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STUDY OF MOSQUITO DETECTION AND POSITION TRACKING ALGORITHM

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To kill Mosquito, it is necessary to detect its position. Mosquito can be detected from the video by Frame Difference Method (FDM). The camera can change its movement during shooting and exactly target the Mosquito. The background motion also is considered in this way. The image processing and vision properties can be applied for this method to detect the Mosquito. This paper has concentrated to detect the Mosquito and its position by using the sum of the Absolute Difference Estimation (ADE) and with the help of image processing. In this paper it has been organized about the Mosquito detection and position tracking algorithm to destroy the Mosquito.

Keywords: Detection, Mosquito, Positions, Score, Destroy.

Introduction

The video motion detection technology has been developed. It has been used for object tracking, surveillance, motion detection, traffic monitoring etc. The static and moving camera images are two main video images [1]. However, the background of the images is static and it is possible to detect the Mosquito by subtracting the background image from the original video moving camera image. The moving or flying Mosquito is in the central region of the image. Thus, the histogram and statistical information can be helped to detect the Mosquito's position. During the video frame or normally taking image it can be appeared the pixels among the frame. The pixel can help to indicate the position of the Mosquito, because the value can be changed when it can be changed and the position of the pixel are not same. Thus the pixel value shows the position of the Mosquito where it is.

There are three commonly used ways for the moving objects detection [2]: frame difference [3], background subtraction [4] and the optical flow field analysis [5].Though the background subtraction of an image is not very difficult but there are some limitations such as the background extraction, background updating, background perturbation, and so on. Thus instead of background subtraction to detect Mosquito, it is better to choose the optical flow field analysis to detect Mosquito. However, it has low efficiency for noise and the calculation is not very simple. So it is not suitable for real time processing. Whereas if it can be used by pixel extraction and pixel analysis then flying Mosquito can be easy to detect even the without flying mosquito can be detected easily and it can be extracted more information. This is the reason why it has been used this technique to detect Mosquito. The adjacent frames have a less rate of illumination change and nonzero, nonnegative pixels of the differential image pointed the change of positions. So then it can be easily detect the mosquito and its positions.

Motion Vector & Method for Image Processing

Normally to detect the mosquito with image processing, it has been made a box that is called Mosquito box. As a test, it has been put two Mosquito inside the Mosquito box. The Epson vision camera and Robot has been calibrated its coordinates and origin position. The background also has been set up. Inside the Mosquito box when Mosquito moves its positions then the Epson camera has been detected the mosquito and its position. The camera can be provided some statistical information to analyze its position, pixel value, Robot position and its coordinate, time dependent condition etc. If the mosquito flies inside the Mosquito box it also can be detected its positions, pixel values and angle of movement.

The Sum of Absolute Difference (SAD) algorithm can be useful for this detection that can be defined as,

$$SAD(u,v) = \sum_{i=1}^{m}\sum_{j=1}^{n}|S_t(k,i,j) - S_{t-1}(k,i+u,j+v)| \tag{1}$$

Where,$-p \le u,\ v \le,\ ;$; u and v can be represents the horizontal and the vertical displacement respectively, and i, j refers the index of the row and column respectively in current block k, S_t and S_{t-1} represents the gray scale pixel values of the current and the past frame respectively. P is the searching range. The smaller SAD, higher similarity. The u and v corresponding to the minimal SAD among the searching range indicate the moving vector of the frame block. In the video frames sequences and in the images, the pixels are in the same block that have a high correlation [6], which causes the result of the SAD would not be true always. To solve this problem it need to be remove the correlation before the SAD implementation [7]. Thus, it can be done by the following difference as,

$$D(k,i,j) = \begin{cases} s(k,1,1), & i = 1, j = 1 \\ s(k,i,j) - s(k,i,j-1), & i = 1, j \neq 1 \\ s(k,i,1) - s(k,i-1,1), & i \neq 1, j = 1 \end{cases} \tag{2}$$

Here, $D(i, j)$ is used for SAD reality. In the Figure 2, it can be seen that the 2: Blob01 and 1: ImOp01 are two outside rectangle which indicates the block and inner sides are a lot of pixel values. Off course it could be used here only one block that is 2: Blob01. But here there are two blocks has been used for accuracy test though both results are same. This block can be divided into $i \times j$ matrix form which made similarity calculation and eliminate the redundancy. Since the background has been used as gray scale widely and it has homogeneity so the displacement to the minimum of the SAD may be not unique thus it can be divided the blocks into large pixel values which also indicated by the following tables.

