Imperial College London

BMVC 2022

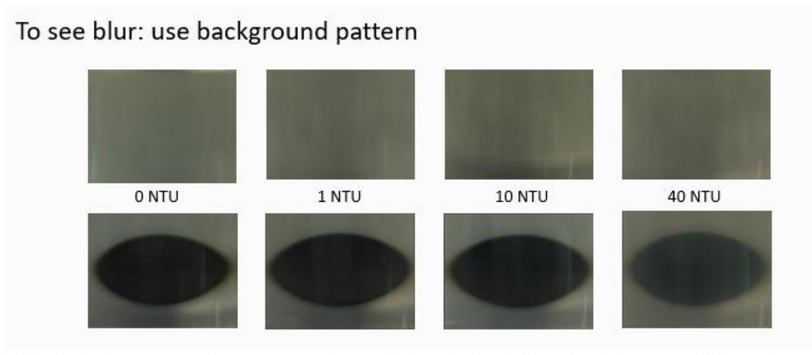
Estimating Water Turbidity from a Smartphone Camera

Lina Maria Lozano Wilches, Chotiwat Jantarakasem, Laure Sioné, Michael R. Templeton, Krystian Mikolajczyk

- The study successfully demonstrates that water turbidity can be estimated with high accuracy.
- It uses only a smartphone camera and a simple CNN architecture.
- Confirmed under various settings:
  - Solutions: Formazine and Kaolin Clay (organic and inorganic).
  - Containers: Glass vial, clear and tinted plastic bottle.
  - Water colour: clear and yellow concentrations.
  - Lighting: artificial and clear.
  - Holder: tripod and handheld.

Introduction

- Water is essential for humans
- Water quality is measured using turbidity
  - It is the scattering or attenuation of light from a variety of sources
  - Measured in NTU
  - Not a direct threat, but quick and reliable measure
- The solution is simple and widely available considering that 63% of the global population has access to a smartphone

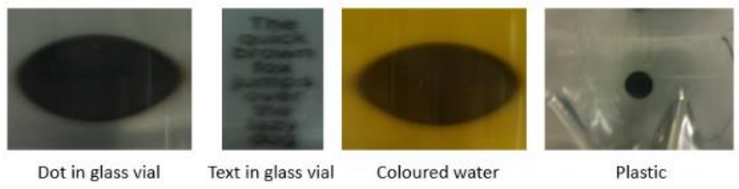


Turbidity in the images can be seen as a form of blur. Distinguishing the different turbidity values naked eye is hard. A background pattern brings more differentiation.

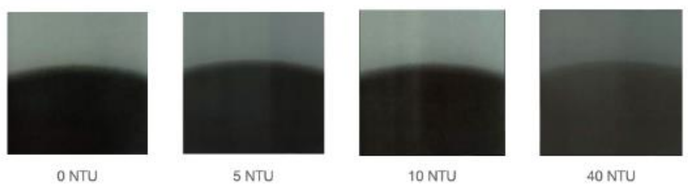
Methodology

- Data Collection:
  - No readily available dataset
  - Turbidity can be seen as a form of blur
  - Settings to minimize in-camera preprocessing and blur
  - Artificial samples 0 – 40 NTU
- Preprocessing:
  - Remove unnecessary elements of the original image and create smaller images that focus only on the parts where the blur is best seen
- Model Architecture:
  - Small model to make inference as efficient as possible

