10 CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

The aim of this research work is to develop a low-cost, PC based, high-fidelity, IR signature model and simulate missile-target engagements and IR countermeasure dispensations. This chapter concludes the research work performed in modelling the high-fidelity IR signature model of an imaging missile seeker. The challenges faced and the limitations are discussed. Recommendations are made for further research work which may be undertaken in continuation of this work.

10.2 Research Objectives

In light of the increasing terrorist surface-to-air missile (SAMs) threat to civil and military aircraft, we cannot overstate the need of a high-fidelity, low-cost, PC based IR signature scene modelling and simulation capability which could be used for development, testing and evaluation of Infrared Countermeasure (IRCM) systems. The IR signature simulator must utilize COTS software and have provision for adapting to greatly expanded and rapidly changing tactical environment. It must be able to model new missiles, targets and their advanced capabilities. The system should be a modular software structure so that new features or changes could be easily incorporated.

10.3 Thesis Conclusions

The algorithm has been developed to simulate passive IR imaging seeker engagements with aerial targets. It can simulate surface-to-air and air-to-air missiles. It models missile guidance, auto-pilot and imaging seeker trackers. The high-fidelity physics based IR signature of military targets, backgrounds and expendable IR flares are modelled. The models are based on the equations derived from open-source material and published literature. The flare ballistic trajectory, spectral and temporal responses are modelled. The atmospheric conditions such as "*good*", "*typical*" or "*bad*" weather conditions are considered to model atmospheric transmission and the sky radiance. The simulator is utilized for IRCM analysis to predict and plan IR countermeasures in a hostile situation.

The input parameters are fed in using Microsoft Excel spreadsheets. The simulation outputs are presented in the form of data files, 2D/3D graphs and also virtual reality scenes or animations. The scenario is built up in a 3D virtual world to position the missile launcher platform, the target platform and move them as per the planned engagement sequences. The IR countermeasures are dispensed at appropriate times and in the desired direction. During simulation the missile, target and flare parameters are recorded for future analysis. The missile imaging seeker output is recorded to animate the output. Various viewpoints are modelled to observe simulations from different aspects.

The code is written in MATLAB which gives it openness for user verification/validation and also flexibility for any future up-grading or modifications. The following paragraphs summarize the work undertaken in this thesis.

10.3.1 IR Signature Modelling

The high-fidelity realistic 3D models of sub-target with different temperature zones and radiometric properties are developed to represent dull metallic body parts, shining leading edges, hot exhaust gas plumes and reflecting glass canopy. These effects are modelled using "*emissiveColor*", "*diffuseColor*", "*ambientIntensity*", "*specularColor*", "*shininess*" and "*transparency*" fields of VRML. The total radiance depends upon the temperature, emissivity, atmospheric transmission and the spectral waveband. The radiance of the sub-targets and backgrounds are converted into RGB colour. It is suggested that the "*jet*" colour-map is the most suitable to represent IR signature in the 3-5 and the 8-12 micron wavebands. The power received at the detector is calculated to estimate the lock-on range for each target. The atmospheric attenuation adversely affects the IR radiance and reduces the lock-on range. The IR background is modelled using the "*background*" node of VRML as sky and ground with the ground as one uniform selectable from pre-stored data and the sky as three horizontal layers representing different altitudes. The IR atmosphere transmittance and sky radiance is modelled using LOWTRAN atmospheric transmission data stored in lookup tables for different weather conditions. The data for desired weather conditions, altitudes and the waveband is called in the main programme. An effort is made to use the "*fog*" node of VRML to represent the atmospheric transmittance. The results of the IR signature modelling needs to be validated in future work.

10.3.2 Missile Modelling

The missile sensor is modelled as an imaging seeker. The resolution of the detector, pixel size, *NEP*, signal-to-noise ratio and refresh rate are modelled. The seeker optics diameter, transmission and FOV are modelled. The spectral range of 1-15 micron is considered, however, the spectral response of the seeker optics is not modelled. The missile aerodynamics is modelled using speed and the load factor to limit the lateral acceleration. The missile seeker is modelled as a gimballed head capable of rotating in a hemisphere in front of the missile independent of the missile-LOS. The missile guidance in modelled using pursuit course and the tracking algorithm is modelled as the binary and the intensity centroid trackers. The kinematic CCM is implemented which gives a forward bias to the seeker head on detection of a fast separating false target such as a flare. The hit criterion is modelled as a cylindrical space in front of the missile. The missile LATAX algorithm is validated using different sets of speed and load-factors and the centroid tracker algorithm is validated against hand calculations.

