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Efficient Utilization of Unmanned Aerial Vehicle (UAV) for Fishing through Surveillance for Fishermen

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***Abstract*—**UAV's are small remote operated or automated aerial surveillance systems without a human pilot aboard. UAV's generally finds its use in military and special operation application, a recent growing trend in UAV's finds its application in several civil and non-military works such as inspection of power or pipelines. The objective of this paper is the augmentation of a UAV in order to replace the existing expensive sonar (Sound Navigation And Ranging) based equipment amongst small scale fisherman, for whom access to sonar equipment are restricted due to limited economic resources. The surveillance equipment's present in the UAV will relay data and GPS (Global Positioning System) location onto a receiver on the fishing boat using RF signals, using which the location of the schools of fishes can be found. In addition to this, an emergency beacon system is present for rescue operations and drone recovery.

***Keywords*—**GPS, RF signals, School of fish, Sonar, Surveillance UAV, Video stream.

I. Introduction

WITH the advent of mechanized boats, fishing output has doubled since 1990's, but the average production per fisherman in India is at 2 tons per fisherman compared with China's 6 tons per fishermen. This small output in production is mainly due to lack of sophisticated equipments and also training required for handling and maintaining the equipments.

Current fishing practices/Techniques: Fishing is one of the most important industries for food production. There is a growing demand in this sector. It has its limitations due to the lack of technological development and insufficient funds. As the number of fishing fleet have increased over the years, the need for sophisticated electronic equipments and components such as sensors, sounders and SONARS have also grown. Over the years fishermen have adapted various traditional techniques which include hand gathering, spear fishing, netting, angling and trapping of schools of fish. But these are restricted to small time fishermen. But commercial fishing fleets are mostly dependent on acoustic sonar and sounders to detect fish. Quite often fishermen use active sonar and echo sounder technology to determine water depth, bottom contour, and bottom composition .An array of sensors for underwater measurements and transmit the information back to a receiver on board the boat. The Data is transmitted from the sensors using wireless acoustic telemetry and is received by a hull mounted hydrophone. The analog signals are then decoded and converted by a digital acoustic receiver into data which is transmitted to a bridge computer for graphical display on monitors.

Effect of sonar on marine life: Research has shown that use of active sonar can lead to mass stranding of marine mammals. Some marine animals, such as whales and dolphins, use echolocation systems, sometimes called bio sonar to locate predators and prey. It is conjectured that active sonar transmitters could confuse these animals and interfere with basic biological functions such as feeding and mating.

Effect on fish: High intensity sonar sounds can create a small temporary shift in the hearing threshold of some fish.

Need for alternative equipment's: Instead of using advance sonar based equipment's we plan on using UAV's that would help the fishermen locate the fishes by giving them a bird's eye view of the surrounding ocean surface for beyond normal vision can see. It helps them look for signs of fishes in presence of predatory birds, shadow etc. This reduces ideal waiting time, saves fuel, reduce cost and increases output, thereby reducing illegal fishing practice like the use of Pair trawlers and purse seiners types of nets are banned in India as it damages the ecosystem.

Pair trawlers operate together towing a single trawl. It keeps the trawl open horizontally by keeping their distance during towing. Here Otter boards are not used. Pair trawlers operate both mid water and bottom trawls. This has caused some controversy, due to the high level of marine mammal by-catch associated and the damage to the coral formations which are an important part in the marine ecosystem.

A purse seine is a large wall of netting deployed in sea to capture the school of fish. The seine has floats along the top line with a lead line threaded through rings along the bottom. Once a school of fish is located, a skiff encircles the school with the net. But where purse-seining is a bad idea, when targeting fish that also involves the By-catch of non-target species, which can't take the fishing pressure on their populations.

Another restriction problem faced by fishermen is the lack of emergency communication tool like Satellite Phones which are banned in India due to security reasons. This delays

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response time as it would take a few days for people to notice the missing, trapped or damaged boats [2], [3]. So augmentation of Unmanned Aerial Vehicle is proposed in this paper.

II. Proposed Work of UAV

A. Description

UAV will be fitted with two things (i) a location transmitter (that transmits location at continuous internals) and (ii) an Emergency Beacon as shown in Fig. 1.

