Drone Based Bird Hazer for Sunflower Crop

ABSTRACT

Bird's damage to agricultural crops is an important cause for the reduction of yield resulting in huge economic losses for the farming fraternity across the world. The natural habitats' of flocks across the world, for their feeding, largely depend on field crops. This would in turn cause problems to farmers, in large scale crop losses measuring up to 10 to 30% of total yield. To mitigate this huge crop loss due to the instincts of birds, we developed a technology to solve the problem permanently by adopting the latest available user-friendly techniques in the form of bird hazer. Numerous methods have been used in controlling birds, e.g. chemical, auditory, visual and lethal. In this research, visual and auditory methods were applied, where reflective boards and speakers were installed on a drone and were flown at different altitudes and intervals. The scaring approach was divided into four (4) categories; UAV, a combination of UAV and High DB Buzzer, a combination of UAV and signal generator and a combination of UAV, High DB Buzzer and signal generator respectively. The test was conducted at a sunflower field in GKVK, Bangalore. The findings indicate that a combination of UAV, High DB Buzzer and signal generator techniques scared the highest number of birds at a height of 2 m. The interval of flight does not show any correlation with the number of birds that flew away. In this research work, we developed an unmanned aerial bird hazer to mitigate and minimize flocks menace in the field for the reduction of crop damages by flocks.

***Key Words*:** Sunflower, Unmanned aerial vehicle, Flocks, Bird hazer, Field crops.

1. INTRODUCTION

"Sunflower (*Helianthus annuus L.*) crop is species that originated in North America. It was probably first introduced to Europe through Spain and spread through Europe as a curiosity until it reached Russia where it was readily adopted. The high oil lines from Russia were reintroduced into

the U.S. after World War II, which rekindled interest in the crop. Production of sunflower found new uses in the market for the seeds as an oil crop, Bird seed crop, and as a human snack food. In India, sunflower as an oilseed crop was introduced in 1969, before which it was used as an ornamental plant" (Anderson et al., 2013).

Several methods have been used in bird management control to reduce the population, deter or scare them from eating and damaging the crops. These methods can be categorized into; lethal control, habitat modification, physical exclusion, chemical deterrents, auditory deterrents, and visual deterrents. Lethal control methods permitted are by shooting, a cage trap, and/or net (hand-propelled). Shooting is divided into two different approaches; shooting to kill and shooting to scare. Shooting efficacy depends on several factors; the target species, site characteristics and shooting regime. It is more effective at the smaller site, and the number of consecutive days and shooting parties affect the reduction of bird numbers. Trapping birds help in reducing the population but is not significantly able to reduce the damages to crops. Habitat modification involves the removal and/or alteration of habitat features. Typical actions include trimming or cutting trees, removal of puddles or ponds, revegetation of barren areas and allowing grass to grow taller, especially near airports (Wanga et al., 2019).

As for physical exclusion methods, netting is commonly used in vineyards. It is also used to prevent birds from eating fish from aquaculture farms. However, it is not suitable if the covered area is large because the cost of netting will be expensive. Chemical deterrents can be categorized as tactile, behavioural and taste repellents. Tactile repellents are a sticky substance that repels birds from sitting on perches, ledges, antennas or signboards. Applying the sticky substances on the identified ledges and perches are laborious, and the stickiness is not long-lasting. Auditory deterrent methods are scaring stimuli such as loud noises detonated from guns, cannons, modified rockets, firecrackers, or high-intensity sound transmitted from sonic devices such as recorded bird alarms, distress calls, ultrasonic and predator sounds. The auditory methods were found to be effective due to loud noises which provoke a fear response from birds and birds' instinct to avoid danger (Anderson et al., 2013).

Fig. 1: Birds Damaging Sunflower Flower

Materials and methods

The bird scaring experiments were performed iat the sunflower field plot, GKVK, Bangalore. The size of each plot is about 90 x 60 meters (refer to Figure 2) as mentioned in K Map. A sunflower field is a place of interest for parrots as sunflower is the main crop eaten by parrots.

