# Detection and Tracking Techniques for Infrared Searching and Tracking System with Robust Control System

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Abstract: Infrared searching and tracking system is the heart of modern armament system generally used in air defense and missile shields system. The IRSTs used in fighter aircraft, tanks and missile defense systems to passively search, detect, track, classify, and decides their priorities in multiple airborne targets under all aspects and engage the target from long ranges as possible. In this paper, authors have proposed a new concept in which all three units i.e. IR channel, TV camera, and LRF are installed in a single optical window. Also, studies have been done on various detection and tracking algorithms for multiple airborne targets in clusters, clouds and noisy environmental conditions and authors have find out a suitable algorithm and control system for IRST system.

## 1 INTRODUCTION

With the development of modern electronic warfare system, infrared searching, tracking and ranging system is used to detect and track possible threats through IR signature but it is less efficient in traditional microwave frequency radar system. For ranging, it uses a coherent high power laser beam to measure distance of target. Due to capability of passive detection and tracking of target, the IRSTs (Yilmaz, 2003) are getting more importance in air defense and missile defense. Infrared detection and tracking system has significant advantage over radars such as passive surveillance, which do not suffer jamming by jammer and gives warning against anti-radiation missiles threats.

The IRST system surveys environment and analyses the IR radiation, emitted by target as compared to background (Nengli, 2001) (Yang, 2001). Generally, western IRST systems IR channel and TV camera is installed at same optical window/ platform, and LRF installed other optical platform. On the other hand in Russian system IR channel and laser range finder (LRF) worked in same optical window. The proposed IRST system have all three units IR channel, TV camera, and LRF is installed in a single optical window with two different signal processer, first IR signal processor use for IR signal processing in IR channel and second video signal processor for video signal in Thermal/ video channel. For IR channel authors have used mid IR having wavelength 3.5 to 5.5 µm for beyond visible range target and for thermal channel, authors have used upper IR having wavelength 10 to12.6µm for visible range target.

To achieve IRST task to detect and track target various different algorithm may be used. The Interacting Multiple Models (IMM) filters algorithm (Blom, 1998) (Mazor, 1998) is best for data selection and processing in IRST application. This algorithm uses multiple Interactive models for parallel processing.

The GNN and JPDA (Konstantin, 2003) (Tchango, 2003) tracks targets 5 to 6 times faster than MHT depending on the motion of targets by using various models. However, The IMM motion model makes all three trackers run 3 to 4 times slower. Tracker JPDA with IMM filter and Tracker TOMHT (Blackman, 2004) with IMM filter track-maneuvering targets more precisely and did not break or lose track even during turns and in the ambiguous region. However, runtime for a tracker TOMHT is significantly longer than using tracker JPDA and computational data is less hence requires less memory space than tracker JPDA. In case JPDA with Interactive Multiple model algorithm (IMM)

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proves to be best for real time application and best option for IRST system.

In this paper, authors have proposed a robust control system for the composite axis (azimuth and elevation both) in IRST System to solve jitter and oscillation problem at airborne vibration environment. Robust control system is used to improve the control performance. A servo-control motor with Tunable PID controller (Li, 2017) used for control the scanning mirror in azimuth and elevation. For focusing problem of IR/ thermal signal on PSD device, solved by Roll control drive and optical modulator. The roll control drive aligns the optical line sight between scanning mechanism and PDS through servo control motor and tunable PID controller in azimuth. Optical modulator aligns the fine mismatch the position at elevation between scanning mechanism and PSD.

## 2 BASIC PRINCIPLE OF IRST SYSTEM

The principle of IRST system can be divided three parts:

i. System ensures reception of IR (infrared) signals from airborne as well as ground & water surface target. Searching is detection and auto-tracking of target through its heat radiation with measurement of angular coordinates of the targets, when target is beyond visible range (BRV) (Srivastava, 2007).

ii. System ensures reception video signals targets through its video signal with measurement of angular coordinates of the targets, when target is visible range.TV camera is used for video signal recording and processing.

iii. System ensures transmission and reception LASER beam reflected from targets by LASER Range Finder (LRF) and calculate the range of target.

### 2.1 Detection Principle

Any object, whether solid, liquid or gas whose temperature is above absolute zero (-273°C or 0° K) would emit electromagnetic radiation called IR signature. When the object is in thermal equilibrium with its surrounds then it is simultaneously radiates and absorbs a constant band infrared radiation at same rate.

