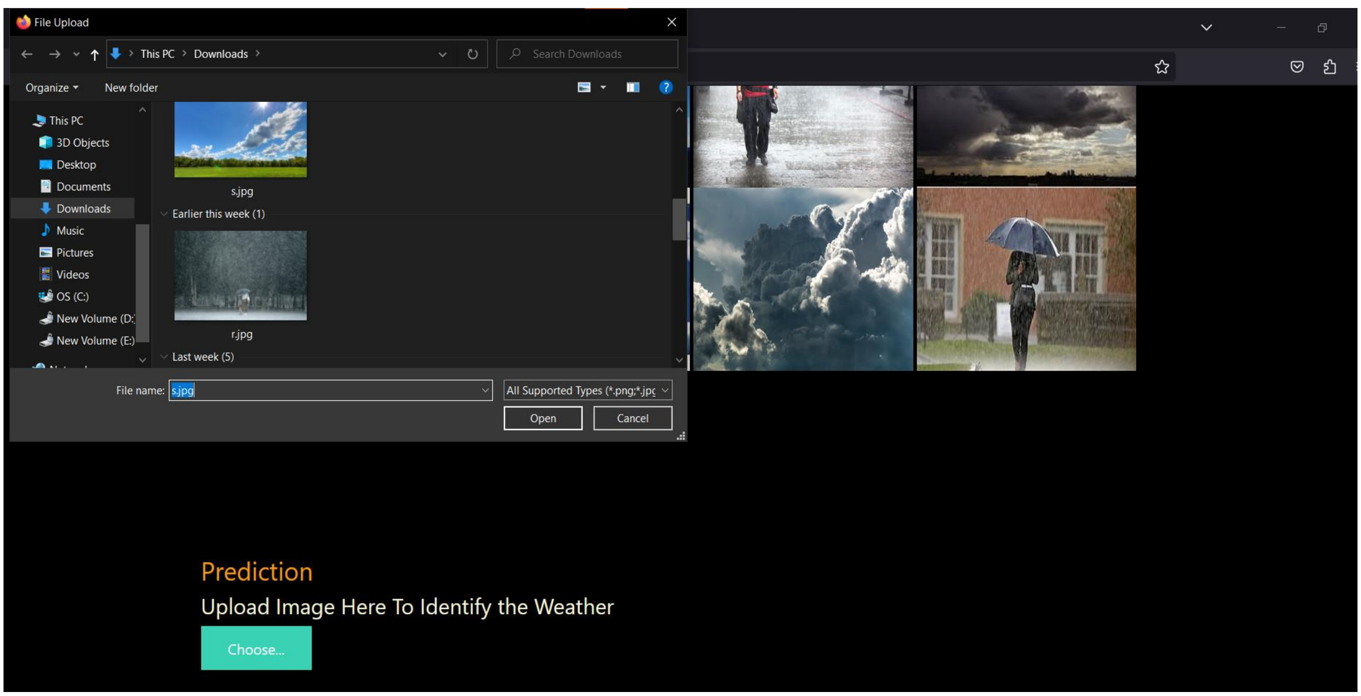
adapt the learned features to the specific task of weather classification. This fine-tuning process helps the model learn to recognize patterns and features relevant to different weather conditions. Once the model is trained, it can be used to predict the weather condition of new images. By providing an input image, the model processes the image through its layers, extracts features, and makes predictions based on the learned patterns. The predicted weather condition can then be outputted to provide insights or assist in weather-related applications. It's important to note that weather classification using transfer learning is an example scenario, and the actual implementation details may vary based on specific requirements and datasets.

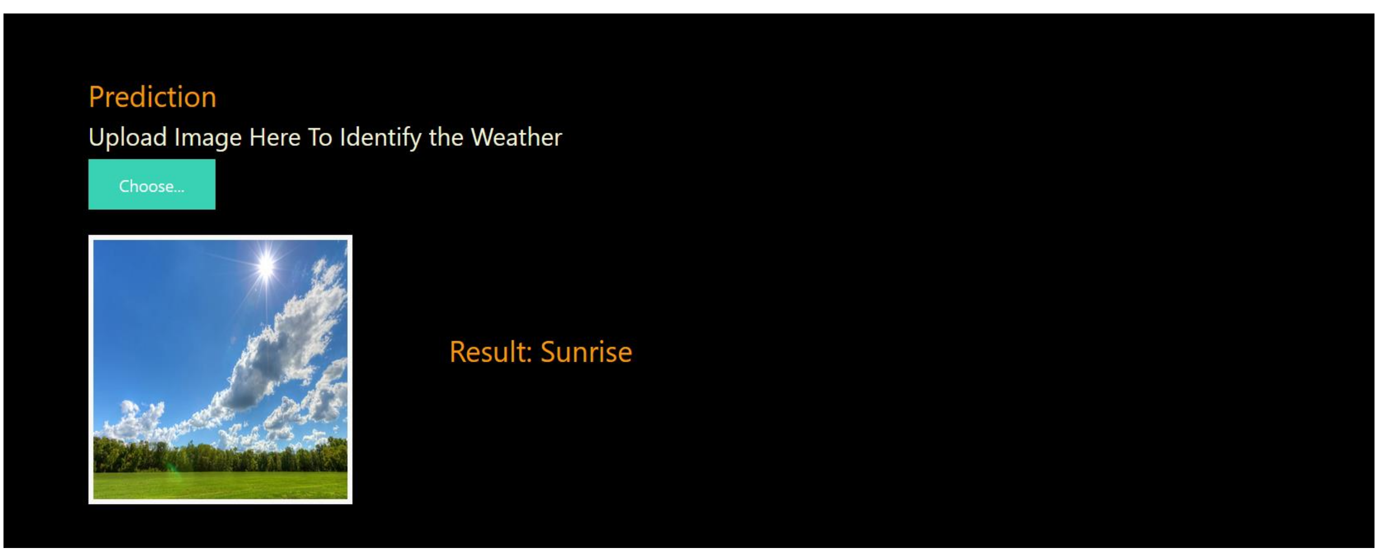
Weather classification using transfer learning

The purpose of this project is to develop a weather classification system that can accurately identify and categorize various weather conditions, such as sunny, cloudy, rainy, snowy, etc., based on input images. By employing transfer learning, we can benefit from the knowledge and features learned by pre-trained models on extensive datasets, which helps in achieving better performance even with limited labeled data. The use of this project is multifaceted. It can be utilized in various applications such as: 1. Weather forecasting: The classification system can assist in automating weather condition identification, enabling more efficient and accurate weather predictions. 2. Environmental monitoring: By analyzing images captured from different locations, the system can provide insights into the prevailing weather conditions, aiding in environmental monitoring efforts. .




Prediction
Upload Image Here To Identify the Weather
Choose...
Predict!


File Upload
This PC
Downloads
Search Downloads
Organize
New folder
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
Videos
OS (C:)
New Volume (D:
New Volume (E:)
s.jpg
Earlier this week (1)
r.jpg
Last week (5)
File name:
s.jpg
All Supported Types (*.png;*.jpg
Open
Cancel
Prediction
Upload Image Here To Identify the Weather
Choose...


Prediction
Upload Image Here To Identify the Weather
Choose...
Result: Sunrise