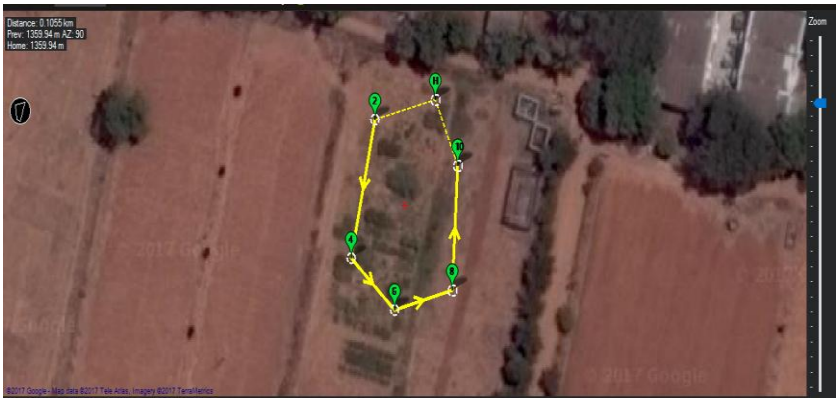


Fig. 2: Research Plot in K File Format

The hexacopter drone used in this study was a multi brushless rotor. G10 is a material commonly used instead of carbon fiber to make a UAV's frame since it is very rigid and light weight, but significantly less expensive. Dampeners are moulded rubber parts used to minimize vibration transmitted throughout a UAV. The frame is like the "skeleton" of the

aircraft and holds all of the parts together. Simple frames have motors connected to light weight extrusions ("arm") which then connect to a central body.

Fig. 3: Hexacopter drone frame

Multirotor landing gear normally does not have wheels as you might find on an airplane this is to prevent it from moving when on the ground and reduce overall weight (fig. 4). Retract normally refers to landing gear that has two positions: one for landing and takeoff, and another, which takes up less room or improves visibility, during flight. Shell is used to improve resistance to the elements and sometimes improve aerodynamics. Some production UAVs only have a plastic shell which also acts as the "frame".

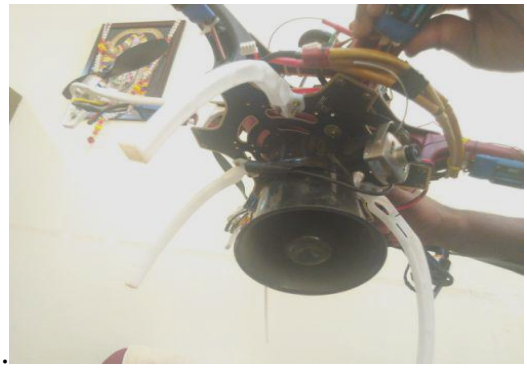


Fig. 4: Landing gear

Propeller blades are the aerodynamic surface that generates lift. A propeller normally has two to four blades that can be fixed or folded. Electronic Speed Controller is connected to the battery, motor and flight controller and controls the speed at which the motor rotates (fig.5) and most

commonly lithium polymer batteries are used. Motors are used to rotate the propellers in UAVs, a "brushless" motor is much more common (fig. 6).