The IR detector of IRST system detects the target based upon its infrared radiation. IR emission by a target in rear hemisphere is more than that in front hemisphere. The energy of heat emission expressed by Boltzmann law:

$$Energy \quad (E) = \delta T^{4} \tag{1}$$

$\delta$ = Boltzmann constant (1.38X10$^{-23}$ m$^{2}$ Kg s$^{2}$K$^{-1}$)

T= absolute temperature of the body.

This heat gives rise to radiation of IR waves. Wien's displacement law gives the relation between IR wavelength and absolute temperature expressed as:

$$Wavelenght \quad (\lambda_m) = 2897 \;\; / \, T \tag{2}$$

$\lambda_m$ = maximum wavelength of IR Radiation.

According to reference (Srivastava, 2007) IRST system detects targets from long distance that located at beyond visible range and appears on detector plane as point image. The maximum detection range defined by using range formula for point image target:

$$Range \;(Dr) = \sqrt{(\Delta E * t_R \;/\; Nei \;*\; Sn\,(} \tag{3}$$

$t_R$ = Atmospheric transmittance over the sight line of target

$\Delta$E= IR radiation intensity of target,

Sn= Signal-to-noise ratio

Nei= Equivalent noise irradiance of the sensor.

The position sensitive detector is an optical transducer use to find position of falling light on its surface. Generally, Photosensitive Detectors devices divided in two categories:

a) Thermal Photo Sensitive Detectors
b) Quantum Photo Sensitive Detectors.

Thermal Photo Sensitive Detectors are detectors that sense the infrared Signature and convert IR flow into electrical signal depending on intensity of IR flow without any requirement of cooling system. These detectors are also very sensitive to surrounding temperature but responses are slow**.** The same principal used by Quantum Photo Sensitive Detectors but these detectors (Koretsky, 2013) are requiring cooling to distinguish the IR signature of target from electrical noise of detectors material. The detectors device packed in vacuum chamber or cold shield. Cold shield consist of detector, optical window and cooling hose and prevents thermal energy surround.

### 2.2 Detection through TV Camera

Although in this era, the comparison between the color and monochrome camera is illogical but most important points to be considered while choosing a thermal camera for detection and tracking of targets in IRST. In the IRST, resolution is important but color is not necessary then Monochrome cameras are better for Long-range application and color CCD camera for medium range application. TV camera has two parts:

a) CCD Sensor.
b) Optical system with zoom control gear.

### 2.2.1 CCD Sensor Sizes / Camera Resolution

Sensors (CCD/CMOS) often referred to fraction of an inch designation such as ¼” or 4/3” called optical format. Aspect ratio of most of the CCD devices is 4:3. For selection of camera resolution and lens focal length, the number of column and rows of CCD pixels in the camera sensor are important. It further depends on the following factors.

- **i.** Field of view is the Area under surveillance that is cover by camera.
- **ii.** Size of the target, that camera has to detect.
- **iii.** Distance: from camera to target.

Viewing filed of all pixels of one Horizontal line in camera sensor will be distributed throughout the length of the arc as shown in fig. Spacing between two nearby pixels in the arc distribution is equal to Length of arc/number of pixel in one horizontal line. To detect the air target by TV camera means the spacing between two pixels should be equal or slightly less than the width of aircraft. If it is greater than the aircraft width

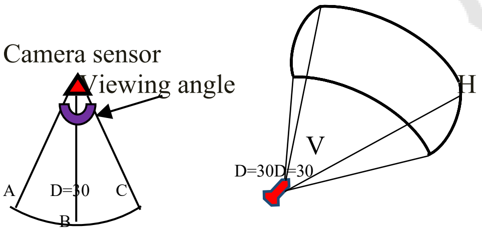

Figure.1: viewing angle and viewing area of camera sensor

$$S_{\text{spacing}} = \frac{8199.36}{H_{Dection}} \leq 14 \; .$$

So $H_{\text{detection}} \geq 8199.36/14 \approx 586$ (4)

Then aircraft will not be detected. Means number of pixels in Horizontal line must be equal or greater to 586.As per Johnson criteria, at least two pixels are required for detection with 50% probability means total no of pixels are required is:

$$586\times2=1172 \text{ pixels} \qquad (5)$$

The same calculation can do for Elevation. Further for aspect ratio 4:3. Therefore, size of camera sensor for recognition is must be equal to or greater than 1758×1318 nearby standard size of CMOS Sensor is 2448×2048= 5 Mega pixel. SONY IMX250 series will be suitable for this application.

