Jyothi Engineering College
NAAC Accredited College with NBA Accredited Programmes*
Approved by AICTE & affiliated to APJ Abdul Kalam Technological University
A CENTRE OF EXCELLENCE IN SCIENCE & TECHNOLOGY BY THE CATHOLIC ARCHDIOCESE OF TRICHUR
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NBA accredited B.Tech Programmes in Computer Science & Engineering, Electronics & Communication Engineering, Electrical & Electronics Engineering and Mechanical Engineering valid for the academic years 2016-2022. NBA accredited B.Tech Programme in Civil Engineering valid for the academic years 2019-2022.

Ship Detection Using SAR Imagery

Group No. : 17

Department of CSE

Jyothi Engineering College

Thrissur

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Group Members

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GIT : https://github.com/NithinPeter-GIT/Group-17_final_project

Vision of the Department

- Creating eminent and ethical leaders in the domain of Computational Sciences through quality professional education with a focus on holistic learning and excellence.

Mission of the Department

- To create technically competent and ethically conscious graduates in the field of Computer Science and Engineering by encouraging holistic learning and excellence.
- To prepare students for careers in Industry, Academia and the Government.
- To instill Entrepreneurial Orientation and research motivation among the students of the department.
- To emerge as a leader in education in the region by encouraging teaching, learning, industry and societal connect.

Course Outcomes

C410.1 The students will be able to analyse a current topic of professional interest and present it before an audience.

C410.2 Students will be able to identify an engineering problem, analyse it and propose a work plan to solve it.

C410.3 Students will have gained thorough knowledge in design, implementations and execution of Computer science related projects.

C410.4 Students will have attained the practical knowledge of what they learned in theory subjects.

C410.5 Students will become familiar with usage of modern tools.

C410.6 Students will have ability to plan and work in a team

CO Mapping to POs

	POs											
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
C410.1	3	2	3	2	3	3	2	3	3	2	3	3
C410.2	2	3	3	3	3	3	2	3	2	3	3	3
C410.3	3	2	3	3	3	2	3	3	2	3	3	3
C410.4	3	3	3	2	3	3	3	2	3	3	3	3
C410.5	2	3	2	3	2	3	2	3	2	3	2	2
C410.6	3	3	3	2	2	3	2	3	2	3	2	2
Average	2.67	2.67	2.83	2.5	2.67	2.83	2.33	2.83	2.33	2.83	2.67	2.67

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Introduction

- In this project we present an innovative way to detect ships in the ocean using SAR image
- Detection of ships is complicated, especially under unfavourable conditions, such as during night-time or on cloudy days
- Locations of ships in the ocean can be useful in many situations like finding route,search & rescue, surveillance, fisheries management, etc.

Objectives

- Build a ship detection system for SAR images
- Make a system that has high accuracy
- Increase the speed of the system without sacrificing accuracy

Abstract

- Ship detection plays an important role in marine transportation, fishery management, and maritime disaster rescue.
- Current research is focusing on improving detection accuracy while detection speed is neglected.
- Synthetic aperture radar (SAR) imagery has been used as a promising data source for monitoring maritime activities
- YOLO is a network for object detection.
- We are proposing a new and better method for ship detection using YOLO.

Literature Survey

- Improved YOLOv3
  - High detection Speed
  - Low amount of resources
- YOLOv3-Ship
  - High accuracy for large and medium objects
  - use of SE module for better performance
- Using CNN approach for ship detection in Sentinel-1 SAR imagery
  - Ships are categorized into small medium and big
  - This method helps to maintain a real time surveillance of ships with its size and route

Literature Survey

- Significance of ship based detection from SAR imagery
  - The algorithm used is simple and easy to implement.
  - process of target detection is less complex
- Classification of Patterns
  - The main advantage of this fusion method comes in the proper differentiation of patterns within homogeneous and heterogeneous areas where the existing methods fails.
  - Computational complexity gets reduced due to the usage of block wise estimation.