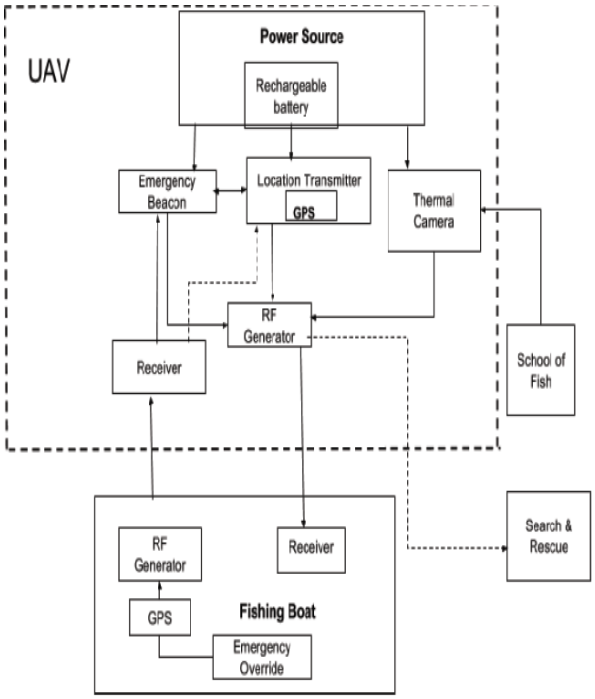

Fig. 1 Block Diagram of Efficient Utilization of UAV for Fisherman

B. The proposed UAV incorporates

Location transmitter: The surveillance equipment's present in the UAV will relay data and GPS location onto a receiver on the fishing boat using RF signals, using which the location of the schools of fishes can be found. It has a dual purpose of transmitting the GPS coordinates for further data analysis.

RF signal generator: These types of signal generators are capable of generating continuous wave signals. The output frequency can usually be tuned anywhere in their frequency range. The RF signal generator is a segment of the chipset used for the control of the UAV and other operations. It is the single most efficient and least complex system. It eliminates the need for a SONAR system.

Thermal Camera: It relay's information on to the boat. Its functionality is to capture pictures of high Resolution and PPI [1]. It has an added trait of night vision and its visibility is not restricted by fog or mist.

Endurance: In order to cover as much distance as possible, especially for surveillance application, the plane has to fly at maximum lift-to-drag ratio condition [4]-[6] refer to (1):

$$\left(L/D\right)_{max} = \frac{1}{2}\sqrt{\frac{\pi \varepsilon b^2}{C_{fe} S_{wet}}} \quad (1)$$

where C_{fe} is the equivalent skin friction coefficient, S_{wet} is the wetted area and S_{ref} is the wing reference area, b is the wingspan. And the term b^2/S_{wet} is known as the wetted aspect ratio.

Electric propulsion system can take up to 60% of the UAV weight [7] as shown in Fig. 2.

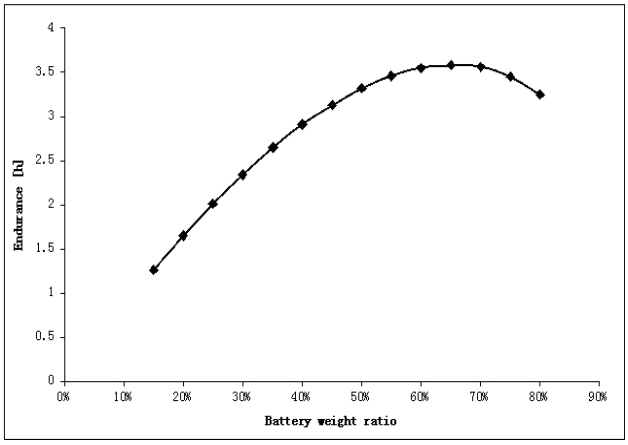

Fig. 2 Typical relationship between endurance and battery weight ratio

By implementing the maximum lift to drag ratio and by ensuring the battery weight is around 60% of the UAV's weight we can ensure that the flight radius of the aircraft is maximized, enhancing loiter time there by ensuring higher probability of detecting fishes as well as improving the duration of the emergency beacon which enhances survival rate in case the operator gets stranded at sea.

Power source: The power source of electric powered UAV is battery. Comparisons of various batteries [8] are given in Table I.

It can be observed that NiCd, has better characteristics compare to other batteries but it requires constant maintenance. Hence we plan to use Lithium polymer battery in electric powered UAV for its relatively high energy density and high discharge rate. It has high flexibility and it's of light weight hence more batteries can loaded onto the UAV without compromising on other parameters. It is also much safer than ordinary Li-ion batteries. Though Lithium polymer batteries are expensive compared to other types of batteries due to high manufacturing cost it is believed that this will come down once mass production facilities start operations in the coming years. Hence we plan on using Lithium polymer batteries in our UAV's in order to maximize the endurance and also keep the cost of operation low.

Design: The UAV will have a delta wing design [9] as it allows for more volume to fit in batteries required to increase

the endurance of the aircraft. It also allows for complex instruments to be fitted on board given its higher surface area.