### 2.2.2 Optical System with Zoom Control Gear

Above camera sensor cannot work alone without optical system. Optical system with zoom control will focus the complete FOV on the sensor because FOV is 5.87 X 5.87 in degree or 8199 X 8199 in meter and sensor’s pixel size is 3.45 X 3.45 µm (SONY IMX5XX SDI).For calculation of optical zoom parameters for Thermal camera, Focal Length calculated as per figure 2. For Recognition as per Johnson criteria 6 pixel is required so effective pixel size is:

$$= 3.45\times6= 20.7\ \mu\text{m} \qquad (6)$$

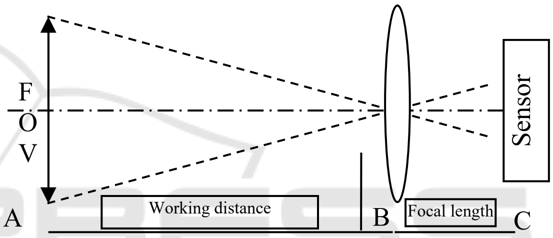

Figure 2: Focal Length calculations

Focal Length recognition BC = Focal Length BC
= (AB× Pixel size)/ Target size
=(30000×20.7×10-6)/14 = 1109 mm (7)

As per above calculation focal length is required from 39.4 - 1109 mm The standard nearby focal length available is 25 -1550mm with 62× zoom.

## 2.3 Tracking Principle

Tracking is the prediction of future locations of moving target, based on its estimation and measurements by uses deferent models of real environment that estimate present, past and even predict future states.

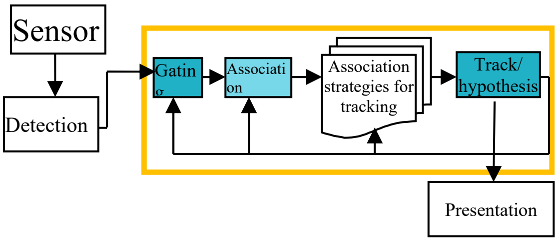

Figure 3: Block diagram of the system

The track is a symbolic representation of a target moving in given vision of filed. In tracking system, a track is representing by a filter state gets update on each new measurement. Tracking function can divided into following two steps:

i. Estimate the current state of target based on tentative measurements selected according to certain rules (Gaitanakis, 2019).
ii. Calculate the accuracy and credibility associated with state estimation.

On the basic of hypothesis the tracker are divide in two categories:

1. Single hypothesis tracker,
2. Multiple hypothesis tracker

## 2.4 Range Measuring Principle

LASER used in the form of a pulsed signal for finding out the range of the target. Time taken by a LASER beam to travel to and fro is compute to measure the range as per following relationship:

$$R_{LRF} = \frac{C * t}{2} \tag{8}$$

d = range of the target,
C = velocity of light.
t = time taken to travel to and fro,

Depending on the beam divergence, the size of target and laser spot projected on a target the targets are can be divide in two categories as under filled targets and overfilled targets. In under filled target, all of energy in laser pulse is scattered by the target. In the over filled target, only a segment of pulse energy will be scattered by target surface at angle of incidence ϴ. According to (Williams, 2018) the maximum effective range R $_{max}$of LRF is calculated given by equations:

When target is under-filled, (i.e. target is larger than laser spot)

$$R\max_{UF} = \frac{1}{\sigma} W_0 \left| \sigma \sqrt{\frac{\eta\rho P_t cas(\theta) D^2}{4 N_f NEI * E_{ph}}} \right| \tag{9}$$

When target is over-filled, (i.e. target is smaller than laser spot)

$$R\max_{UF} = \frac{2}{\sigma} W_0 \left| \frac{\sigma^4}{2} \sqrt{\frac{\eta\rho P_t A_t cas^2(\theta) D^2}{4\pi\varphi^2 N_f NEI * E_{ph}}} \right| \tag{10}$$

$W_0$ = Lambert function. This special function is compute numerically by mathematical software where it known as Lambert w.

