

A Real Time Image Processing Based System to Scaring the Birds from the Agricultural Field

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Abstract

Objective: This paper discusses about the development of hardware system which can be used to chase the birds from the farm by using an embedded technology. **Methods:** The system is able to detect and track the pest birds from the real time video frame using Kalman filter. The Kalman filter is a predictive filter, that dependent on space techniques and recursive algorithms using image processing tools in Matlab environment. The various states of operation of a dynamic system are estimated using this algorithm. **Applications/ Improvements:** The proposed system has been simulated in Matlab. It can be extended to a complete bird frightening system by incorporating the video processing algorithm with hardware such as camera, linux based embedded board and ultrasound generator. The video obtained from the camera is processed using the ARM7 Raspberry Pi board based on linux OS. This system detects the birds from the video and a high frequency ultrasound is generated and directed towards the pest birds to drive them away from the farm.

Keywords: Kalman Filter, Linux Based Embedded Board, Ultrasound Generator

1. Introduction

In India, two- third of people is directly depending on the agriculture for their income which contributes to one part of GDP of the country. In recent years, crops and grain efficiency decreases in India due to various factors like poor maintenance of the farm and the agriculture methods which are neither economically nor environmentally sustainable. The birds feed mostly on grains, seeds, fruits, green vegetables of the crop plants and grasses¹.

The searching activities of cropland bird species like house crow have caused more damage to wheat, while pigeons and duck cause damage to pearl millet and sunflower. A maximum loss of 52% is recorded in the maize crops due to sparrows and parrot. The minimum damage was recorded for wheat crop which was 17% and most of the damage was caused by crows, which was recorded on the site in different district. Pigeons damaged 42% of the peas crop (chick peas and pigeon peas) while sparrows and pest birds damaged the groundnut crop

by 26% in the sampling plots². Though there are several methods available like chemical repellent, net, spike guards, shooting the birds with gunshot, and making loud noise by fragment fire crackers in order to scare the birds which is costly or lethal³. Traditional methods are trial and error method, and the bird types become habitual for such techniques⁴.

A lethal technique may be an effective solution to the problem but by homicide birds, it may be destroying one of the important bio indicators in the nature. This project intends to develop a hardware system that can be used to chase the birds from the farm by using a video processing technique. The techniques such as state space analysis and recursive algorithm forms the basis of a recursive predictor filter called the kalman filter.

The project can be extended to a complete bird frightening system by incorporating the video processing algorithm with hardware such as camera, linux based embedded board and ultrasound generator. The video obtained from the camera is processed using the single

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board computer known as Raspberry Pi. If the bird is detected from the video and the system generates a high frequency ultrasound which is directed towards the pest birds to drive them away.

2. Materials and Methods

The methodology diagram illustrating the hardware setup of the proposed bird frightening system is shown in Figure 1. The ARM processor receives real time video from the camera that is interfaced with ARM 7 cortex linux based board. The video acquisition process consists of two steps, video streaming and frame capturing. Video streaming process involves getting the video file from the camera. This video is given as input to the image processing algorithm which recognizes and detects the birds in the video frame. Once the birds are detected and located in the video, the algorithm continues to track the birds till they disappear from the camera's field of view. The location of the bird at any moment is calculated and based on its position, the motor connected to the embedded board is rotated and high frequency ultrasound is directed towards the bird to scare and chase them away from the field.

2.1 Software Development

The video taken from the field is analysed and process using two algorithms,

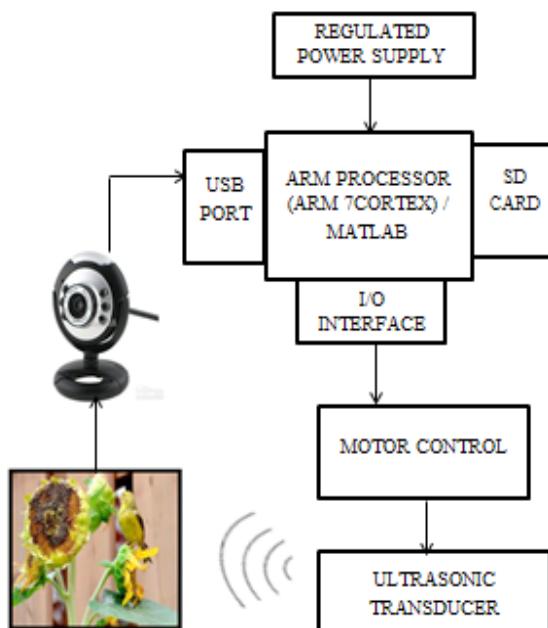


Figure 1. Methodology diagram.