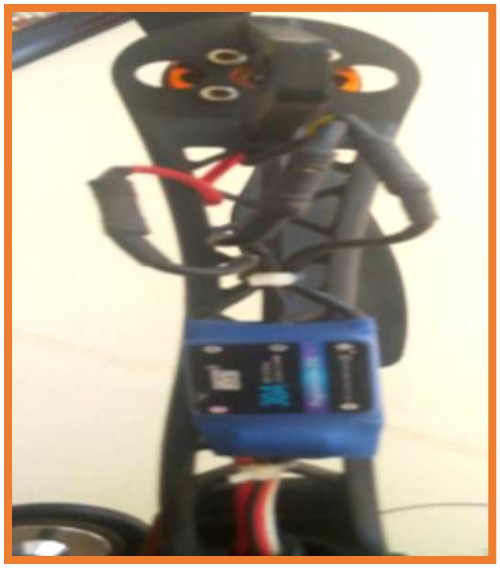


Fig. 5: Electronic speed controller

Fig. 6: Brushless motor

The Flight Controller is the "brain" of a UAV and handles all of the data processing, calculations and signals. The core of a flight controller is often a programmable "microcontroller". The flight controller may have multiple sensors on board, including an accelerometer, gyroscope, barometer, compass, GPS etc. If the flight controller can control the aircraft on its own (for example to navigate to specific GPS coordinates), it may be considered to be an "autopilot".

Test	Mode
T1	UAV
T2	UAV + HIGH DB BUZZER
T3	UAV + SIGNAL GENERATOR
T4	UAV + SIGNAL GENERATOR + HIGH DB BUZEER

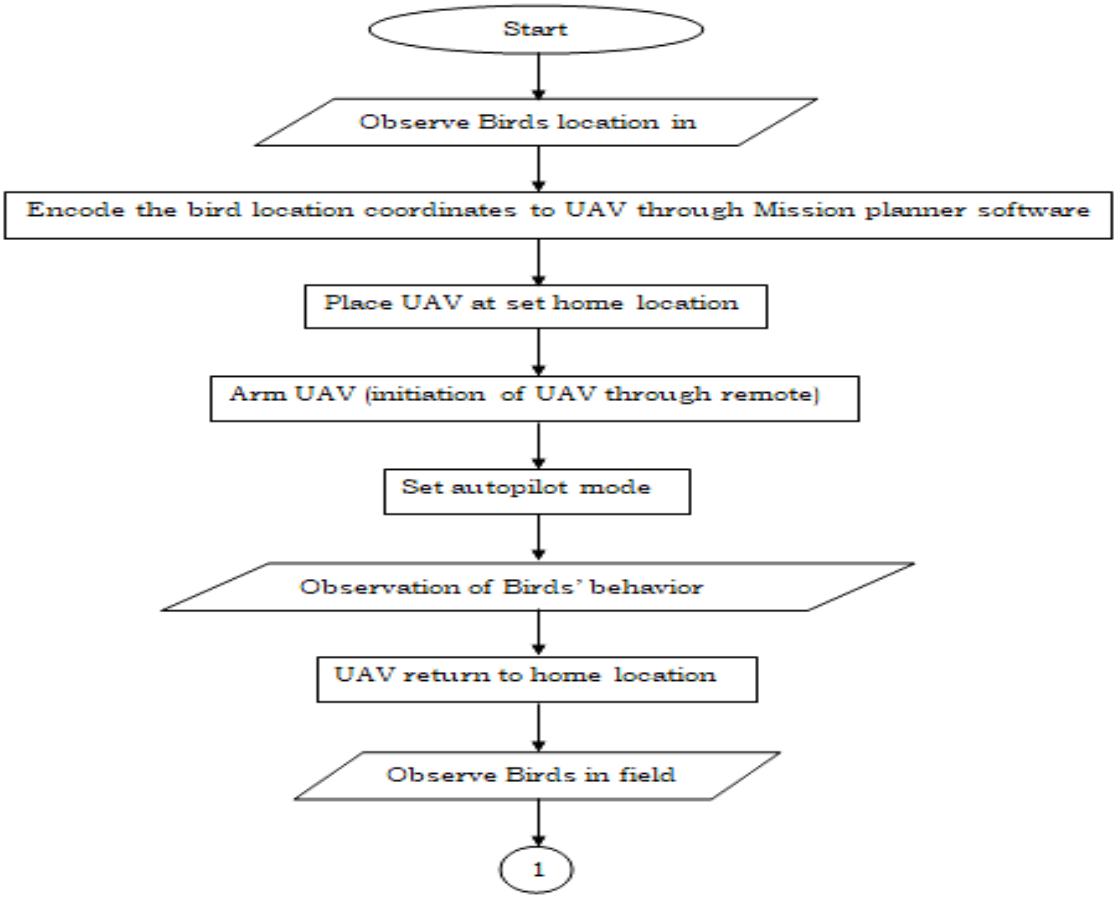
Table 1: Tests Conducted to scare birds at sunflower plot at GKVK Campus, Bangalore