NEI = noise equivalent input,
At = target area
Eph = photon energy in joules,
η= efficiency of optical system,
Pt= transmitted pulse energy,
D =is receive- aperture diameter,
$N_f$=factor required to achieve particular FAR

## 3 THE FUNCTIONAL DIAGRAM AND DESCRIPTION OF IRST

The schematic functional diagram of IRST given in following figure 4 and functional details given bellow:

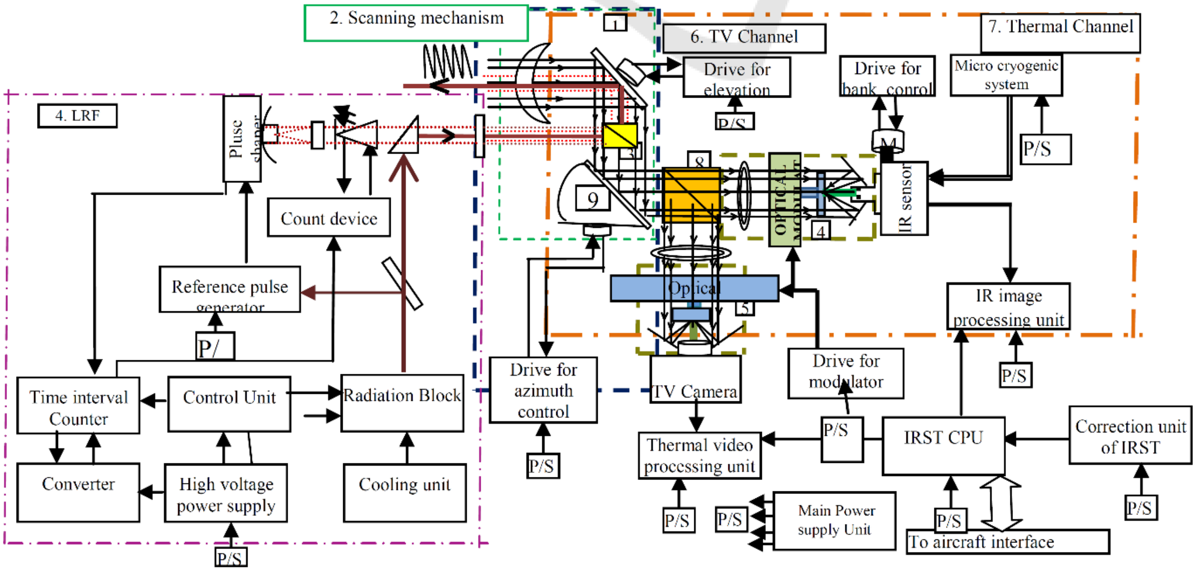

Figure 4: Schematic functional diagram of IRST system

Optical system of infrared channel, which ensures reception and focusing of infrared emission in plane of installed infrared receiver. It consists of fairing (1), scanning mirror (2), and fixed mirror (9), mirror-lens objective with modulator (4).Optical system of thermal channel, which ensures reception and focusing of thermal IR emission in the plane of installed thermal receiver. It consists of fairing (1), scanning mirror (2), fixed mirror (9), wave from splitter (8), mirror-lens objective (5) with modulator, which is a plain-parallel mirror.

Moving scanning mirror is set up the scanning field /zone and controlled by motor and digital position sensors of scanning mirror in azimuth and angle of Elevation. Turning of PSD by an angle proportional to angle of scanning mirror in azimuth Carried out with the help of roll drive, for compensation of turning of image in focal plane of optical system. Roll pitch motor control unit, which control IRST Roll drive using the information from bank and azimuth angle sensors for turning PSD-1 and modulator. Diaphragm pitch motor control unit, that carries out diaphragm drive control for regulating infrared stream at input of objective lens. During this, information from image amplifier about target signal amplitude is used.

Logical block which generates the impulses ND1 and ND2 during zero position of modulator.

In Thermal camera during video recording some time require to zoom the particular area of view there are two type of zoom system first optical zoom can be obtained by optical zoom lens and second digital zoom can be obtained by image processing tools. To control the thermal IR intensity authors have used gain control unit, which control the gain of camera according to amplitude of detected signal by controlling the diaphragm aperture.

Optical system of laser ranger consists of airing, laser optics mounted at scanning mirror, fixed mirror, waveform splitter mirror in laze path. Optical circuit of laser ranger ensures generation of laser beam in the reflected direction of line of sighting, reception and focusing of radiation from the target in plane of mounting of photoreceptor (PSD-2) of laser ranger.PSD-2, which converts reflected energy from target or from the surface of the ground into electrical signal. Pulse generator, generates reference pulse of time interval counter and echo-pulse. Time interval counter which measures delay time between the reference impulse and first arrived echo impulse in probing clock.

## 3.1 Working Mode of IRST

IRST system has generally three modes. One detection and tracking mode called infrared mode (IR channel), distance-measuring mode called laser mode (LR mode) and target detection and tracking through video channel (TV Camera).

1. Mode 0: IR and TV mode;
2. Mode 1: IR mode;
3. Mode 2: TV mode

## 3.2 Viewing/Scanning Mode Operation

In IR mode, following article has four operational modes, which listed below.