Detection

Firstly it is necessary to remove the background motion then it need to apply the difference frame algorithm to detect the mosquito and its position accurately. The moving parts or background simply the difference of the higher nonzero pixel values that can be segmented the flying mosquito by binary pixel segmentation of different images. Here it can be shown the histogram but it is very difficult to detect the mosquito and its position thus it is better to consider the pixel value where there is X and Y coordinate position of pixels that represents the Mosquito's position. The pixel value has been segmented as a binary pixel value that segmentation can be considered as Ostu algorithm [8-9]. The pixels with zero difference are not considered in Ostu algorithm to get better threshold.

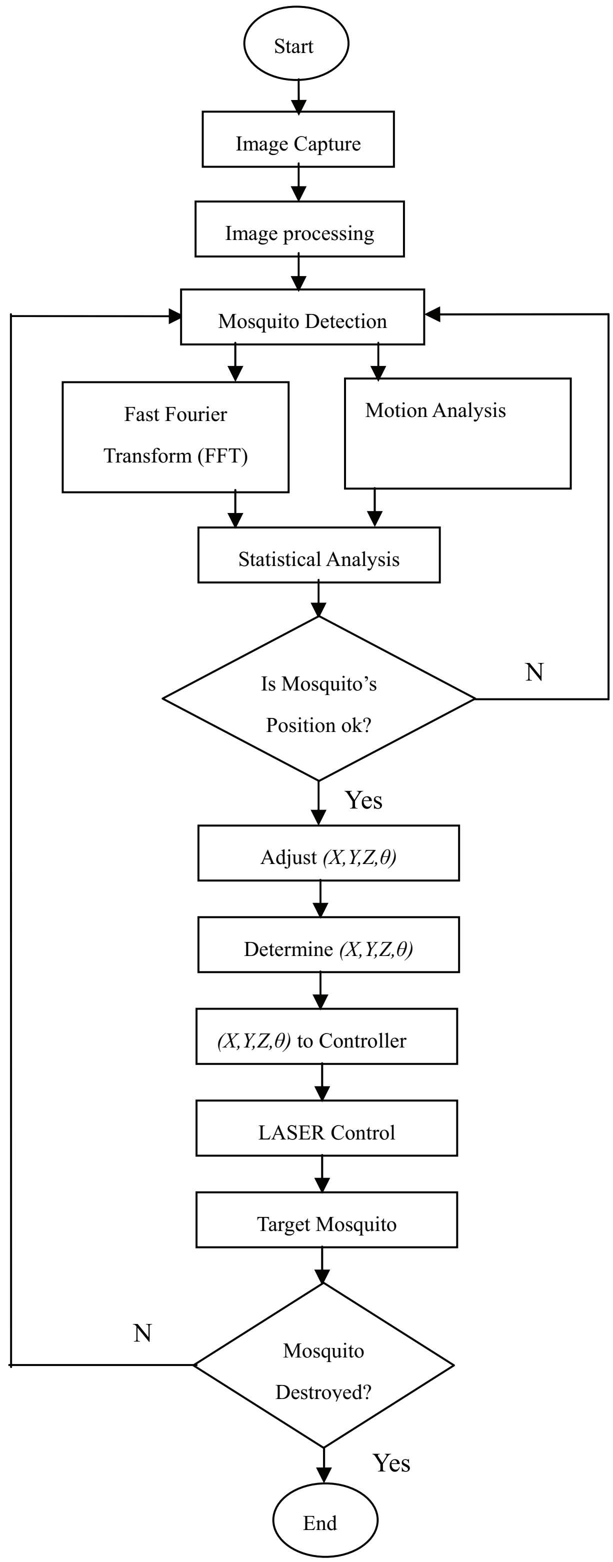


Figure 1. Mosquito Detection and Position Tracking Algorithm with Target Destroy

The Figure 1 shows the proposed method about Mosquito Detection, Mosquito's position tracking and controlling method for destroy the Mosquito. To detect Mosquito, it has been analyzed the FFT process, motion analysis with optical flow and then the statistical method can be conformed to detect the Mosquito's pattern or shape. The