

## Background

Developing countries suffer from social inequalities, poverty and limited access to electricity, sanitation and transport facilities, vertical axis turbines can offer:

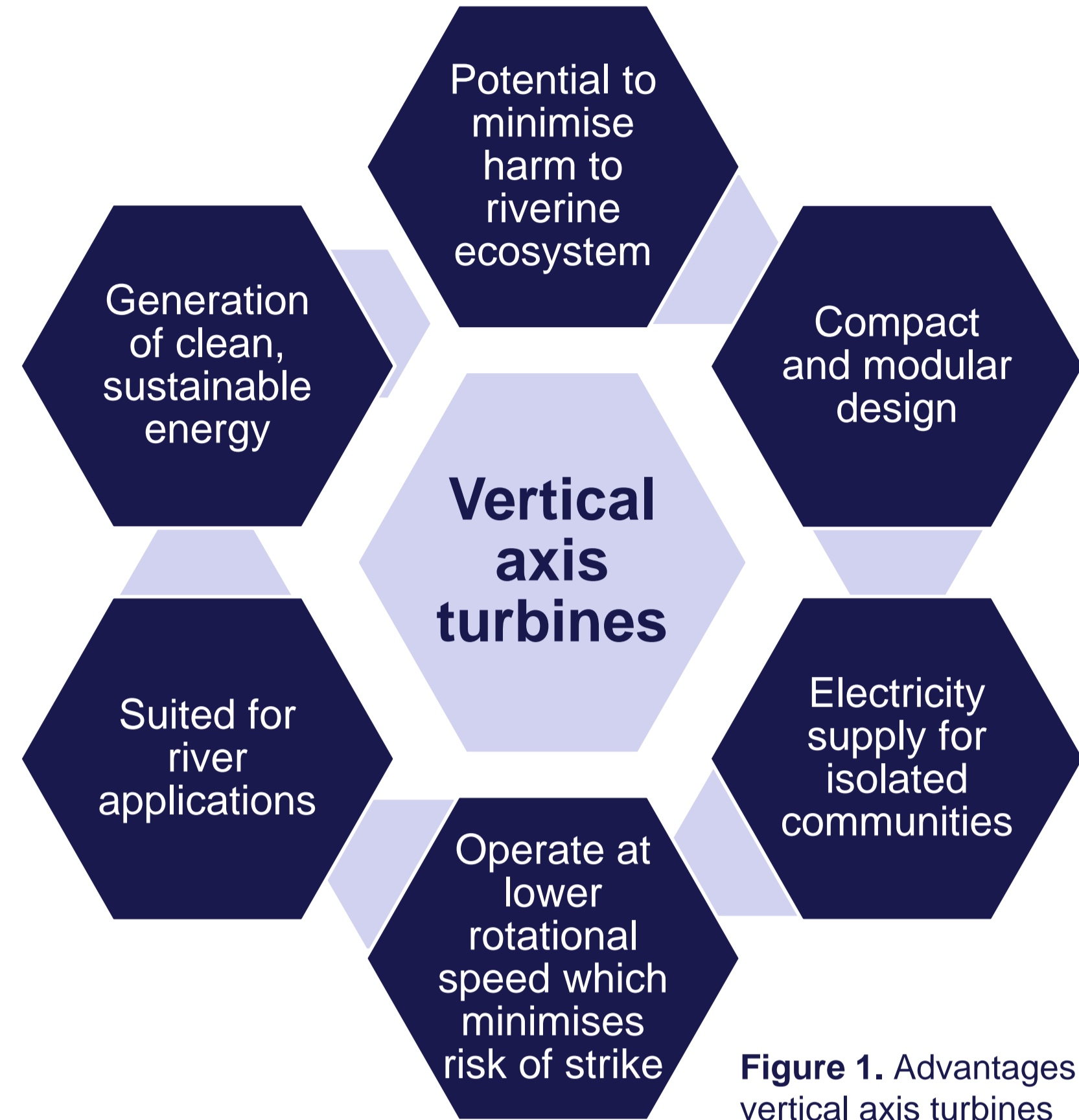


Figure 1. Advantages of vertical axis turbines

Flow alterations caused by turbines and risk of collision may prevent fish migration and harm fish