- i. Large field Surveillance Mode
- ii. Small field surveillance Mode.
- iii. Lock On & Tracking.
- iv. Working of Laser range finder (LRF)

### 3.2.1 Large Field Surveillance Mode

Block diagram of big surveillance field mode shown in figure 5. This mode solved by ICPU with frequency 500 Hz. At this, dedicated software program is use to establish coordinate of boundary of the field ($70^0$ X $20^0$) in preset order. At the points, 12, 3, 6, 9 the sign of control signal for drive is changed. At the points 3, 6, 9, 12; operation carried out on E. The coordinates of each new point of trajectory of sighting line given in the form of target

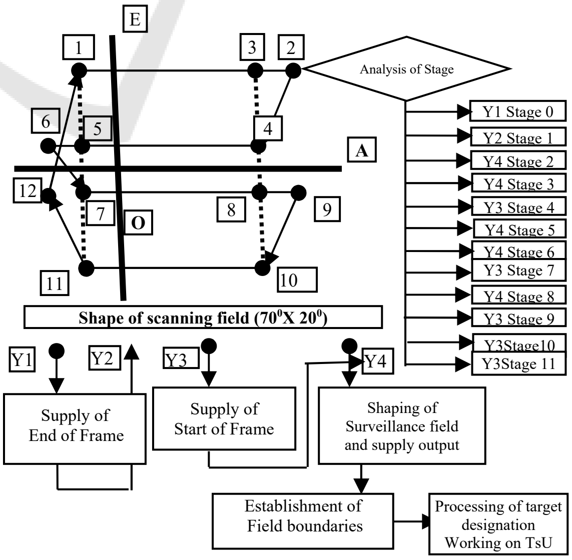

Figure 5: Flow diagram of big surveillance field ($70^0$ X $20^0$) mode

indication on A and H. When operating in $140^0$ X $20^0$ modes, the point with coordinates of external target indication is center of field. The whole field has 12 checkpoints. Points 1, 4, 7, 10 are specific in that, they are starting of working sections, on which calculation and supplying of coordinate of detected targets onazimuth φy andelevation angle φz:

$$\varphi y = \varphi^{HDF} y = \varphi At,$$
$$\varphi z = \varphi^{HDF} z = 2\varphi Et \pm \boldsymbol{\delta} E; \text{ is carried out.} \qquad (11)$$

**δ**E – mismatching code between coordinate line of sight and coordinate target on angle of elevation. When switch on first time, for smooth movement of line of sight, the current value of output code of azimuth sensor φAt and doubled current value of output code of elevation angle of sensor 2φEt sent tocorresponding memory cell, where the value of integrator is solved:

$$\varphi Aii = \varphi At, \& \varphi Eii = 2\varphi Et. \qquad (12)$$

After working out checkpoint 11, the signal "End of frame" ("EF") is supply to onboard digital computer. Marking of view field ($140^0$ x $20^0$) is carryout with respect to the coordinate of external target indication $\varphi^{TD}y$, $\varphi^{TD}z$ (on A & E) in accordance with the stage number.

### 3.2.2 Small Field Surveillance Mode

Block diagram of Small surveillance field mode given in figure 6. This mode solved by ICPU with frequency equal to 500 Hz. The following tasks solved:

i. Viewing the field (30° X 10°); ii. Drive control on bank.
iii. Tracking the target in the field (30° X 10°); (13)

The whole field (30° X 10°); has six characteristic points. Until detecting first target, the coordinates of external target indication are center of field. On detection of target, device is shifted to internal target indication the coordinates of tracking target to be tracked are its coordinate. At this, the task of selecting tracking target arises, coordinates of which determine the position of center of viewing field in the next frame. In the remaining, the shaping of viewing field carried out similarly as in (140° X 20°) mode. During first setting of device to mode, if still it is not in any mode, for smooth movement of sighting line, the current value of output code of azimuth sensor φAt and doubled value of output code of elevation angle sensor 2φEt are recorded in corresponding memory cell, where the values of integrator:

$$\varphi Aii = \varphi At; \quad \Phi Eii = 2\,\varphi Et, \text{ are served.} \qquad (14)$$