robotic vision have been finished detecting the Mosquito with simultaneously track the position of the Mosquito. The inter-frame difference method is the best way to detect the Moving or flying Mosquito. Thus in this method SAD method has been proposed for displacement and moving Mosquito. The above Fig.1 is an implementation of the SAD method. The position of the Mosquito by the system and to destroy as a target, which need to be offset value, after setting the offset value then the controller, can be informed for accurate position and then send LASER ray to destroy the Mosquito. The systems and this method are effective to destroy the Mosquito and it has higher efficiency.

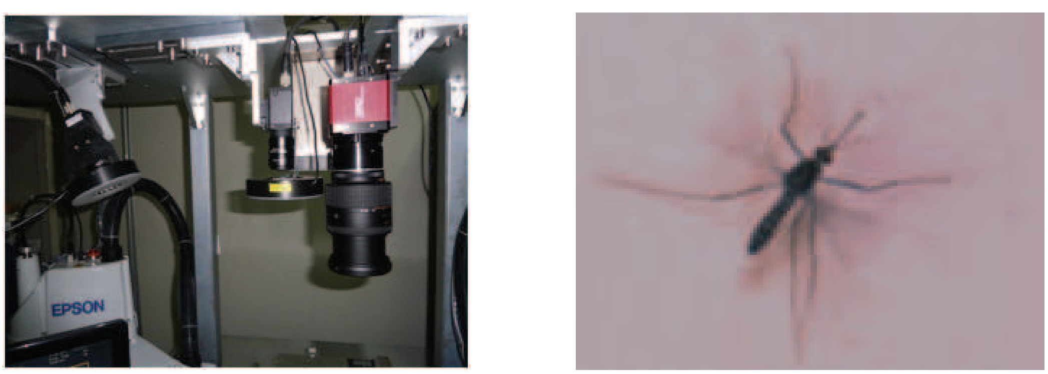
To detect Mosquito, statistical score calculation is important. If the score is M and $L(p; q)$ is the log-likelihood function then the score can be found from the following equation as,

$$M(p,q) = \frac{\partial}{\partial \theta} log L(p;q) = \frac{1}{L(p;q)} \frac{\partial L(p;q)}{\partial p} \tag{3}$$

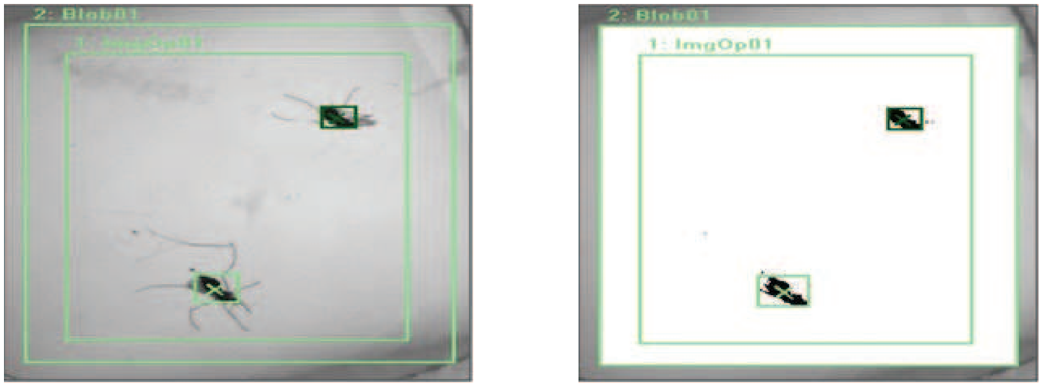
Where score M indicates the sensitivity of the $L(p; q)$, p is the maximum likelihood estimate and q is the observation of Mosquito. It has been tested for score as the null-hypothesis.