Proposed System

- High speed ship detection using YOLO
- Fast detection means we can have real time detection is possible
- SAR images are used so that we can detect ships even in adverse weather conditions

Requirements

Functional Requirement

- Ship detection from SAR Images
- Detection of ships in adverse weather conditions

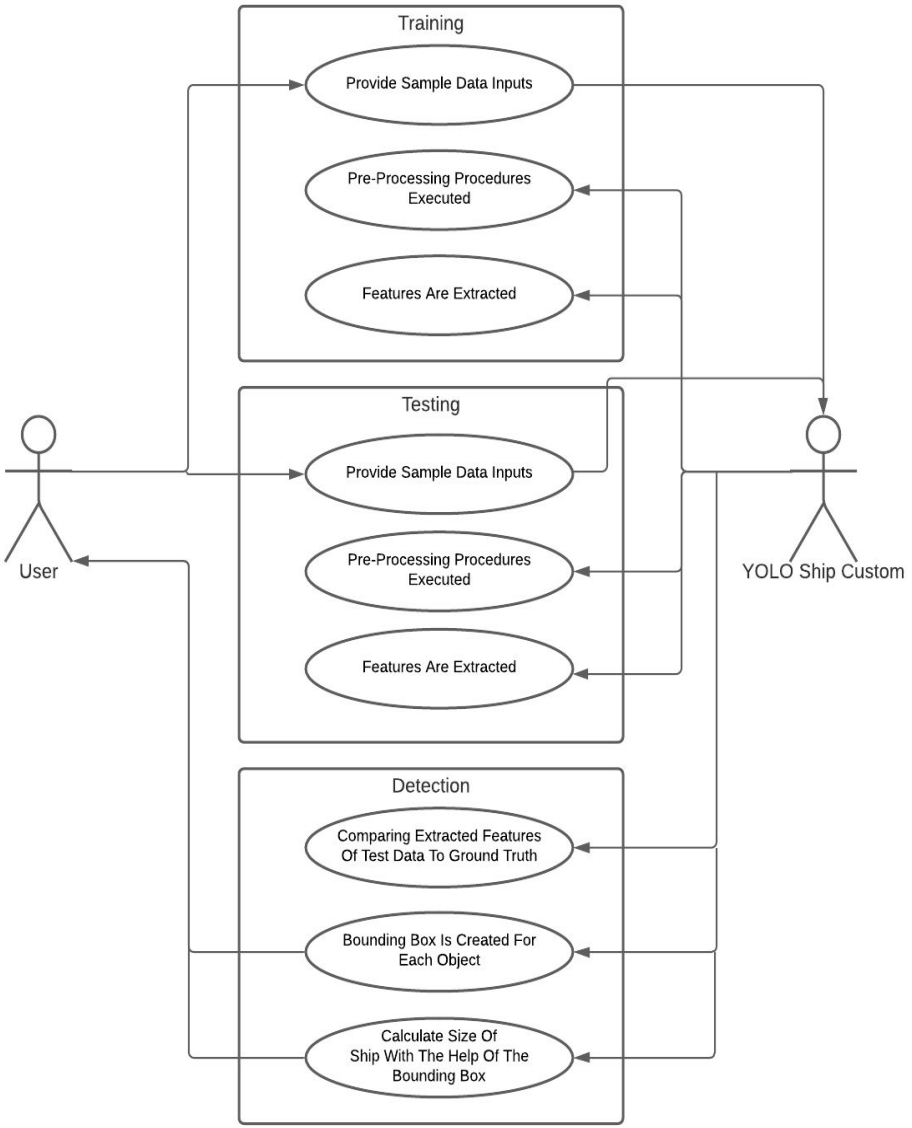
Non-Functional Requirement

- The System should be scalable
- The system should be secure

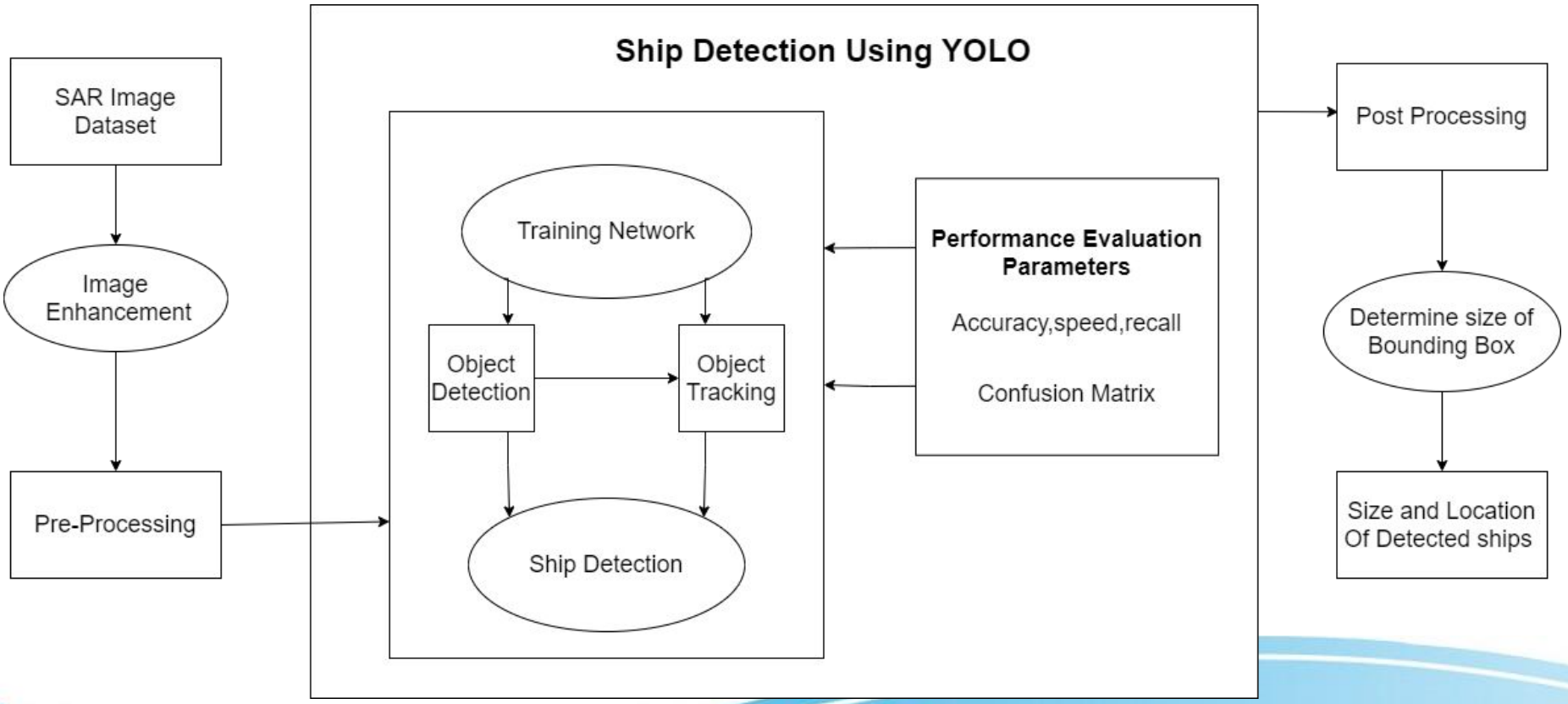
Modules

- **Data Acquisition Module**
  - SAR image dataset collection
  - Set the sample size
- **Image Enhancement Module**
  - Noise Reduction
  - Size Correction
- **Ship Detection Module**
  - Features are extracted
  - YOLO detection algorithm is used
  - Location of ships are identified

UML Diagram


Training
Provide Sample Data Inputs
Pre-Processing Procedures Executed
Features Are Extracted
Testing
Provide Sample Data Inputs
Pre-Processing Procedures Executed
Features Are Extracted
Detection
Comparing Extracted Features Of Test Data To Ground Truth
Bounding Box Is Created For Each Object
Calculate Size Of Ship With The Help Of The Bounding Box
User
YOLO Ship Custom

DFD


Ship Detection Using YOLO
SAR Image Dataset
Image Enhancement
Pre-Processing
Training Network
Object Detection
Object Tracking
Ship Detection
Performance Evaluation Parameters
Accuracy,speed,recall
Confusion Matrix
Post Processing
Determine size of Bounding Box
Size and Location Of Detected ships