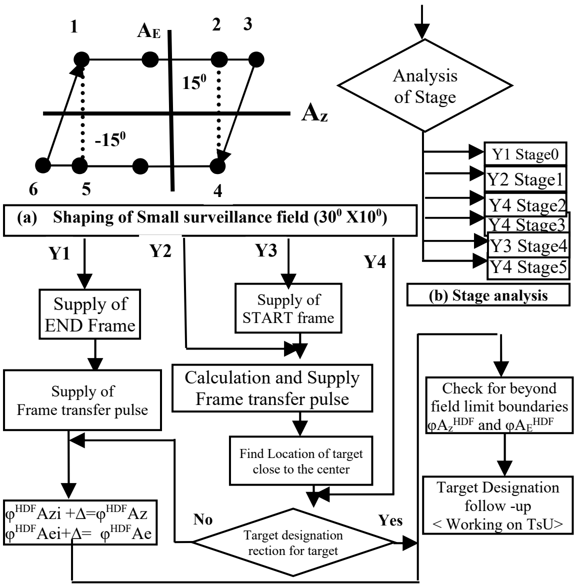

Figure 6: Flow diagram of small surveillance field ($30^0$ X$10^0$) mode

ΦEii –Current value of angle of elevation integrator; ΦAt&ΦEt – Current values of Azimuth& elevation sensor; For determining the coordinate of target, near to the center (for frame), calculation of distance between the coordinates of target and coordinates of center of field carried out by formula:

$$\sqrt{\left(\varphi y - \varphi_y^{HDF}\right)^2 + \left(\varphi z - \varphi_z^{HDF}\right)^2} \qquad (15)$$

Minimum distance from the center of field is established.

## 3.3 Lock on & Tracking Mode

Firstly, lock on is effected in $4^0$ azimuth and$4^0$ elevation area. Here IRST mirror does not move in elevation at all. There are 64 photo elements arranged vertically, which covers $4^0$ in elevation. To cover $4^0$ in azimuth, a small mirror inside the Opto-mechanical assembly oscillated at the rate of 25 Hz since it is very difficult to move the outer IRST mirror with such a high rate due to its bulkiness. The target automatically brought to the center of the area with the help of control signal from the ICPU to the outer mirror antenna. As soon as the target brought to the center of ($4^0$ X $4^0$) area, the second phase of lock on starts. In this phase of lock-on, the coverage area is reduced to 40' X 40'. Elevation coverage of the area done with the help of 12 central photo receivers, without physical movement of the antenna. In azimuth plane, 40' covered by oscillation of the inner small mirror at the rate of

100 Hz. As soon as the target brought to the center of 40’ X 40’ area, the third phase of lock on starts.

Now, the lock-on area further reduced to 12’ azimuth and 18’ elevation. Azimuth plane is covered by oscillating the inner mirror at 100 Hz, whereas elevation plane covered by 06 central photo receivers (out of previous 12).

### 3.4 Working of Laser Range Finder (LRF)

LRF operates in two modes as follows: Modes of operation of LRF decided by a command received from Mission Computer through electronic unit.LRF Operates in stand- by mode when the target range is above than 1600 meters. Laser pulse, repetition frequency is 0.25Hz. Range up to the target calculated by timer circuit by calculating the period of pulse and generated equivalent range of target. LRF Operates in main mode when the target range is less than 1600 meters. Laser pulse, repetition frequency is 2Hz Range up to the target is calculated and generated as stand-by mode.

## 4 ROBUST COMPOSITE AXIS CONTROLSYSTEM FOR IRST

The tracking precision, accuracy and stability are most important in IRST system. Scanning mechanism has mismatching position error between servo-control system and sensor unit at azimuth or elevation arrived, then scanning mechanism oscillating at their current position. This problem comes due to mismatching in sensor reading servo control feedback or motor eddy current and hysteresis loss of motor and this effect called jitter. To overcome limitation of IRST control system we proposed a control system for both axis azimuth and roll is called composite axis controller consists of the scanning mirror angle sensor, stepper motor for drive and free steering movable control system(FSM) with modulator. The robust controller consists of PI controller with following coefficients given as:

J = Armature moment of inertia

$T_F$ = Armature viscous damping,

.$K_e$= Velocity constant.