10.3.3 IRCM Modelling

The IR expendable flare ballistic trajectory, spectral and temporal responses are modelled. The flare pallet ballistic trajectory is modelled as per the host platform velocity, flare ejection velocity, firing angle, the drag-coefficient, mass of the pallet, cross-sectional area and atmospheric density. The flare plume shape is modelled as layers of co-centric cones of different sizes. The spectral response of the flare is modelled and the radiance of the plume is calculated as per the temperature and emissivity of each layer. The flare temporal response is modelled using the burn-time, rise-time, burn-time constant and rise-time constant. At present a maximum of four flares can be dispensed simultaneously or with different time gaps and with different firing angles in the forward and downward directions. However, sideways firing is not modelled. It is assumed that during the flare burn time the mass of the flare and the cross-sectional area remains constant. The effect of the wind drift, atmospheric turbulence and lift induced due to spin are not modelled. The flare trajectory is validated against published data.

10.3.4 Missile-target Engagement Simulation

The simulations of the missile-target engagement have been performed successfully. The mission planning and scenario building is performed using input parameters of the missile, target, flare and the background and are stored in the Excel spreadsheet. The 3D virtual world is developed using virtual models of the military target (such as F-16, C-130, Boeing B-737 and HIND Mi 24), flare, background and the missile. The target is modelled to perform movement in 4-DOF, the pitch and role movements of the aircraft are not modelled. The target simulator generates trajectories using speed and load factor and rate-of-descent. Depending upon the mode selected, the target aircraft may perform crossing, head-on or tail-on manoeuvres. The aircraft may follow straight-and-level or level-turn flight paths. The manoeuvres such as landing, climbing and spiral descent can also be modelled. The missile can move with 5-DOF but the role movement is not modelled. The "*translation*" and "*rotation*" fields of VRML are used to control the movement of the missile, target and the flare in the 3D virtual world. Multiple viewpoints are selected to observe the missile-target engagement sequences from different aspects such as seeker head view, missile-LOS view, missile launcher view, bird's eye view and fly-along missile view. During the simulation each frame is captured from 3D VR viewer to generate the error signal to steer the missile towards the target. The seeker output is captured at every frame and can be recorded for playback.

10.3.5 Extracts form IRCM Analysis

The IRCM analysis is performed on a target aircraft flying in straight-and-level or in level-turn flight and deploying different types of flares, fired at different angles. The following are the conclusions of the IRCM analysis:

(a) The standard flare fired downward or forward is suitable to protect the fast-jet aircraft from an IR seeker missile not equipped with kinematic CCM feature. It provided about 89% self-protection level.

(b) The standard flare fired downward or forward is not suitable to protect the fast-jet aircraft from a kinematic CCM based IR seeker. The self-protection level for crossing target is about 10-20%.

(c) An aerodynamic flare C_D 1.0 fired forward may protect the fast-jet aircraft from a kinematic CCM based IR imaging seeker. The self-protection level for crossing targets improved to 70%.

(d) An aerodynamic flare C_D 1.0 fired forward and taking a level-turn does not cause any significant improvement in the self-protection level.

(e) An aerodynamic flare C_D 0.1 fired forward is suitable to protect the fast-jet aircraft from a kinematic CCM based IR imaging seeker. For crossing-targets the self-protection level has increased by 90%. However, in tail-on aspect due to the re-lock (after flare burn-out) the self-protection level has reduced to 62.5%.

The analysis and results of a standard and an aerodynamic flare (C_D 1.0) deployed by an aircraft flying in a straight-and-level mode are validated against published results of CounterSim simulations. However, the results of the aerodynamic flare C_D 1.0 in level-turn and the aerodynamic flare with C_D 0.1 could not be validated as the CounterSim analysis data was available only for the straight-and-level flight.

10.3.6 Fidelity of the Model and the Assumptions Made

In this work, efforts have been made to achieve high fidelity IR signature model using virtual reality modelling techniques. The 3D realistic sub-targets with different temperature zones and radiometric properties have been modelled. Considering the reflectivity and transmissivity of the material, the special effects such as the exhaust gas plume, leading edge reflection and cold sky reflections from the glass canopy have been modelled. The multiple flare dispensation with spectral and temporal responses is modelled. The background has been modelled as multiple layers of sky and the ground can be modelled as detail terrain and man-made structures. The LOWTRAN atmospheric transmission code has been used to model the atmospheric transmittance. Although efforts have been made to model as accurate and as close to reality as possible, still many assumptions were made to keep the code simple and easy to implement. Table 10-1 list out the features available and the assumptions which were made at different stages of the thesis work.