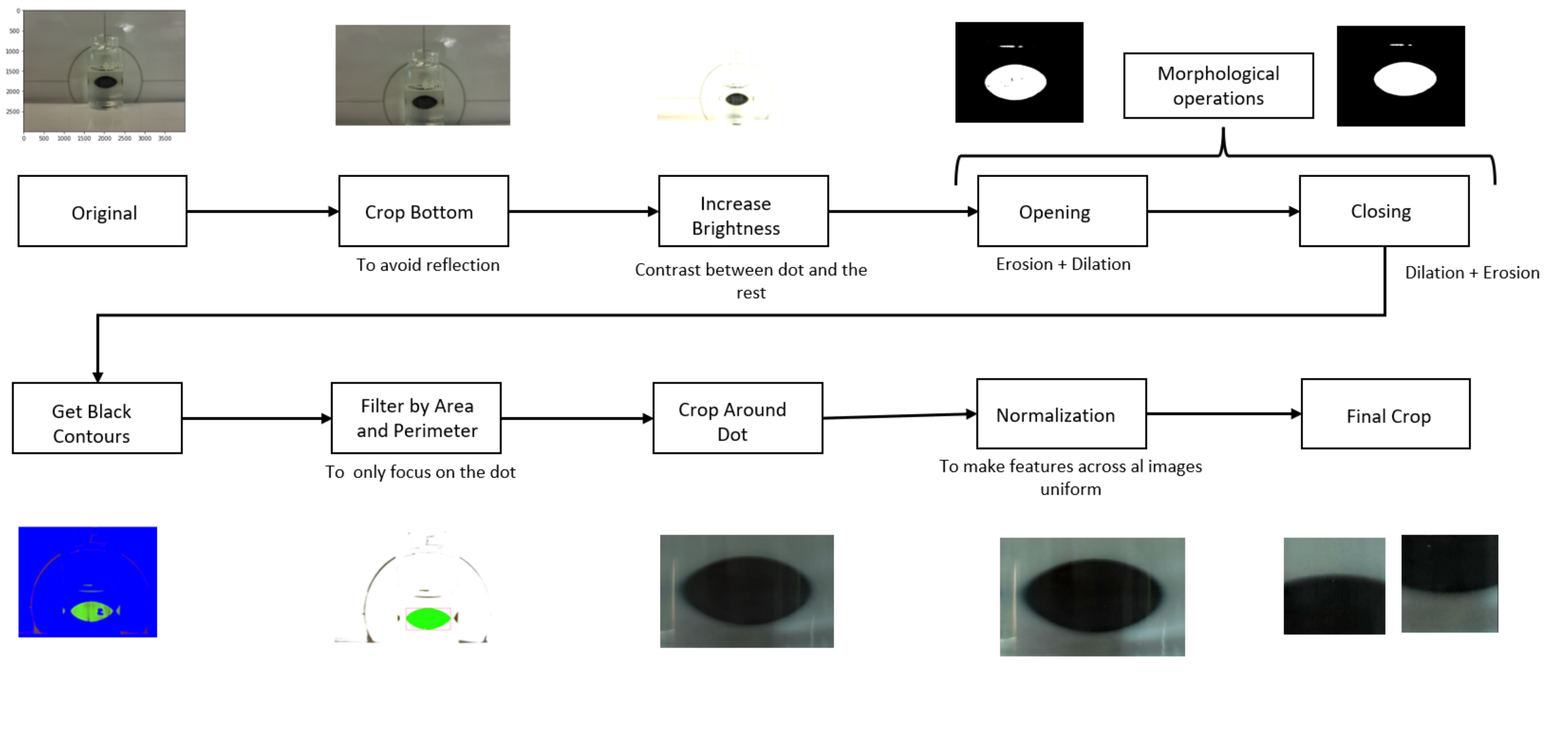
Three dataset collection set-ups. Left: glass container, tripod and indoors. Middle: plastic bottle, tripod and indoors. Right: window, handheld smartphone and plastic bottle.



Cropped pictures from the different datasets.



Sample pictures after preprocessing for different NTU in the Formazine dataset.



Preprocessing Pipeline.

Results

- Successfully demonstrates that water turbidity can be estimated with high accuracy by only using a smartphone camera and a simple CNN architecture
- The CNN achieves high performance when trained from a sample of that dataset for the 0 – 40 NTU range, which is the common range for drinkable water turbidimeters
- The experiments were conducted in a way to reproduce field conditions as closely as possible

Dataset	Formazine	Text	Kaolin Clay	Plastic	Yellow	Natural Tinted	Natural Clear
# Images	15397	2522	2149	1256	5897	1224	1228
Acc (%)	97.34	96.43	91.16	99.20	98.05	95.92	99.59
RMSE	0.0559	0.2046	0.3300	0.2947	0.0964	0.3188	0.0180

Table reflecting the datasets, the number of images, accuracy and root mean squared error for each of the datasets.

Further Work

- Further relaxation of the controlled conditions to make the methodology for the data collection simpler for its exploitation in the field
- Extensions such as data augmentation or domain adaptation to improve generalisation properties