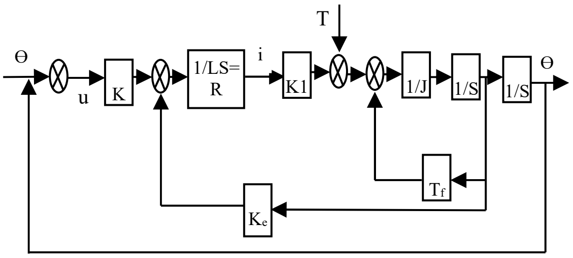

Figure 7: Control system

### 4.1 Free Steering Movable (FMS) Controller to Compensate Image Turing Due to Roll of Target

For focusing problem of IR / thermal, signal on PSD during the turning of image due to rolling of target solved by free steering movable robust controller. The block diagram FMS controller shown in figure 8 and consists of:

1. Roll/bank control drive
2. Optical modulator

The roll control drive aligns the optical line sight between scanning mirror and PDSin azimuth through servo control motor and tunable PID controller in azimuth and Optical modulator aligns fine mismatch position between scanning mirror and PSD in elevation. The optical modulator is oscillating mirror fixed on two springs. Its oscillate at 2Hz in $4^0$ X $4^0$ viewing flied and .25Hz in40’ X40’ viewing flied during lock-on and tracking mode. At frequency 25 Hz, Zero position fixation error is 2’.

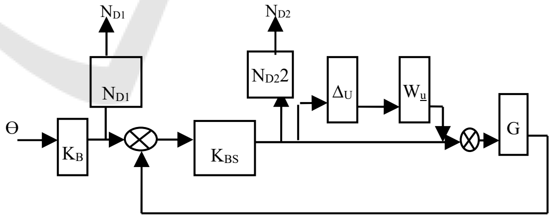

Figure 8: FMS Controller

At frequency 100Hz is 0.2’. The signals $N_{D1}$ and $N_{D2}$ are standard digital signal logic 1with duration 2 to 20 μ sec.

## 5 RESULT AND DISSCUSSION

To find the best algorithm for IRST detection and tracking for maneuvering targets, authors have estimated the motion of targets by using various models. It assumed that two targets are closely spaced; they can fall within a single sensor resolution cell and sensors reports, only single detection form multiple targets when targets are so closely spaced that sensors cannot resolve them spatially.

To demonstrate a case where sensor reports an ambiguously assigned to tracks, authors have created a simple scenario. In this scenario, a single IRST radar sensor object, located at origin, scans a small region about 20 km from radar. Initially, radar reports about two detections per scan. When detections are coming from a region around X = 0, Y = -20 km position, the radar reports a single detection per scan for a while, followed by two radar detections reported from around Y = -19.5km and toward the sensor (up).

Simulink model for evaluation of detection and tracking algorithm for closely spaced target shown in figure 9.

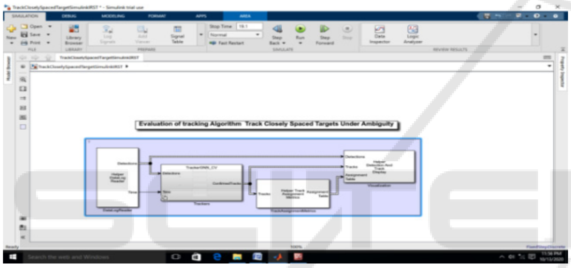

Figure 9: Simulink model for evaluation of detection and tracking algorithm for closely spaced targets.

The scenario and detections log already saved in a mat file. The detection and time data from this scenario saved in scenario file "CloselySpacedData.mat".

JPDA allows a single detection to be used for updating multiple tracks in its vicinity JPDA does not maintain multiple hypotheses over multiple scans, which makes it a sub-optimal approach as opposed to MHT. Tracker JPDA with IMM filter tracks the maneuvering targets more precisely and did not break or lose the track even during turns and in ambiguous region. The targets more precisely tracked during the turn and sufficiently separated in the ambiguity region.

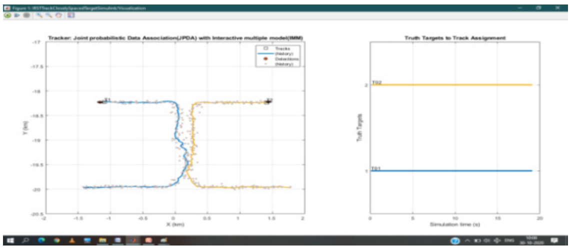

Figure 10: Tracker "Joint probabilistic Association (JPDA) with Interactive Multiple Models (IMM)

The tracker TOMHT with IMM filters, tracks maneuvering targets more precisely and did not break the track even during the turns and in the ambiguous region throughout the scenario. The runtime for a tracker TOMHT is significantly longer than using tracker JPDA.The tracking accuracy is similar to the combination of single-hypothesis tracker with IMM filter.