Implementation

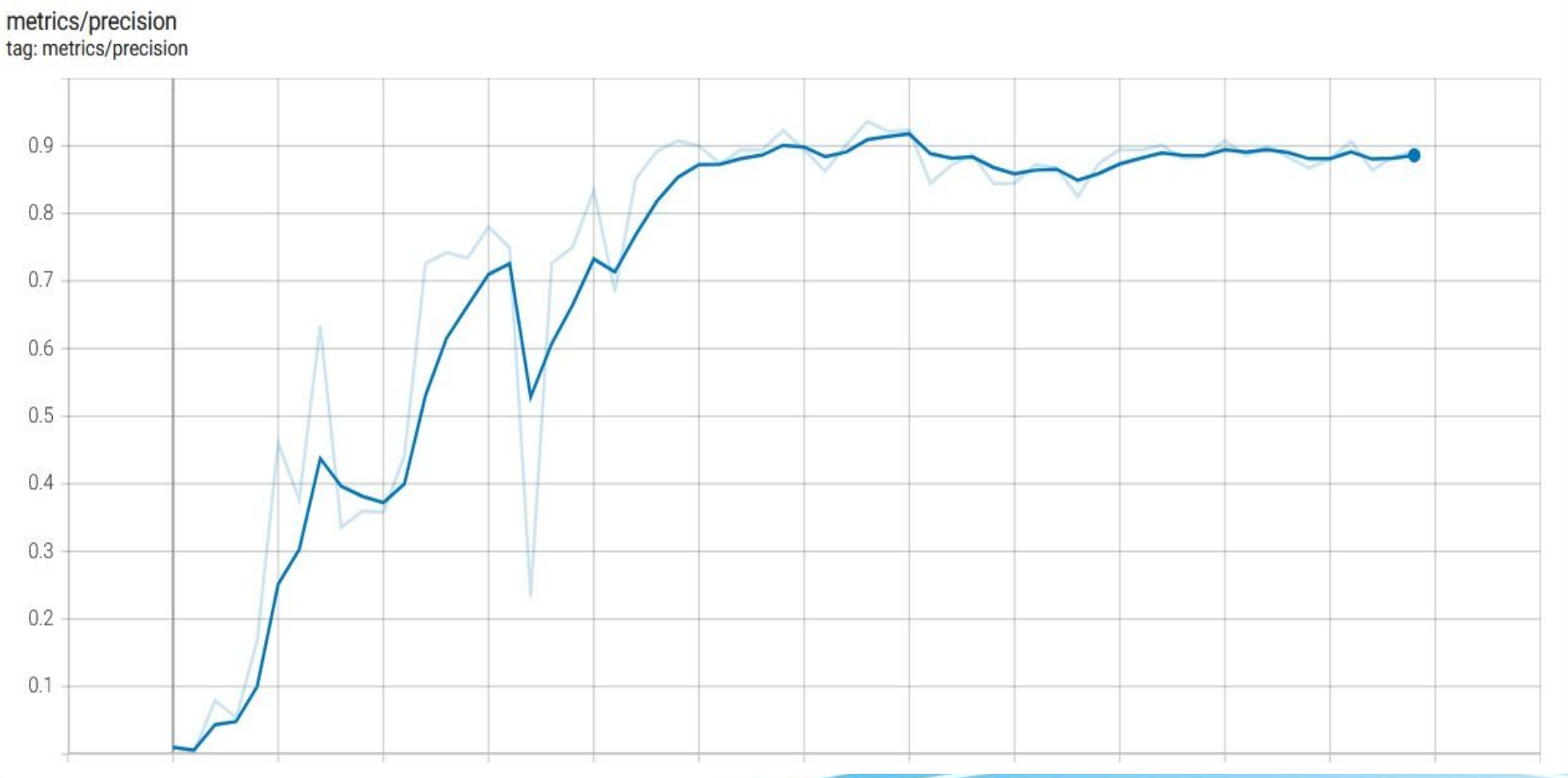
- We use the HRSID database for our project
- The database was initially in the MS COCO format which was then converted into the required YOLO format
- All the images in the database were resized to 416x416px
- Image augmentation steps were added to vary the images in the database
- The set of images were then divided into training, validation, and test sets with a 70:20:10 ratio

- For implementation we trained our model with 70% images from the dataset which after augmentation came to a total of 15000 images
- We are training our model on YOLOv5 which is made using Pytorch
- For our initial training we used the smallest variation of YOLOv5 called YOLOv5s
- Size and number of layers are reduced so as to increase the speed of execution, reduce the memory usage and for the minimal usage of data

