Robust Automatic Identification of Microplastics using AI-vision
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ABSTRACT
Microplastics (<5 mm) are now becoming a global pollution concern, and still, there is a lack of technologies for the real-time detection of microplastics in the water bodies. Therefore, this study aims to develop AI-vision-enabled techniques to detect microplastics in aquatic environments. Image collection was performed in the lab environment with a Logitech C270 camera, and the microplastics were manually annotated on those images before being applied for model training. We employed Yolov5 model for object detection and for real-time object tracking, we used Simple Online and Realtime Tracking with a Deep Association Metric (DeepSORT). This system can detect up to 34 real-time object tracking, we used Simple Online and Realtime Tracking with a Deep Association Metric (DeepSORT). This system can detect up to 34 cm/sec of water velocity and successfully detect track, count, and calculate the velocity of microplastic of size 5mm.

INTRODUCTION
- Microplastics (MPs) are polymer particles with size less than 5 mm,
- MPs are one of the most environmental concerns by United Nations (UN) [2],
- By 2050, There may be more plastics than fish in the ocean, by weight, WEF [3]
- We collected videos using a Logitech C270 camera in a lab environment for training.

METHODOLOGY
- After capturing the frame, the frame is passed to object detection model
- If object is detected, then the information is passed to DeepSORT for tracking
- There are two imaginary lines placed in the frame for calculation
- When MPs pass first line we start counting,
- When MPs pass second line we calculate velocity from the time difference and distance.

EXPERIMENTAL SETUP
- The experiment was performed in a 12 m long and 0.45 m wide, recirculating open channel flume with a slope of S0 = 0.005.
- A transparent flume bed with no large roughness elements (boulders, vegetation, etc.) The flow rate was recorded by using pressure gauges connected to a computer and the velocity profile was calculated with Acoustic Doppler velocimeter (ADV).
- The two different kinds of Microplastics (MPs): polystyrene (PS) (4.9 mm) and Cellulose Acetate (CA) (2.3 mm) were released from the height of 41 cm and the movement of the MPs were tracked with the Logitech C270 USB camera.

MODEL SELECTION AND TRAINING
- We choose smaller and faster model as our plan is to run real-time detection.
- In Yolov5 most accurate model is Yolov5x, we did not use because is large
- Compared to Yolov5, Yolov5s is smaller and less accurate.
- So we chose Yolov5s for our project, keeping accuracy and speed in mind.

RESULT AND DISCUSSION
- Figure 3. GPU speed and average precision of comparison among Yolov5 models and EfficientDet. EfficientDet is also a small and faster model that runs on embedded devices. From Figure 4, we can see that Yolov5 performs better than EfficientDet.
- Collected over 2000 images of microplastics (<5mm)
- Annotated all images manually using labelling [4]
- Randomly divided as 80% for training, 10% for test, 10% for validation
- Ran the training for 300 epochs
- As simply object detection options don't work well for counting moving objects, we used Deep SORT to track objects instead.

<table>
<thead>
<tr>
<th>Si</th>
<th>Water Velocity (cm/sec)</th>
<th>Accuracy (5mm)</th>
<th>Accuracy (1mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.07</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>2</td>
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<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>3</td>
<td>34</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 1. Shows the system can detect up to 35 cm/sec; faster than that, accuracy reduces. With 1 mm microplastic, the system can accurately detect water velocity up to 20 cm/sec and fails to detect over 30 cm/sec.

FUTURE WORK
- Need to provide more data to increase the accuracy of the model
- We will study on different high-resolution camera for more accurate detection
- We want to add different MPs types (colors, sizes, shapes)
- Implement in the rivers and check the accuracy of the model.

REFERENCES