Experimental procedure

Select the field where flocks problems are very high, then connect USB transmitter to laptop/PC after connecting laptop to GPRS. In the mission

planner software set the network prototype is COM7 (57600), it is a standard value to connect the software and UAV. Click Connect option. Check battery condition. Select flight plan. Read previous way Points (WPs). Set home location. Set the waypoints which allow adjusting bird hazer to travel in the field. Adjust waypoint attributes in the attribute window. Save the waypoints. Write the waypoints then disconnect the system. The working of the system is shown in the flow diagram (Fig.7).

An experiment was conducted in an agronomy sunflower field in GKVK with 4 different treatments UAV (T1), a combination of UAV and High DB Buzzer (T2), a combination of UAV and signal generator (T3) and a combination of UAV, High DB Buzzer and signal generator (T4) and three different heights, H1, H2 and H3 (1m, 2m & 3m) respectively, three replications are made and the average was considered for comparison. Photographs were taken when the birds are scared away to calculate the number of birds flying away from the field.



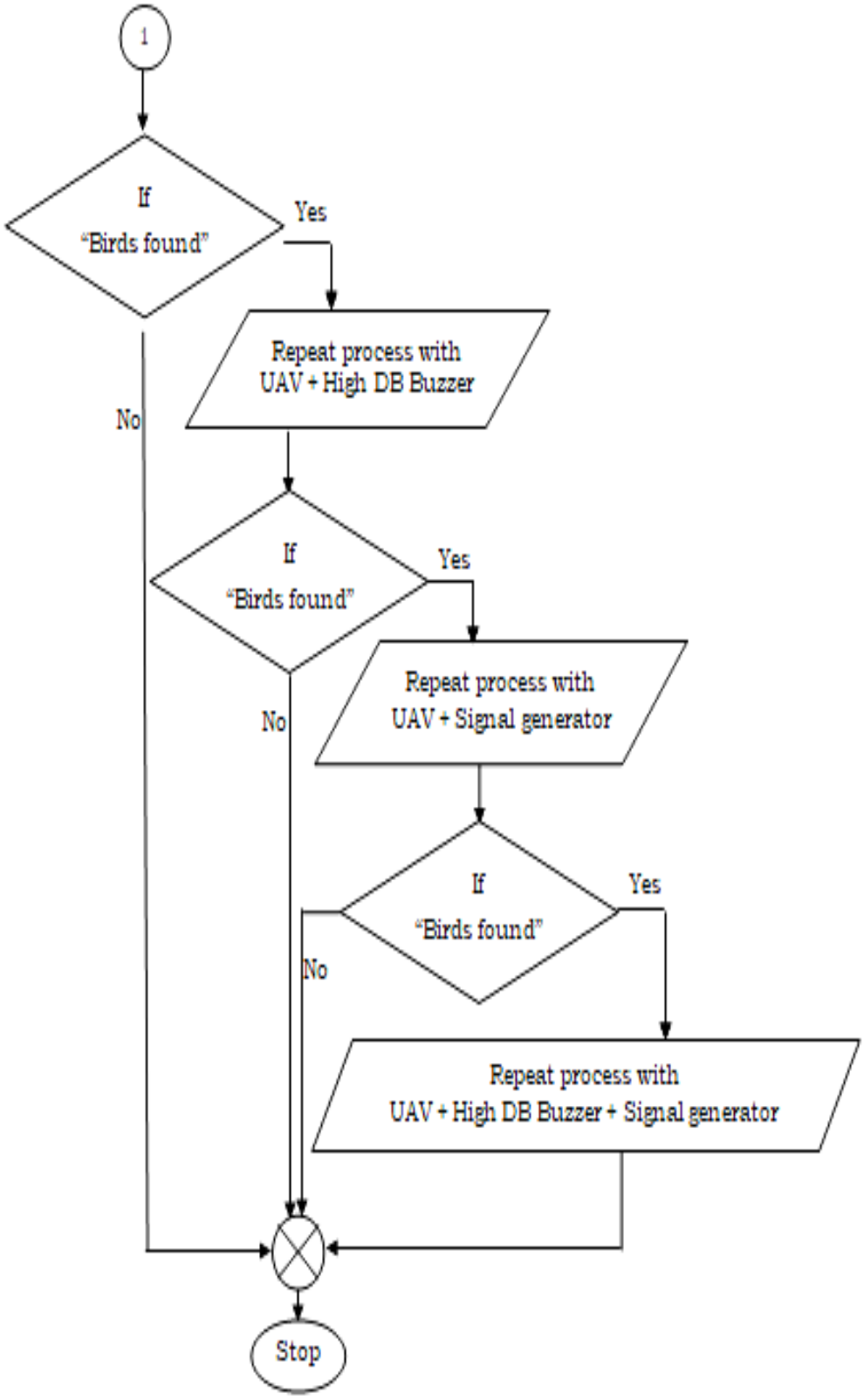


Fig. 7 The process flowchart of the experiment

4. Results and discussion

Percentage of birds scared away in the experiment carried out under different treatment are shown in the table 2.

Height	Replication	Before use of bird hazer (No.)	Birds scared away (%)			
			T1	T2	T3	T4
H1	R1	95	45	80	88	98
	R2	55	46.66	85	90	100
	R3	70	50	79	80	100
	Average		**47.22**	**81.33**	**86**	**99.33**
H2	R1	100	40	77	83	98