- Training was done only for 60 epochs and the highest precision is stored in best.pt
- After training we were able to get a precision value 93.6%
- It only takes an average of 10ms for detection of images
- Using the weight of the best iteration ships are detected
- Labels are obtained which contains X-Y coordinates, width and height for each bounding boxes within the image
- Size and Location of each ship is calculated so as to ease the surveillance of ships

```
# train yolov5s on custom data for 100 epochs
# time its performance
%%time
%cd /content/yolov5/
!python train.py --img 416 --batch 16 --epochs 60 --data '../data.yaml' --cfg ./models/custom_yolov5s.yaml --weights '' --name yolo
```

```
     Epoch   gpu_mem       box       obj       cls     total   targets  img_size
     33/59     0.721G   0.01916  0.006185         0   0.02534         3       416: 100% 736/736 [01:00<00:00, 12.10it/s]
               Class      Images     Targets         P         R      mAP@.5  mAP@.5:.95: 100% 35/35 [00:04<00:00,  7.34it/s]
                 all    1.12e+03    3.31e+03     0.936      0.44       0.531       0.341

     Epoch   gpu_mem       box       obj       cls     total   targets  img_size
     34/59     0.721G   0.01863  0.006112         0   0.02475         3       416: 100% 736/736 [01:00<00:00, 12.11it/s]
               Class      Images     Targets         P         R      mAP@.5  mAP@.5:.95: 100% 35/35 [00:04<00:00,  7.46it/s]
                 all    1.12e+03    3.31e+03     0.921      0.431       0.512       0.333

     Epoch   gpu_mem       box       obj       cls     total   targets  img_size
     35/59     0.721G   0.01801  0.006029         0   0.02404         3       416: 100% 736/736 [01:00<00:00, 12.13it/s]
               Class      Images     Targets         P         R      mAP@.5  mAP@.5:.95: 100% 35/35 [00:04<00:00,  7.59it/s]
                 all    1.12e+03    3.31e+03     0.924      0.482       0.552       0.354

     Epoch   gpu_mem       box       obj       cls     total   targets  img_size
     36/59     0.721G   0.01807  0.005951         0   0.02402         3       416: 100% 736/736 [01:00<00:00, 12.07it/s]
               Class      Images     Targets         P         R      mAP@.5  mAP@.5:.95: 100% 35/35 [00:04<00:00,  7.66it/s]
                 all    1.12e+03    3.31e+03     0.844      0.578       0.615       0.379
```


metrics/precision
tag: metrics/precision
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