- (1) Background subtraction
- (2) Kalman filter

2.2 Background Subtraction

Background subtraction is also called as foreground Detection. Background subtraction is particularly a commonly used technique for motion detection and tracking in static scenes⁴. It attempts to detect moving regions by subtracting the present image pixel-by-pixel from a reference background image that is created by averaging images over time in an initial period. There are different methods to this basic scheme of background subtraction in terms of foreground detection method, background maintenance and post processing^{5,6}.

The system uses a statistical background model where each pixel is represented with its minimum (S) and maximum (T) intensity values and maximum intensity difference (Di) between any continuous frames observed during initial training period where the division contains no moving objects. A pixel in the current image is classified as foreground if it satisfies⁷:

$$|S(x, y) - It(x, y)| > Di(x, y) \text{ or } |T(x, y) - It(x, y)| > Di(x, y) \quad (1)$$

After thresholding, a single rehearsal of morphological method is applied to the detected foreground images to remove one-pixel thick value noise. In order to grow the detected regions to their same sizes, the erosion and dilation method is applied on the foreground pixel value⁸.

2.3 Kalman Filter

The kalman filter is also known as recursive predictive filter that is based on the use of recursive algorithms and state space techniques⁹. The Kalman filter object is designed for detecting and tracking the moving object. There are two distinct scenarios that the Kalman filter addresses. When the birds are detected, the Kalman filter first predicts its state at the current video frame, and then uses the newly detected object location from the frame to correct its state¹⁰. This produces a filtered location. When the birds are missing, the Kalman filters use the previous state to predict the bird current location. The flowchart for bird detection and tracing using kalman filter is given in the Figure 2,

The time update equations are given as

$$Xk^{-} = A Xk-1^{\wedge} + BU_k \quad (2)$$

$$Y_k^{-} = A Y_{k-1} A^T + Q \quad (3)$$

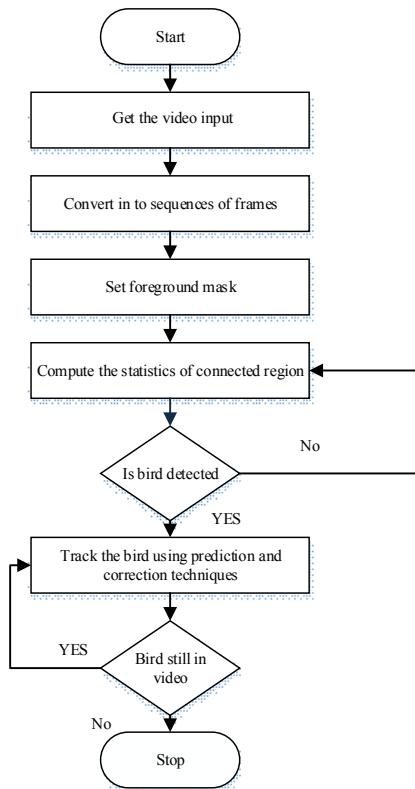


Figure 2. Flow chart for Kalman filter.

Where 'A' is state matrix, 'B' covers control input and 'Q' is process noise covariance.

The measurement update equations are given as

$$K_k = Y_k^{-} H^T (H Y_k^{-} H^T + R)^{-1} \quad (4)$$

$$X_k^{\wedge} = X_k^{\wedge-} + K_k (- H X_k^{\wedge-}) \quad (5)$$

$$Y_k = (1 - K_k H) Y_k^{-} \quad (6)$$

Initially, the computation of updated kalman filter gain K_k is done. Followed by this we actually measure the process by which X_k is obtained, and then it generates and estimates a posterior state by incorporating the measurement as in equation (4). The final step is to obtain a posterior error covariance with the equation (5). After each time and measurement update pair, the process is combined with the previous a posteriori estimates and is repeated to predict the new a priori estimates¹¹.

3. Results and Discussion

The recorded video is processed using Matlab and the birds in the video are detected and tracked. Two type of algorithm are tested to detect and track the bird,

1. Background subtraction
2. Kalman Filter

The input video is shown in Figure 3. The output of Background subtraction algorithm is shown in Figure 4. The birds are detected and tracked accurately but the background movements (clouds) are also detected. To overcome this drawback, Kalman filter is used for detection of birds.

