

AI on Low-Cost Camera for Counting and Classification of Microbes in Nature Water

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PROBLEM

Traditional methods for water monitoring and classification of water borne microbes and pathogens rely on expensive instruments and time-consuming processes, which hinder the extent of discovery possible. With the contents and quality of water being crucial today, developing convenient, effective and accurate methods is imperative. With artificial intelligence models being prevalent today, the utilisation of an automatic detection model for water quality assessment and microbe detection could pose a novel approach to the task of water monitoring. This could help advance the performance of the water quality detection task in a manner that is convenient, efficient, and reliable.

CURRENT SYSTEM

This project aimed to develop an artificial intelligence-based model for the automated detection and classification of microbes in natural water working in conjunction with a low-cost camera for real-time inference. This was achieved using a neural network developed on Edge Impulse, a chipset, and an ESP32-CAM development board.



Sample Image
taken by
ESP32-CAM

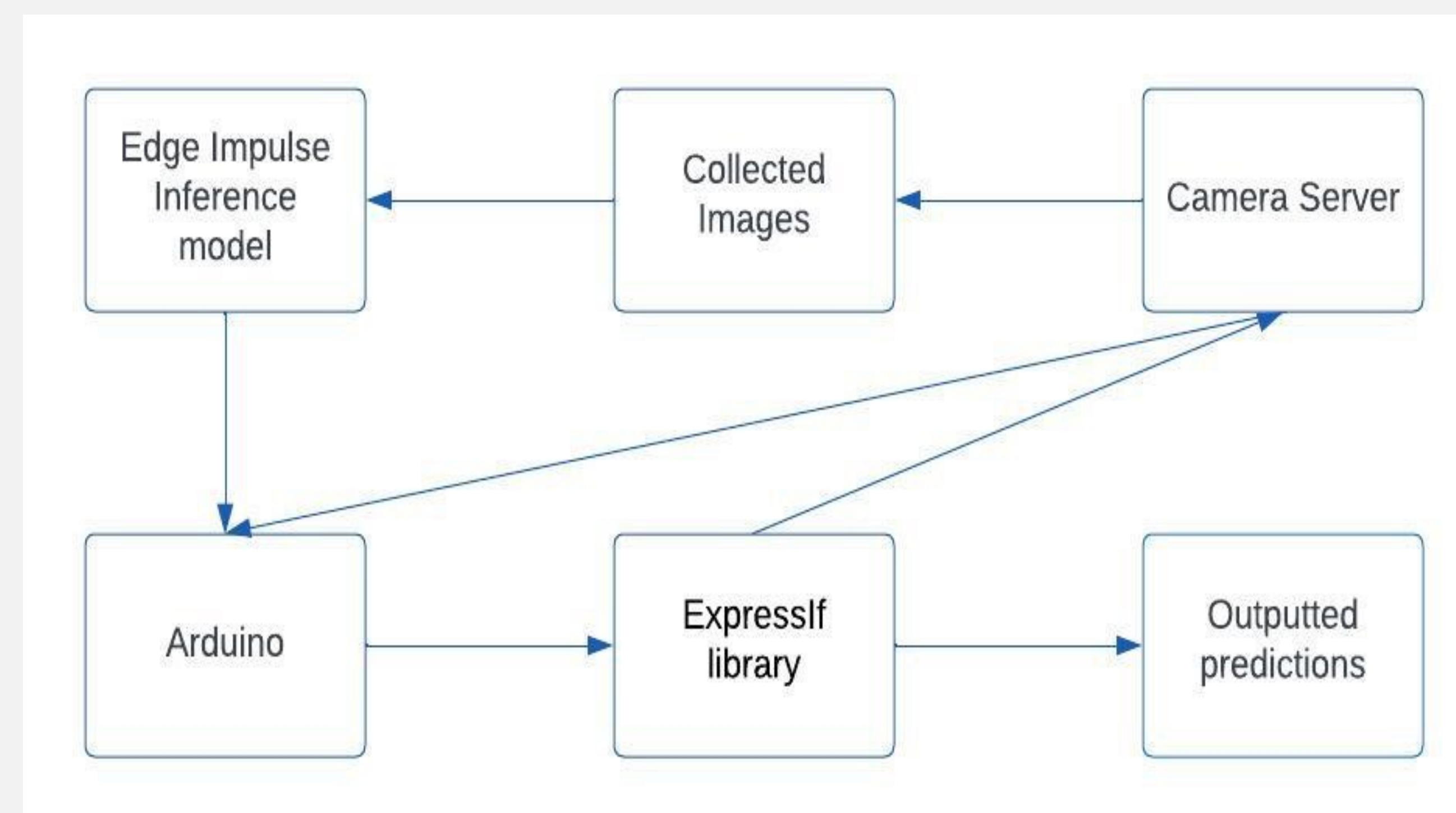
REQUIREMENTS

- Arduino IDE environment
- ESP32-CAM Development Board
- Edge Impulse (edgeimpulse.com, for building of AI-model)
- ExpressIf library
- Microscope

SYSTEM DESIGN

The system uses a microscope and ESP32-CAM to collect live sample images and video of any sample of water and water bacteria and pathogens. Pictures of the sample and bacteria are collected using the available camera web server and are kept in a dataset of pictures to be used for the training of the inference model. The model is created and trained on the Edge Impulse platform, using appropriate settings and the dataset of images. The model is then deployed and loaded onto the chipset to output an inference on the classification of algae detected on the camera feed obtained from the microscope and ESP32-CAM.

OBJECT DESIGN



IMPLEMENTATION