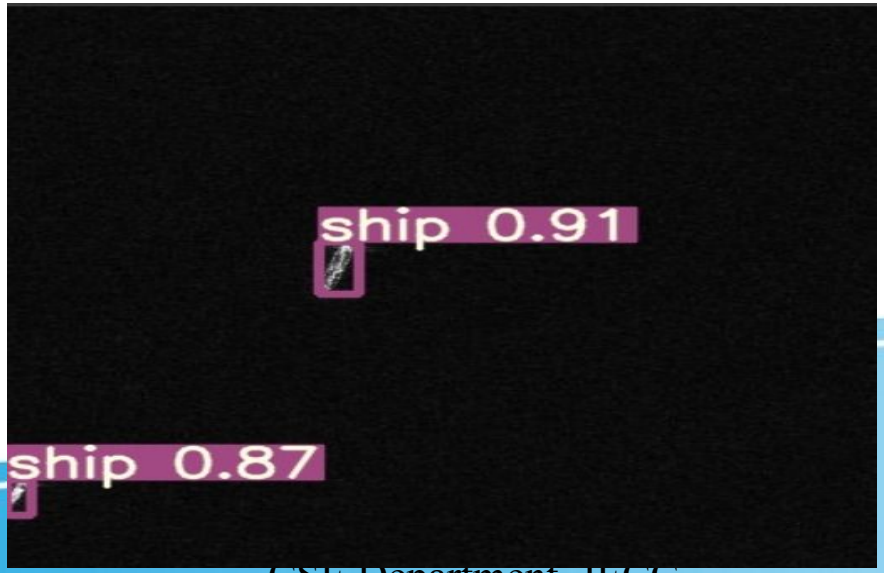
```
# use the best weights
%cd /content/yolov5/
!python detect.py --weights runs/train/yolov5s_results/weights/best.pt --img 416 --conf 0.4 --source ../test/images --save-txt
```

```
lov5/../test/images/P0014_4200_5000_2400_3200_jpg.rf.ce9e3dd5b405a6a7e0196d4075e15c16.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0014_4560_5360_6600_7400_jpg.rf.cf88da3124413ddf270f47fd795d4ef8.jpg: 416x416 1 ship, Done. (0.007s)
lov5/../test/images/P0015_0_800_7200_8000_jpg.rf.2ffb573e32947e2ff9c159fd29ecb15b.jpg: 416x416 7 ships, Done. (0.006s)
lov5/../test/images/P0015_0_800_7800_8600_jpg.rf.191da564f7cc6beb2aa64c626c6e1b43.jpg: 416x416 2 ships, Done. (0.006s)
lov5/../test/images/P0015_2400_3200_3000_3800_jpg.rf.b09fa5f734469af62d2f18908a428fc8.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0015_3000_3800_4200_5000_jpg.rf.2d4b264c3e59a61e4f830ffcbb017dce.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0015_4800_5600_2400_3200_jpg.rf.8823195a219d714a276969d240879764.jpg: 416x416 2 ships, Done. (0.006s)
lov5/../test/images/P0016_1200_2000_4200_5000_jpg.rf.5808e6aa83df5e18ff637973a83159d0.jpg: 416x416 2 ships, Done. (0.007s)
lov5/../test/images/P0016_3000_3800_0_800_jpg.rf.d9a5551a24f24ea68c3f151139f0057d.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0016_3000_3800_600_1400_jpg.rf.c367541b029ff6b3231ce437ee5faab5.jpg: 416x416 2 ships, Done. (0.007s)
lov5/../test/images/P0016_4910_5710_0_800_jpg.rf.cd14a81fa281e4c8b7759c2f9425971d.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0017_1200_2000_5400_6200_jpg.rf.e149592bfc83ed3464115ed699c62cda.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0017_2400_3200_1800_2600_jpg.rf.e212518b0e17a3d2aca82b6f8dda5754.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0017_3000_3800_1800_2600_jpg.rf.4cc5b02a508e811a2f93212a3d43d277.jpg: 416x416 2 ships, Done. (0.006s)
lov5/../test/images/P0017_4800_5600_3000_3800_jpg.rf.42e0a74b3971b3d4b6876966637c6f73.jpg: 416x416 1 ship, Done. (0.007s)
lov5/../test/images/P0017_4800_5600_7200_8000_jpg.rf.eddebe4d8697f8c7476d562eb0e18d83.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0017_600_1400_7800_8600_jpg.rf.64d7cd92ead73c0fac1ff3b833417265.jpg: 416x416 2 ships, Done. (0.006s)
lov5/../test/images/P0018_1200_2000_3000_3800_jpg.rf.53d85791438373a5584642d6fc1705aa.jpg: 416x416 1 ship, Done. (0.006s)
lov5/../test/images/P0018_1800_2600_4800_5600_jpg.rf.77d982a62deff05308f7c6b610e47aa7.jpg: 416x416 2 ships, Done. (0.006s)
olov5/../test/images/P0018_4800_5600_6600_7400_jpg.rf.66e7cb961bc52cdb867bc7357f43e294.jpg: 416x416 2 ships, Done. (0.006s)
olov5/../test/images/P0018_600_1400_8889_9689_jpg.rf.4f9c0cc03132e1216ef1ceff3a36f1e9.jpg: 416x416 1 ship, Done. (0.006s)
olov5/../test/images/P0019_1200_2000_7800_8600_jpg.rf.7ceb4d5399b2b73eb6eddc0e4be6deb5.jpg: 416x416 1 ship, Done. (0.006s)
olov5/../test/images/P0019_4200_5000_1800_2600_jpg.rf.4118376df2af29917e69eadda7728167.jpg: 416x416 1 ship, Done. (0.006s)
```

```
0 0.969952 0.810096 0.0168269 0.0192308
0 0.721154 0.575721 0.0144231 0.0600962
0 0.508413 0.111779 0.0264423 0.0552885
0 0.579327 0.959135 0.0432692 0.0528846
0 0.0288462 0.19351 0.0576923 0.0600962
0 0.371394 0.390625 0.0649038 0.0552885
0 0.127404 0.677885 0.0336538 0.0673077

Size : 56.00001279987712
Location : 11.987442777600002,8.351441683199997

Size : 150.00035520018432
Location : 8.912598055200002,5.935222933199999

Size : 253.0001023999488
Location : 6.2833745844000015,1.1523520667999998

Size : 395.99960320008194
Location : 7.1597865276000014,9.887914541999997

Size : 600.0003807999386
Location : 0.35650441656000004,1.9949332919999994

Size : 620.9999903996927
Location : 4.589984167200001,4.0270312499999985

Size : 391.99950719993853
Location : 1.5745605552000002,6.988452041999998
```


ship 0.85
ship
ship 0.89


ship 0.57
ship 0.834
ship 0.52


ship 0.91
ship 0.87

Application

- The Size and location of the ships can be calculated
- It can be used to track incoming and outgoing ships in harbour
- Used for surveillance and by search and rescue teams
- Can be used in fishery management, military surveillance and also by port authorities
- The system is both fast and accurate so it can also be used for real time monitoring

Future Work

- In future we will be able to add the speed calculation of the ship from its wave
- Predict the path of the ships based on its movement patterns

Conclusion

- Ships are detected by applying our model on SAR images
- All the ships within an image are detected along with this their size and location are also identified
- This system can be used in different weather conditions like fog, rain, storm, etc
- Our model has 93.6% accuracy
- The system is very fast and uses less amount of resources

References

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Thank You