TABLE I
CHARACTERISTICS OF DIFFERENT RECHARGEABLE BATTERIES

Characteristics	NiCd	Lead Acid	Li-ion	Li-ion polymer
Energy density (wh/kg)	45-80	30-50	110-160	100-130
Cycle life (80% of initial capacity given regular maintenance)	1500	200 -300	300-1000	300-500
Fast charge time (hours)	1 hour	8-16 hours	2-4 hours	2-4 hours
Maintenance requirement	30 to 60 Days	3 to 6 months	Not required	Not required
Battery cost (US dollars)	$50	$25	$100	$100
Cost per cycle (US dollars)	$0.04	$0.12	$0.14	$0.29

Operation: Fig. 3 shows the operation of efficient utilization of UAV for fishing The UAV used here is a customized and augmented vehicle. It has special capabilities and is custom built to achieve a specific goal of helping the Fishermen at large. The UAV is hand launched and autonomous. It circles the boat at 5 km radius and returns near the boat when battery is low. The UAV constantly sends back information back to the boat. The onboard receiving system records flight imagery data signal.

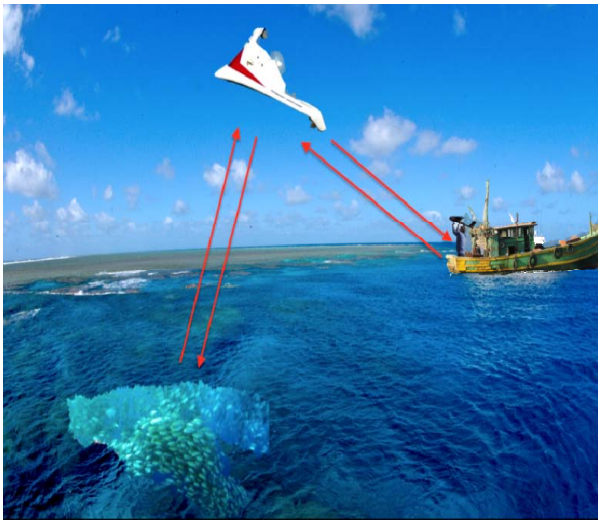

Fig. 3 Pictorial Representation of UAV based Fishing Technique

The UAV will be preprogrammed to be autonomous. All the fisherman has to do is turn it on and launch it. Since it is preprogrammed there is no need to control it, there is an emergency over ride switch which enables its emergency mode (it means that the boat is in trouble and the UAV will seek the nearest boat or move towards land emitting emergency messages which has the GPS location of the boat so that others can come and rescue them). These autonomous features reduce the need for training them in UAV operation. It has a lithium polymer rechargeable battery and a solar panel, which would continuously charge the battery during the day time which increases the endurance of the UAV making it possible to operate it over long stretches of time. The UAV will act as a patrol vehicle. It flies in a limited radius, trying to find the school of fish. It uses the Thermal camera for this purpose. The Thermal camera has good resolution and wide visibility, which will capture the location of the school of fish as a picture and will send this to the UAV for further processing.

Inside the UAV is the presence of a location transmitter. The picture is sent to the RF signal generator. The RF generator would convert this picture to a radio frequency signal for easier transmission of data or picture to the boat. There is a GPS system located inside the UAV. This would generate the GPS coordinates and will send the data to the RF generator, inside which the data is converted to RF signals. Now it is ready for transmission of both the GPS coordinates and the picture to the boat. The boat is fitted with a system, using which data can be seen. There is presence of an emergency beacon in the UAV for search and rescue operations. When a fisherman is in trouble he switches on to the UAV's emergency system. It listens to the location signal of nearby UAV's moving that direction, emitting the SOS (Save Our Ship) signal and the GPS location of the boat, thereby helping them to rescue them before it is too late.

In the absence of nearby UAV's or ships the UAV will move towards the shore and send SOS to the nearest ground station, as it moves towards the shore. In case the batteries are low, the UAV will decent to the water level and emit the signals (It will shut down its systems and use power only for emergency).

III. RESULT AND DISCUSSION

Though this method has various drawbacks compared to sonar it compensate by giving the ability to cover a wider area and also providing a cheaper alternative that does not require constant maintenance and also technical expertise require to operate sonar based equipment's. Unlike sonar even smaller ships can implement UAV based fishing. It also poses the ability to alert neighboring ships with data like location, presence of fishes and potential threads. The UAV ability to act as emergency beacon gives the advantage of being able to save lives on time.

Another potential drawback of UAV is endurance this however can be solved in the coming years given the significant breakthroughs in lithium polymer technologies [10] that exponentially increases the capacity and also significantly reducing the recharging time. Endurance can be further enhanced by using solar powered UAVs [11] that can recharge the batteries during the presence of day light there by increasing loitering time and also enhancing the flight radius of the UAV.

A possible application for UAV is the integration of cloud computing technologies that allows for live monitoring of fishes that could be used to assess the environmental impact as well as help us better understands migratory routes for different species of fishes.

IV. Conclusion

This paper describes the efficient utilization of UAV, an alternative to sonar based equipment's. This proposal reduces ideal waiting time, saves fuel, reduce cost and increases output, thereby reducing the need to use pair trawlers and purse seine which damages the marine ecosystem. It also maintains ecological sustainability as with a community of UAV's the fishing can be monitored live helping them keep track of the numbers and thereby help understand ecological effects of fishing in real time.

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