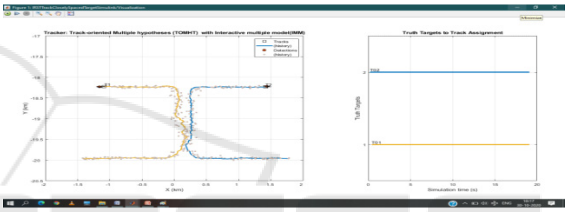

Figure 11: Tracker "Track-Oriented Multiple Hypotheses (TOMHT) with multiple interactive models (IMM)"

The results show that GNN and JPDA can track the targets 5 to 6 times faster than MHT depending on the motion model. The IMM motion model makes all three trackers run 3 to 4 times slower. Note that each tracker processing time varies differently depending on the scenario's number of target, density of false alarms, density of targets, etc. In this case, JPDA proves to be the best option. In different scenarios, we may require the more complex MHT when neither GNN nor JPDA gives acceptable tracking results. You may as well prefer GNN if there are less ambiguity regions or low clutter density. The robust composite axis control model made on Matlab Simulink 2020 platform that is consist of:

1. Target model
2. IRST model with PI controller

The screen shot of Matlab simulation model shown in figure 12. In simulation model assumed that motion of target is unknown and random in nature. Tracking and pointing error of scanning mirror simulated by target model and PI controller with FMS controller at Matlab 2020 trial version.

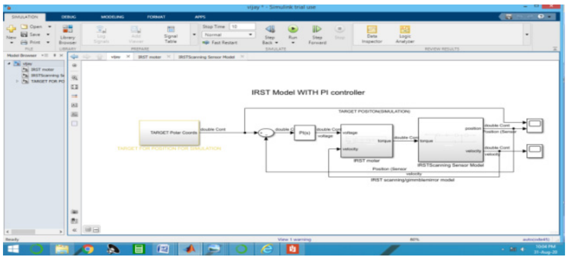

Figure 12: IRST model with PI controller

PI controller Parameter values:{ Kg=2000, Kf= 0.027, Kt= 0.07, R=10, L=1e-05, Kd = 5, I/J=8.6, PI & AI value are tunable}

During simulation, when we setup the parameter of PI controller [proportional (P) =240 and Integral (I) =180], the simulation result showed there much error in target position and senor measured position as figure 13..After tuning and simulation we found that at PI Proportional (P) =1000 and Integral (I) =500, there is less error found in actual position and senor measured position as shown in figure 14.

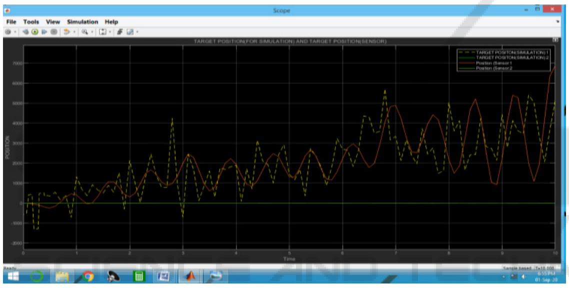

Figure 13: Graph target position and senor measured position[Proportional (P) =240 and Integral (I) =180]

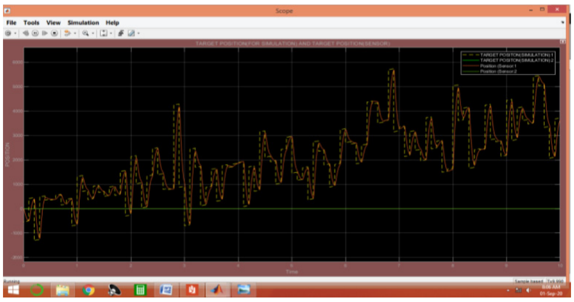

Figure 14: Graph target position and senor measured position [Proportional (P) =1000 and Integral (I) =500]

## 6 CONCLUSION

The proposed IRST system have IR channel, TV camera, and LRF is installed in a single optical window with two different signal processer, first IR signal processor use for IR signal processing in IR channel and second video signal processor for video signal in Thermal/ video channel. The communication between IRST CPU (ICPU) with aircraft system done by using two type of bus protocol. The IR signal processor use ARINC 429/1535b bus protocol and video processor use ARINC 8181 bus protocol under control and supervision ICPU. The Proposed modification in the IRST system improve the performance, reduce the size, and weight that is basic need of fighter aircraft.

The simulation result shows, that the Tracker JPDA and TOMHT with IMM filter tracks maneuvering targets more precisely and did not break or lose the track even during the turns and in the ambiguous region. The targets are more precisely tracked during the turn and are sufficiently separated in the ambiguity region However, the runtime for a tracker TOMHT is significantly longer than using tracker JPDA and computational data is less hence required less memory space than tracker JPDA.

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