Pi Eye: Real-time Vision Detection System

MICRO HARVEST

FISHING FOR EXPERIENCE

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Company Introduction

MicroHarvest is a BioTech startup located in Hamburg and Lisbon, that has developed the **fastest protein production** technology **in the world**. This technology will be used, to address **global food security** and the environmental impact of the current food system. This is done, by producing **high-quality, protein-rich biomass** from micro-organisms.

Team Introduction

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Problem statement

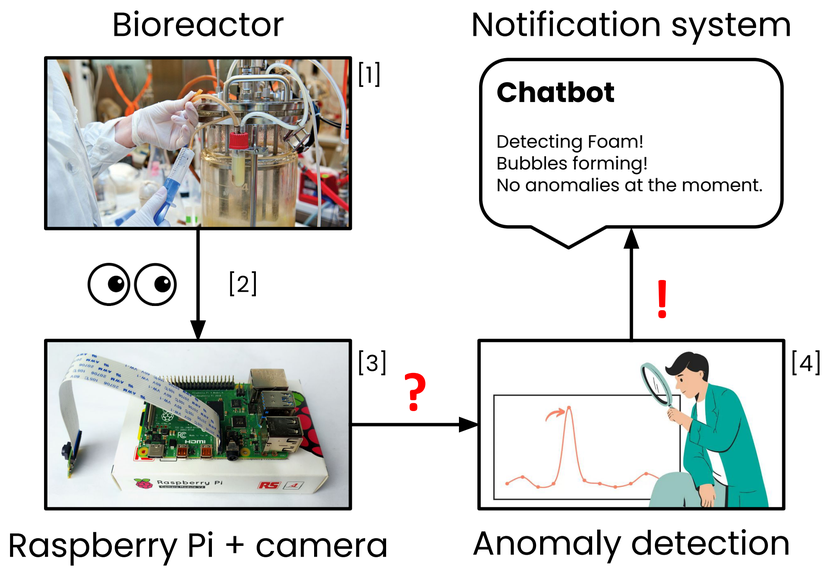
Bioreactor setup

The natural fermentation used for producing protein, can be **prone to technical issues**. An example of such an issue presents, as **foam building up** in the bioreactor. Monitoring of small bioreactors at lab-scale requires **quick action** if an issue arises. This is especially the case for over-night fermentations, where it is not possible to have researchers present in the lab. The company needs an **automated monitoring** and **notification system**.

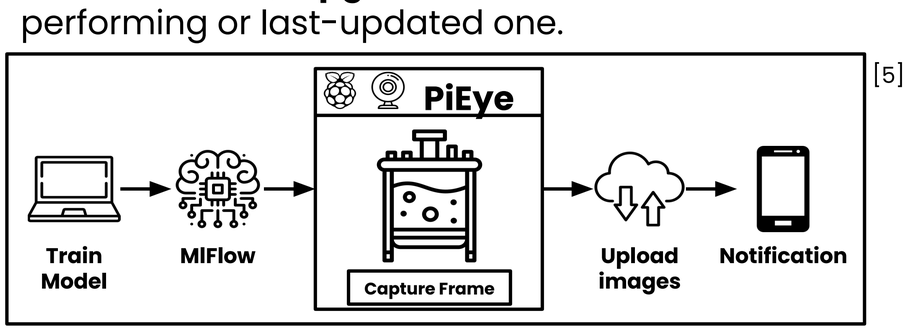
Mission statement

Use a **Raspberry Pi** and **camera module** to constantly observe the fermentation reaction. The Raspberry Pi should run a **machine learning model** on pictures it takes of the bioreactor in situ. In the case that the model detects an **anomaly**, it should send a notification using an **LLM** describing the anomaly in detail.

Methods and Data



- **Raspberry Pi** with **camera module**: has low energy consumption and can be run at any desired frequency.
- **Isolation forest**: **anomaly detection algorithm** using binary trees. Linear time complexity and low memory requirement.
- **Data**: **pre-recorded videos** from the laboratory showing both anomalies and normal reactions are used to **train the model**.
- **Notification system**: Chatbot for **Telegram**.
- **Cloud** access: Use an Azure cloud to **upload images** of the anomalies taken by the Raspberry Pi to be used for further training and model improvement.
- **MlFlow**: used to **log and compare** the performance of the models, **upgrade our model** to the best-performing or last-updated one.



Results

We have successfully delivered a **product** that can:

- **Monitor** the experiment **in real-time**.
- **Log the images** captured by the camera.
- Use and upgrade anomaly **detection algorithms** trained on **real data.**
- **Notify the problem** through Telegram, announcing that **an anomaly has occurred**.

Future work

- As of yet, the detection algorithm is trained on **too little data**. With more data available, it **can easily be upgraded** in the future.
- The **user interface** can be improved.

Image sources:
[1] https://www.genengnews.com/topics/bioprocessing/new-bioreactor-model-could-accelerate-process-development/; [2] https://freepngimg.com/png/140057-picture-eyes-vector-free-download-image;
[3] https://www.circuitbasics.com/introduction-to-the-raspberry-pi-camera/; [4] https://www.stratascratch.com/blog/machine-learning-algorithms-explained-anomaly-detection/
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