In Kalman filter technique, the input video is divided into frames and the frames are processed. The foreground mask value is set to separate the moving foreground objects from background. Then the statistics of connected regions is computed to locate the bird. The detected bird is shown in Figure 5.

Once the birds are located in the video, the Kalman filter algorithm predicts and corrects the birds' location to track the birds further. The prediction step uses previous states to predict the current state and in the next step it is corrected using the current frame, such as object location. The tracked bird is shown in the Figure 6 and Figure 7.

The results of the proposed system is analysed and tabulated in Table 1.

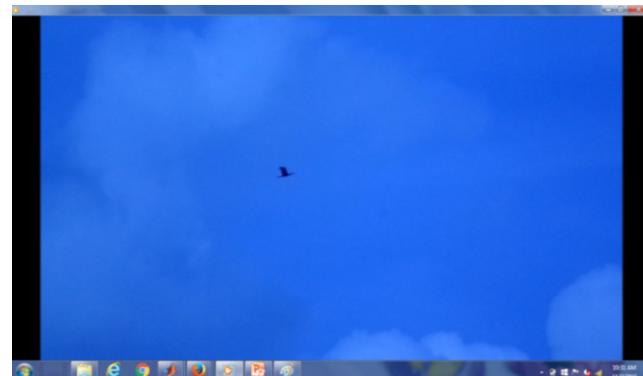


Figure 3. Input video.



Figure 4. Background subtraction output.

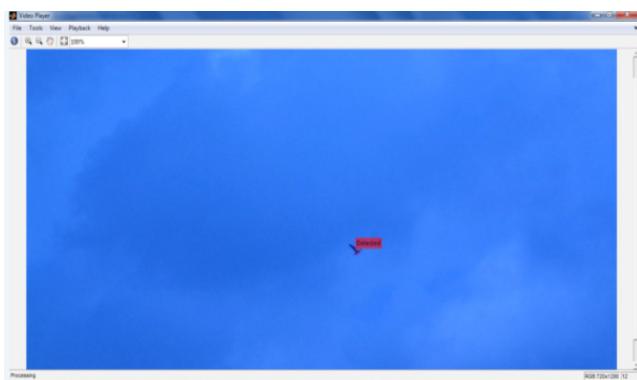


Figure 5. Bird detection using kalman filter.

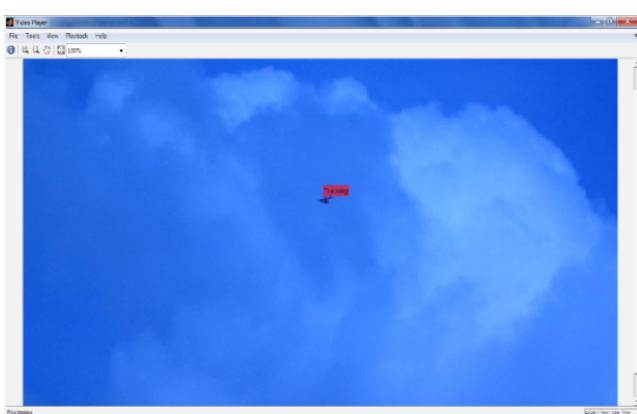


Figure 6. Single bird tracking using kalman filter.

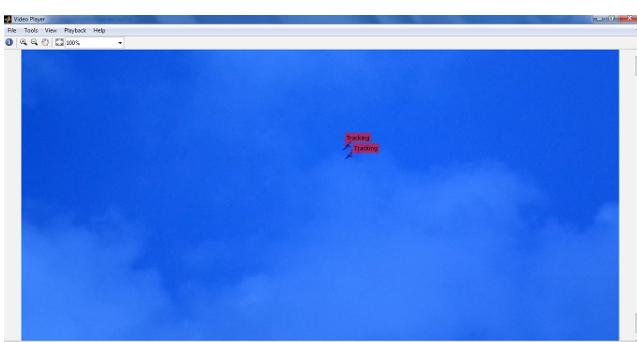


Figure 7. Multiple birds tracking using kalman filter.

Table 1. Result of proposed system

Video number	Number of birds in the video	Number of tracked birds	Percentage of birds tracked
1	4	2	50
2	1	1	100
3	2	2	100
4	3	2	66

4. Conclusion

The birds are detected and tracked using two algorithms namely background subtraction and kalman filter using Matlab tools. The birds are detected accurately using background subtraction algorithm but along with birds, the moving objects in the background are also detected. To overcome the drawback of background subtraction method, kalman filter algorithm is applied and the performance is tested. This method detects the birds accurately and tracks them with very less error probability.

6. References

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