Underwater Mine Detection using Image Processing

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Abstract - *Underwater naval mines have been a major threat to naval assets, these naval mines are stationary and were plotted during war times and now they have been acting as threat to naval ships, submarines. Detection of these naval mines has been one of the most challenging task, with advancing modern technology various techniques have been used to detect these mines such as Using Ultrasonic signals, Symbolic pattern analysis of side scan sonar images but detection through image processing has been one of the challenging and efficient one since it can solve the real time problem with less error, the image classification model uses FRCNN(Fast Region Convolutional Neural Network) algorithm to classify the objects as mine or not. The cloud platform is used to monitor the mine and as soon as the changes are observed the Android application will reflect the changes.*

Key Words: **FRCNN, Cloud, Android, TensorFlow, Python.**

1. INTRODUCTION

Mines are explosive devices placed in ocean during war time mines in order to protect sea boundary which can be very dangerous to naval assets, these mine were not lifted back neither diffused once the war had ended so they restrict the movement of ships and submarines over oceans. So, with modern advanced technology various techniques have come into play in order to detect mine, like using UV signals, Sonar images, and image processing model. Other than detecting mine there are other main objectives also such as detecting mine at proper time so that the naval assets can be alerted at right moment and they can be navigated towards safer directions, the detection should be highly precise and accurate else it will be a waste of resource sink it takes more fuel to navigate through a new path towards destination.

2. VARIOUS TECHNIQUES USED IN MODERN DAYS FOR DETECTING MINE

2.1 Using Ultrasonic signals:

In this technique a Machine learning is created using data, which are noted using sample observations made on mines by projecting signals on mines and noting down the observation such as reflecting angle, intensity of reflected signal. This model is trained by this data set, and can be used in classification of objects.

2.2 Symbolic pattern analysis of side scan sonar images:

Sonar images are symbolized by partitioning the data sets based on the information generated from the ground truth. A binary classifier is constructed for identification of detected objects into mine-like and non-mine-like categories. The pattern analysis algorithm has been tested on sonar data sets in the form of images, which were provided by the Naval Surface Warfare Centre.

2.3 Image processing model:

Image classifier model is generated using data set generated by capturing mine images at different angle and at different water density. Once the data set is collected it can be used to train the model using a suitable image classification algorithm, once the training is done this model is projected to detect underwater mines.

Drawback of conventional system:

It is difficult to classify underwater objects using sonar signals for only mine model can be used only to mine and rocks, an iron model present underwater in shape of mine can be as mine. This has a major drawback.

3. PROPOSED SYSTEM

The block diagram of the system is

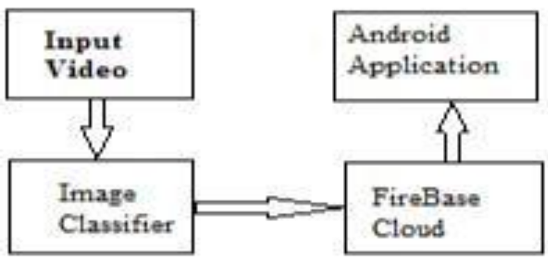

Fig -1: Block diagram of the system

The work is divided into three parts i.e. getting image frame from input video, classifying the objects in frame (finding mine), if mine is present updating in firebase cloud, developing Android application to signal the alert.

3.1 Image Frame acquisition:

Image frames are acquired from input video at rate of 2 fps (frames per second), an high resolution camera should be used so that it can cover large distance and project it and also the camera should be suitable for underwater and is used to capture the video since the salt densities in water varies from various place, the video covered by camera must be classifiable by the model with less errors.

3.2 Object Classification and mine detection:

There are many stages:

- Generating a data set by collecting underwater mine images from various platforms, the images are augmented to different clarities, the images should be captured at different densities of ocean water at different angle.
- Install Anaconda with python 3.7, followed by TensorFlow GPU=1.14.
- Google's TensorFlow object detection API is used which provides the basic framework for the model.
- This dataset is used to generate a mine identifier model, this dataset is classified in 1:4 ratio as training set and test set, in each set the mine is identified using LabelImg software which generates an xml file having the co-ordinates of the mine in images.
- These Xml documents are used to train the model using FRCNN (Fast Region Based Convolution Neural Network) it is an algorithm where it converts the pixel of an image into several pixels and comparing it i.e. the pixel which have high intensity with other pixel and learn about classification.

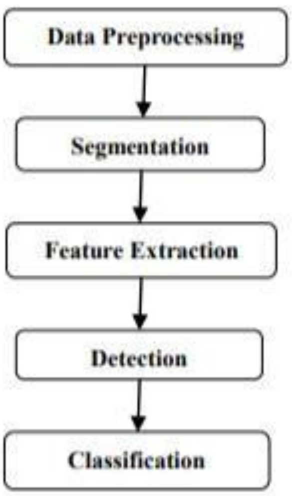

Fig -2: Training procedure of the model

- The Protobuf files are compiled, which are used by TensorFlow to configure model and training parameters. Every .proto file in the \object detection\protos directory must be called out individually by the command.
- A python file is created with labels that were used during mine marking using Labelling master software.
- Training using FRCNN V2 inception model, the training process is done until the loss consistently drops up to 0.05 and it might take up to 10000 cases and 2hrs.
- Once training is completed the export inference graph is generated which will act as a classifier.
- The picture shown below depicts the error loss graph which is decreasing continuously.