	R2	60	50	65	70	100
	R3	50	36	74	80	94
	Average		**42**	**72**	**77.66**	**97.33**
H3	R1	100	15	73	80	92
	R2	125	25	55	79	88
	R3	85	14	34	63	95
	Average		**18**	**54**	**74**	**91.66**

Table 2 Percentage of birds scared away

The test was conducted at 3 different heights (1m, 2m and 3m). When the drone was flown at 1m height number of birds scared were highest but as the drone flew near to the canopy many times the drone was damaged by the herd of birds scattering away. This height was rejected and the results found under the other two heights tested were subjected to statistical analysis to know which height can be recommended for achieving the best results.

Source of variation	Sum of squares	Degree of freedom	Mean square	F-value	P-value	F critical
Heights	988.17	1	988.167	11.83	0.003	4.49
Treatments	13283	3	4427.67	53.02	1.56E-08	3.24

Table 3: Results of ANOVA

It is clearly seen in the ANOVA (table 3) that the calculated value of F is much higher than the critical value of F and the P-value is very much less than 0.005. These results allow us to conclude that there is a significant difference in treatments used in the above experiment. Matthew P. Brinkman and David K. Garcelon (2020) conducted a study at Institute for Wildlife Studies, Arcata, California and in the experiment, they fitted a loudspeaker with an amplifier as a hazing device to deter wildlife from areas such as an active oil spill. The sound was in the form of predatory bird calls, people talking/yelling, or just a song that is blasted at high volume. As the speaker is mounted to a drone, it acted as both a visual and auditory deterrent.