## Key observations

Near wake characterised by low momentum area which is skewed towards the left-hand side of the flume due to anti-clockwise rotation of turbine

Tip vortices develop during up- and downstroke rotation of turbine

Fish were not harmed while swimming close to turbine or passing

## Next steps

Mapping of fish swimming trajectories to flow visualisation and velocity measurements

Extraction of key swimming kinematics

Fish tracking through turbine arrays in 1.2 m wide flume

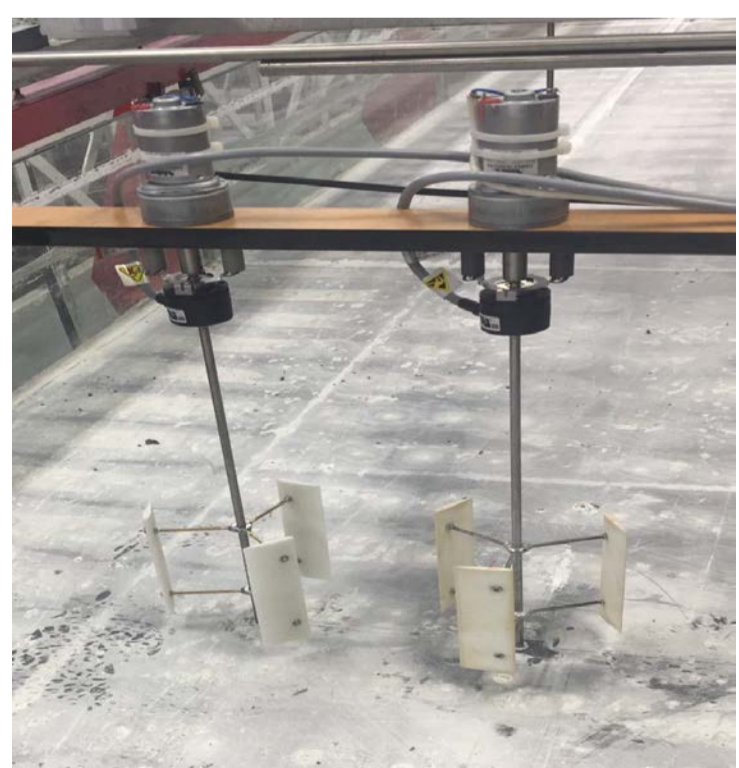


Figure 6. Twin-turbine set-up

# Tracking fish swimming trajectories through vertical axis turbine arrays

Stephanie Müller<sup>1</sup>

Dr. Catherine Wilson<sup>1</sup>, Dr. Pablo Ouro<sup>1</sup>, Prof. Jo Cable<sup>2</sup>



Figure 2. Snapshot of fish swimming close to turbine

## Research Aims

- Tracking fish motion in the vicinity of a single vertical axis turbine by developing a motion tracking algorithm using Matlab
- Analysis of spatial usage and fish swimming kinematics e.g. tail beat frequency, head angle, body undulation
- Mapping of habitat preference and swimming trajectories to hydrodynamic measurements