The system was implemented on a Windows laptop computer with a 64-bit operating system, a storage of 256GB and memory of 12GB, and an Intel® Core™ i5-10210U CPU at 1.60GHz. We used the Arduino IDE as a development environment from which to run our system's programs, and a ESP32-CAM development board mounted on a Nikon light microscope to collect live sample images.

VERIFICATION

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Output: Serial Monitor x
Message (Enter to send message to ESP32 Dev Module on COM9)
New Line 115200 baud

Predictions (ESP: 7 ms., Classification: 453 ms., Anomaly: 0 ms.):
Cluster: 0.0078
Microscopia: 0.0162
Mitochondria: 0.3191
Non-algae: 0.5316
Oscillator: 0.0029
Predictions (ESP: 7 ms., Classification: 453 ms., Anomaly: 0 ms.):
Cluster: 0.0078
Microscopia: 0.0162
Mitochondria: 0.3547
Non-algae: 0.5400
Oscillator: 0.0059
Predictions (ESP: 7 ms., Classification: 452 ms., Anomaly: 0 ms.):
Cluster: 0.0078
Microscopia: 0.0162
Mitochondria: 0.3109
Non-algae: 0.5578
Oscillator: 0.0049
Predictions (ESP: 7 ms., Classification: 452 ms., Anomaly: 0 ms.):
Cluster: 0.0078
Microscopia: 0.0162
Mitochondria: 0.3547
Non-algae: 0.5589
Oscillator: 0.0029
  
```

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-
WiFi connected
Camera Stream Ready! Go to: http://192.168.114.77
Edge Impulse Inference Demo
Camera initialized
  
```

Sample output and process of
inference model

SUMMARY

Traditional water monitoring relies on expensive and time-consuming methods, limiting the extent of work and discovery possible. Developing efficient AI-driven detection for water quality and microbe assessment is of interest for the advancement of water monitoring efforts. This project developed an artificial intelligence-based model for the automatic detection of microbes in natural water working in conjunction with a low-cost camera for real-time inference, with the goal of proposing a novel approach to water monitoring efforts available today that reduces costs, and is convenient, efficient, and reliable.

REFERENCES

- <https://www.edgeimpulse.com>
- <https://github.com/CIS495algaeAI>
- https://fiudit-my.sharepoint.com/:x:/g/personal/sadjadi_fiu_edu/EUKFXI7wm1xGrcliEinx15gBLupDOIFNjjkeKv-y45DS3A?e=0l3Gn6

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