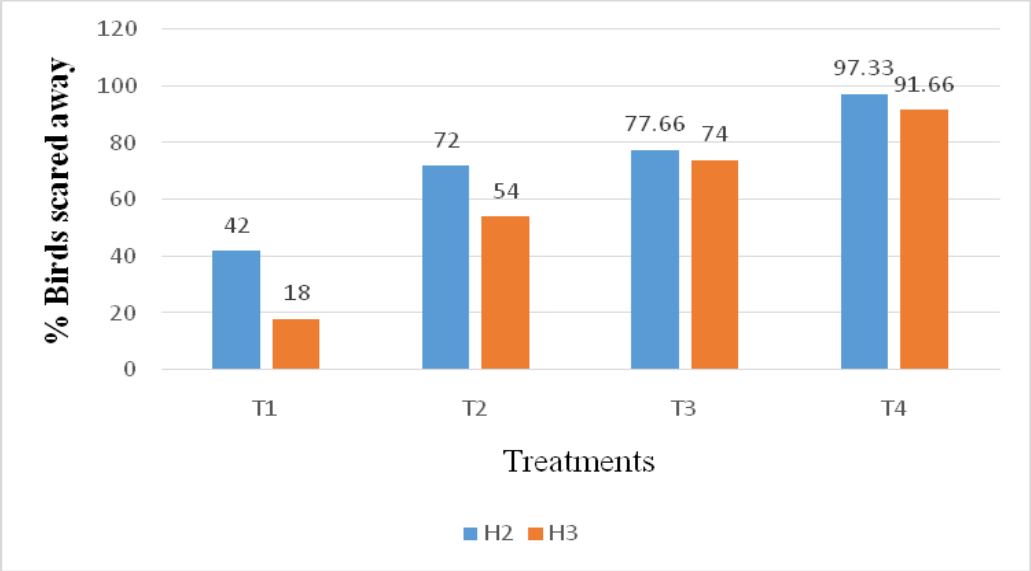


Fig. 8: Comparison between percent of birds scared away under different treatments and heights

The figure 8 shows the comparison between % of birds scared away under different treatments and heights. We can see that under T4 (UAV, High DB Buzzer and signal generator) and height H2 (2m) % of birds scared away is higher than any other treatments. The significance of this result is justified by the ANOVA table given above.

Treatments	H2	H3
T1	42^{c}	18^{d}
T2	72^{b}	54^{c}
T3	77.66^{b}	74^{ac}
T4	97.33^{a}	91.66^{a}

*Values having the same alphabets in a column are not significantly varying with 0.005 %.

Table 4: Comparison of means

The experiment was conducted four treatments at three different heights in a sunflower field at different intervals times. When the drone was flown at H2 (2m) it gives the best results compared to H3 (3m). When the drone was flown at H1 (1m) number of birds scared away was highest but as the drone flew near to the canopy many times the drone was damaged by the herd of birds scattering away. This height was rejected and the results were found. When the drone flew at 2m height, treatment (T4) gives the best results compare to other treatments. Weicai Qin *et al* (2018) studied the impact of the spraying system in different height and different sprayer. They found that at a fixed flying speed (4 m/s) when the flying height was 3.5 m, the droplets coverage rate on wheat canopy and the distribution uniformity were the best.

The above graph indicates that there is a significant difference in combination of UAV+ High DB Buzzer+ Signal generator compared to UAV, UAV + High DB Buzzer and UAV + Signal generator caused major effect on bird's habitat. In the similar study conducted by Zihao Wang et al., (2019) “the UAV was equipped with a loud speaker broadcasting distress calls, as well as a crow taxidermy installed on the undercarriage that appears as captured prey. The result shown that the short-term responses from a variety of bird species indicate that the UAV can potentially eliminate bird damage, provided the UAV can target the birds and take off as soon as the birds have arrived at the vineyard”.

5. CONCLUSIONS

Crop depredation by birds is a serious problem in farming which results in huge yield loss in agriculture. The traditional bird-scaring technology is not effective in controlling the bird menace which involves continuous monitoring of the field and adoption of various scaring techniques which lead to economical loss to the farmers in the form of loss of manpower. The developed unmanned aerial bird hazer with High DB Buzzer or signal generator is effective and proved to be sustained to mitigate bird menace in the field for reducing crop losses as compared to the traditional method. This technology has been tested as per the standard and found effective in controlling bird menace in sunflower plots. The unmanned aerial vehicle bird hazer can also be very effective for other perishable field crops such as maize, finger millet, sunflower, etc. Hence the adoption of smart technologies in the bird hazer has proved to be farmer-friendly and cost-effectively.

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