Experiments and Results

It has been adventured the Mosquito and put it inside the Mosquito box. The observations and experimental set up has been established by setting camera GE4900C, Epson vision camera and Epson Robot Controller [10] in the Figure 2(a). The software SPEL$^+$ and HALCON has been considered to detect Mosquito and it positions. The following figures (Figure 2 and Figure 3) show the detection of the mosquito and its different positions. The results also have been shown in the tables (Table 1, Table 2, and Table 3).



(a) (b)



(c) (d)

Figure 2. Frame Block with gray background and white background

Table 1. Mosquito's Positions of Gray and White Background Images

Result	Unit	Mean	StdDev	Range	Min	Max
PixelX	pixel	379.125	42.866	124.142	361.542	485.685
PixelY	pixel	359.136	21.230	61.318	350.475	411.793
Angle	deg	-38.660	20.696	65.138	-52.833	12.306
Time	ms	3.045	0.579	1.00	2.000	3.000
Area	pixel	395.100	166.600	649.000	223.000	872.000

The Table 2 represents for the light green detected region of the Mosquito. It has been shown some statistical information about Mosquito detection. The position of Mosquito's unit is in pixel. The {minimum (*X, Y*)} pixel value has been found (64.015, 44.777), the maximum pixel value is (502.573, 311.296) and the position angle of the Mosquito is minimum 2.570^{o} and maximum 333.691^{o}. The detected area range can be found 438.558×266.519 pixel unit and it can be detected the angle movement of the Mosquito that is within 331.121^{o}. The other statistical information also observable for this analyzes. The camera and the Robot's (*X, Y*) position are respectively {min (8.097, 21.362)}, {max (58.503, 49.800)} and {min (271.158, 87.999)}, {max (303.992, 137.181)}. These values are adjustable and readjust by camera and Robot's offset setting. The angle to move around the Z-axis and it is min 1.711^{o} to max 334.492^{o}.

Table 2. Mosquito's Positions, Moving Angle, Camera's Position And Robot's Positions

Result	Unit	Mean	StdDev	Range	Min	Max
PixelX	pixel	230.334	57.237	438.558	64.015	502.573
PixelY	pixel	145.113	74.867	266.519	44.777	311.296
Angle	deg	231.256	132.624	331.121	2.570	333.691
CameraX	mm	15.916	15.829	50.406	8.097	58.503
CameraY	mm	20.280	19.670	28.439	21.362	49.800
RobotX	mm	160.306	145.876	32.834	271.158	303.992
RobotY	mm	65.492	59.775	49.182	87.999	137.181
RobotU	deg	120.497	127.183	332.782	1.711	334.492
Time	ms	556.983	337.817	1939.000	110.000	2049.00(
Score		911.769	92.951	246.000	750.000	996.000

The detected Mosquito of the light green region is less time consuming than the dark green detected region as in Figure 3. The time range is 110 ms to 2049 ms and within these ranges, the Mosquito can be detected easily by the Robot and kill by LASER.