Hydrodynamic measurements

Power output and array arrangement analysis

Motion tracking

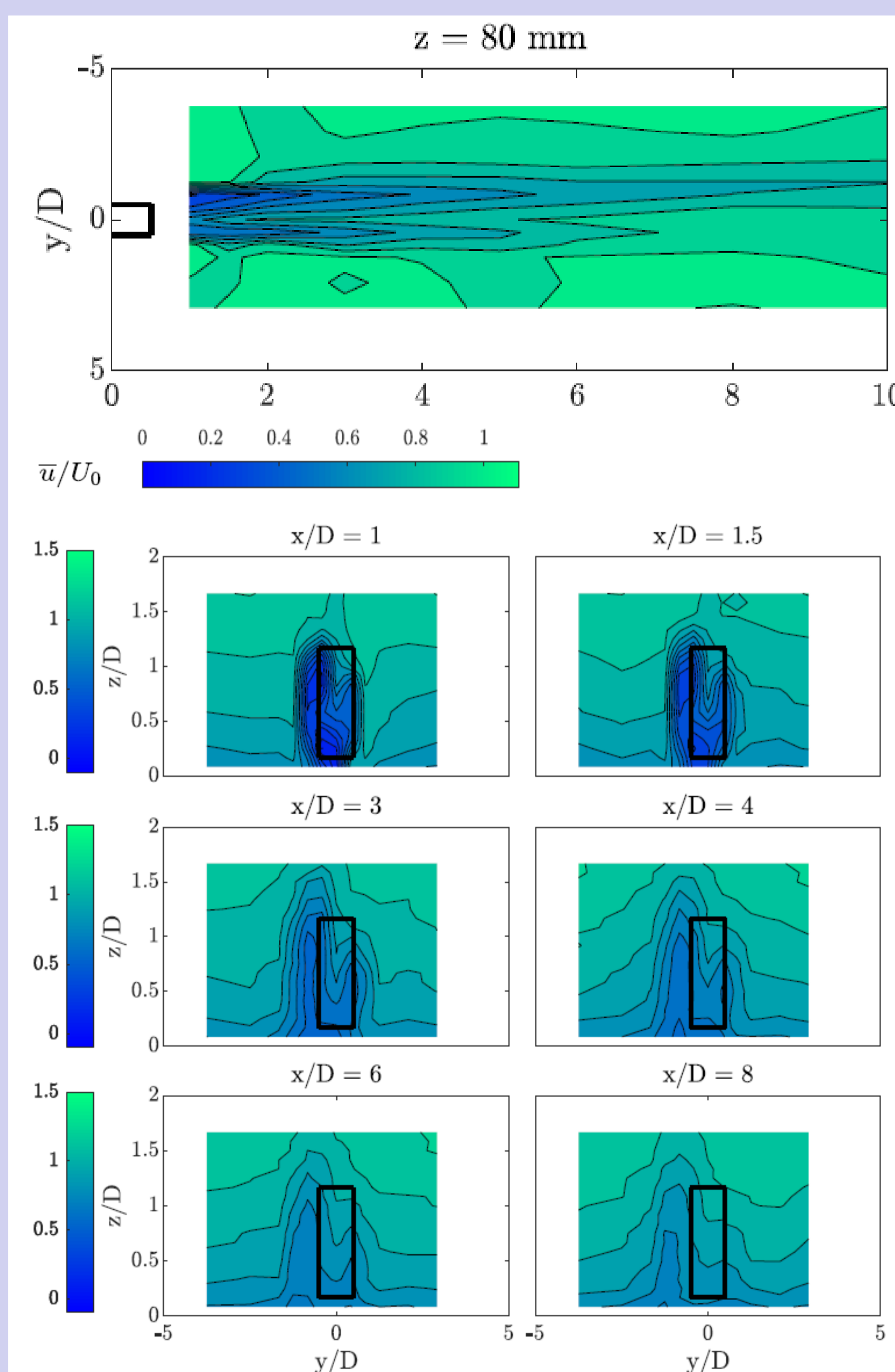


Figure 3 (left). Contour plot (y-x plane) at mid-turbine height ( $z=80$  mm) showing non-dimensionalised longitudinal mean velocities (measurements conducted in 1.2 m flume)

Figure 4 (below). Cross-section contour plots (y-z plane) showing non-dimensionalised longitudinal mean velocity for nine distances in longitudinal direction ( $x/D$ ) downstream of turbine