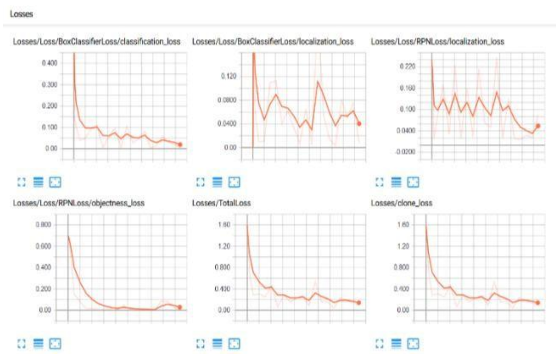

Fig -3: Error loss graph

- Once the training is completed the model is ready to classify the mine in input video frame.

3.3 Updating firebase and Android Application:

The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in Realtime to every connected client. When the input video coverage is given to the model, it classifies the objects in video frame i.e. if mine is present in the frame or not. In case the model detects the object with higher efficiency it updates the variable mine firebase cloud database, which will be monitored by an Android application in a Loop acting as an interface, whenever the mine variable in cloud firebase changes to one the Android Application signals the alert.

3.4 Software Implementation:

This is done using TensorFlow image processing model using FRCNN algorithm and Android Application which acts as an interface, the model and application are connected to firebase cloud platform.

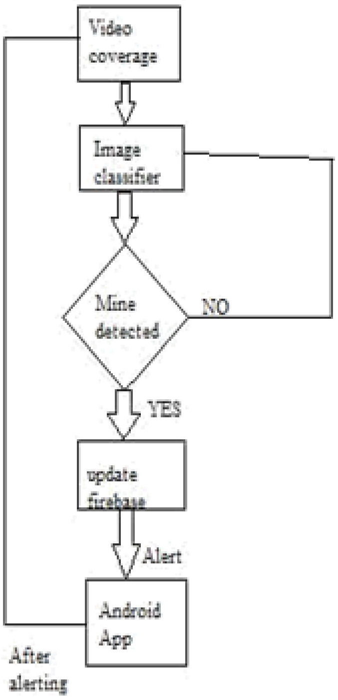

Fig -4: Software implementation flow diagram

4. RESULTS AND DISCUSSION

The following shows detection of mines in image frame given as input to processor.

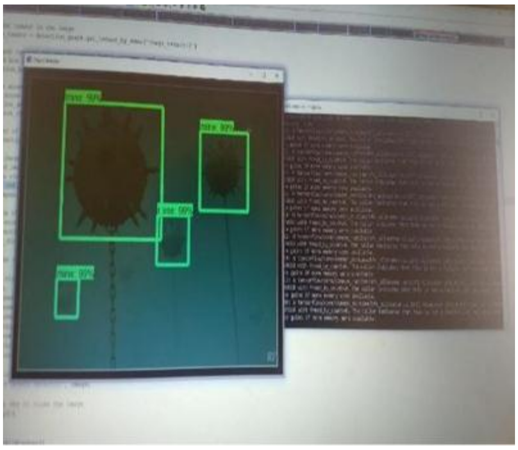

Fig -5: Result showing mine detection

Here is the underwater stationary mines are captured through camera and as soon as the model detects the mine with a probability of more than 0.6 then it updates cloud platform as shown in below picture.

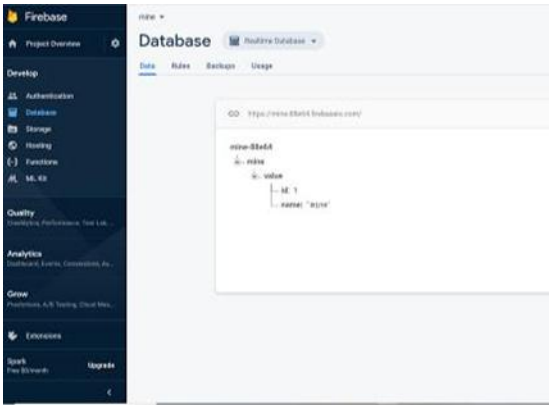

Fig -6: Firebase Database updation

The above cloud is monitored by an application which signals the alert.

Fig -7: Android Application

The proposed system will identify both underwater as well as above water stationary mines.

4. CONCLUSION AND FUTURE WORK

The proposed system successfully identifies underwater mine given an input video and updates the mine variable in cloud which will be monitored by app and as soon as mine is detected the app will signal the alert.

The proposed system can be extended with many upgrades such as, once the model detects the mine, it should also update regarding mine position such as depth, angle, distance .Present model is trained for detecting underwater stationary sphere-shaped mines, but in modern days mines with various shapes are in existence. Hence the model showed be trained with images of different shaped mines of various properties such as different colors, at different depth etc.

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