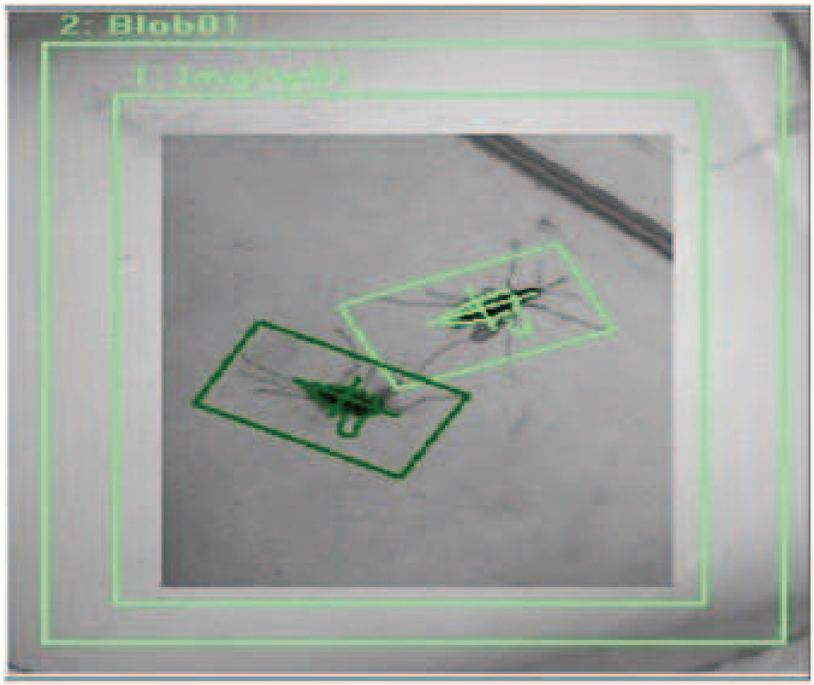


Figure 3. Mosquito detection & its position by Epson Robotics Vision

The Table 3 represents for the light green detected region of the Mosquito. It has been shown some statistical information about Mosquito detection. The position of Mosquito's unit is in pixel. The {minimum (*X, Y*)} pixel value has been found (157.922, 44.777), the maximum pixel value is (502.573, 289.320) and the position angle of the Mosquito is minimum 2.570^{o} and maximum 333.691^{o}.

Table 3. Mosquito's Positions, Movement Angle, Camera's Position and Robot's Positions

Result	Unit	Mean	StdDev	Range	Min	Max
PixelX	pixel	231.652	36.274	344.651	157.922	502.573
PixelY	pixel	90.260	20.887	244.543	44.777	289.320
Angle	deg	327.902	36.525	331.121	2.570	333.691
CameraX	mm	5.856	11.625	0.007	28.694	28.701
CameraY	mm	10.162	20.172	0.010	49.790	49.800
RobotX	mm	62.038	123.146	0.008	303.984	303.992
RobotY	mm	23.426	46.500	0.007	114.782	114.789
RobotU	deg	45.173	89.669	0.195	221.243	221.438
Time	ms	775.245	295.935	1600.000	449.000	2049.000
Score		984.704	41.098	246.000	750.000	996.000

The detected area range can be found 344.651×244.543 pixel unit and it can be detected the angle movement of the Mosquito that is within 331.121°. The other statistical information also observable for this analyzes. The camera and the Robot's (*X, Y*) position are respectively {min (28.694, 49.790)}, {max (28.701, 49.800)} and {min (303.984, 114.782)}, {max (303.992, 114.789)}. These values are adjustable and readjust by camera and Robot's offset setting. The angle to move around the *Z*-axis and it is min {221.243°} to max {221.438°}. The detected Mosquito of the dark green region is greater time consuming than the light green detected region. The time range is 449 ms to 2049 ms and within these ranges all slow motion Mosquito can be detected easily by the Robot. If the Mosquito's position is the function of $f(x, y, z)$ then it can be expressed as,

$$M(x,y,z) = \begin{cases} f(x,y,z), & \text{if } score \geq min\{score\} \\ 0, & elsewhere \end{cases} \tag{4}$$

However, the robotic function can be defined as,

$$R(X,Y,Z;\theta) = \begin{cases} f(x,y,z,\theta), & \text{if Detect the Mosquito} \\ 0, & elsewhere \end{cases} \tag{5}$$

Where $R(X, Y, Z, \theta)$ is the target correlation function to destroy the Mosquito by LASER. This function can be determined for controller.

The above both of the table it has been observed that the maximum score of detected Mosquito is 996 and minimum score is 750. The maximum dedicated and assign score is 999. The high score indicated the confirmation to detect the Mosquito and its position. To detect Mosquito, the higher score, the higher probabilities.

Conclusions

The Mosquito is a funny and interesting characteristic. To detect Mosquito is not very simple and easy. In this way if it can be detected smoothly then further it is possible to kill the mosquito. The killing is the final target about this research and further research. To acquire the information this research would be very helpful.

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