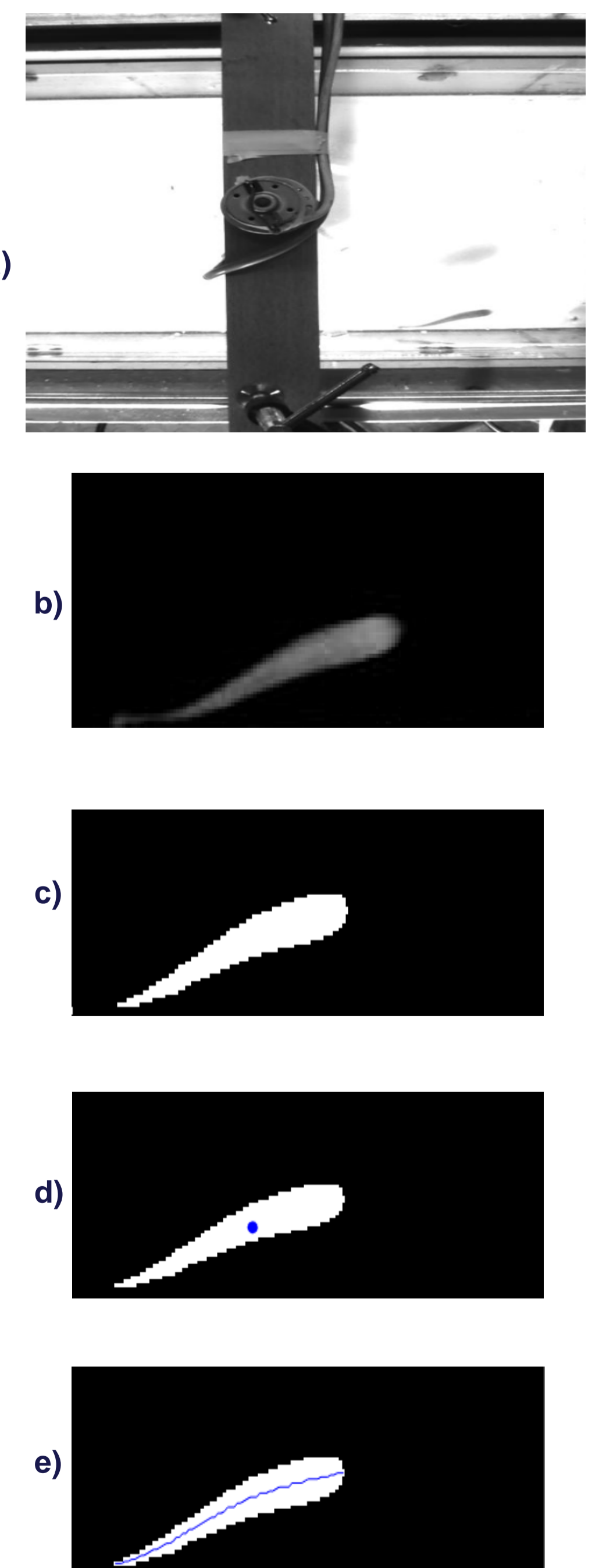


Figure 5. Motion tracking algorithm: a) camera top view, b) background subtraction, c) image binarization, identification of d) centre of mass (COM) and e) fish centreline

## Contact details

Stephanie Müller  
E-Mail: [MullerS1@Cardiff.ac.uk](mailto:MullerS1@Cardiff.ac.uk)

<sup>1</sup> School of Engineering, Cardiff University, CF24 3AA, UK  
<sup>2</sup> School of Biosciences, Cardiff University, CF10 3AX, UK

## Acknowledgement

Funded as part of the Water Informatics Science and Engineering Centre for Doctoral Training (WISE CDT) under grant from the Engineering and Physical Science Research Council (EPSRC), grant number EP/L016214/1