Table 10-1: List of features available in the model and the assumptions made

Feature	Assumption	Remarks
SEEKER		
Spectral resolution	20 cm^{-1} as given in LOWTRAN code	Could be increased to 5 cm^{-1} using MODTRAN code
Spectral waveband	1 to 15 micron	To cover typical IR seeker systems
Spectral step	0.01 micron	For IR signature modelling less than 0.1 micron gives sufficient accuracy
Spectral response of seeker optics	Transmission of seeker optics constant	Spectral response of seeker optics not modelled to keep model simple
Imaging seeker	256x256 pixel detector	Considered a 256x256 pixel seeker to represent moderate resolution imaging seekers
Refresh rate	100 Hz	To represent typical seekers.
Seeker head gimbal maximum angle limit	± 90 deg	Typical missile seeker coverage is in a hemisphere in front of seeker
Seeker FOV	1 to 2 deg	Typical values for most seekers
ATMOSPHERE		
Weather conditions	Good, typical and bad	Just to model affects of different weather types
Atmosphere extinction	First order model	Based on LOWTRAN atmospheric transmittance code
Atmospheric turbulence	No turbulence in atmosphere	Turbulence is due to time-varying temperature in-homogeneities which is not considered in this model
Path radiance	Clear path	The path radiance is not considered
Sky as background	Three layers: sea level, 1 km and 10 km	To demonstrate the feature however more layers could be modelled
TARGET		
Target intensity resolution	Quantized over 256 RGB colour-index	For visual observation considered sufficient resolution. Can be increased to 512, 1024 etc.
DOF	4-DOF for target movement	Aircraft cannot perform roll and pitch movement. Not considered to keep model simple
Sub-target types	Dull metal skin, shining edges, glass canopy, exhaust gas plume	To show how different radiometric properties can be modelled in virtual reality

Table 10-1: List of features and the assumptions made (continued)

Feature	Assumption	Remarks
Exhaust gas plume	Two layers of co-centric cones	Considering only the inviscid core of the plume which holds bulk of the IR radiations
Exhaust gas plume	No effects of altitude on exhaust plume IR intensity	Not considered to keep model simple
Spectral emissivity of exhaust plume	Between 3 to 5 micron in steps on 0.01 micron	Considered only in regions most sensitive to water vapours and CO_2
Aircraft speed	0.4 to 2.2 mach	To cover typical transport and fast jet aircraft
Aircraft ROD or ROC	Input as x1000 of meters/sec	ROD fed as an input parameter
Aircraft manoeuvres	Straight-and-level, in-turn, climb, landing and spiral descent	To cover typical manoeuvres which target can perform
FLARE		
Flare IR plume geometry	Two layers of co-centric cones	Considered inner layer at higher temperature and outer layer with semi-transparent
Flare IR plume radiance	Wind and altitude effects on flare plume not considered	For keeping model simple
Flare pallet geometry	Square/rectangular/cylindrical base pallet	Three shapes with different cross-sectional area calculated
Mass of flare pallet	constant	Flare burn-out affects on mass not considered
Flare cross-sectional area	Maximum area facing air stream and remains constant	Flare burn-out, spin or rotating affects not considered
Flare trajectory	No drift due to wind	It is assumed that the air is still
Flare trajectory	Atmospheric density constant during flare functional time	Flare travel few hundred meters in vertical direction for which atmospheric density is considered constant.
Flare firing angle	Can fire flare in any direction in a vertical plane along the direction of aircraft motion	Sideways firing not considered to keep the code simple
Multiple flare dispensation	Four flares simultaneously or with intervals	Four flare modelled just to show the algorithm is working. However, the number can be increased at any time.
Flare types	Standard and aerodynamic	for comparison and analysis of IRCMs
MISSILE		
Hit criterion	2 meter radius cylindrical volume in front of missile	If missile-target distance is less than missile step and within 2 meters radius it is a hit

Table 10-1: List of features and the assumptions made (continued)

Feature	Assumption	Remarks
Miss-distance	Calculated between centre of target and the missile	Missile and target considered as point objects for miss-distance calculations
DOF	Missile can perform 5-DOF	Roll movement not modelled as it has little effect on IR signature
Missile approach information	Missile launch information given as input	MAWS not modelled and missile position and direction given as input at start of the simulation
Missile speed	1 to 4 Mach	Typical range for aerial targets
Missile LATAX	Based on load factor and speed	LATAX modelled by limiting rate-of-turn based on load factor and speed
Tracker	centroid tracker	Binary and intensity centroid tracker implemented in algorithm

10.4 Contributions

Maximum efforts are focused to develop an algorithm for high-fidelity IR signature modelling and simulation. This work was started from scratch and stage wise the model was improved and new features were incorporated in the algorithm. The following are the areas which took significant effort and time. These are the contributions made towards the development of the high-fidelity IR signature scene in 3D virtual world.

(a) The virtual world of the missile-target engagement scenario is modelled in 3D using several "*nodes*" and "*fields*" of VRML. The code is written in MATLAB to control the appearance of the targets, background and the flare and to model the high-fidelity IR signature scene in the 3D virtual world.

(b) In MATLAB the field values of the virtual world are refreshed during idle time. However, during the simulation refreshing the virtual scene and capturing the seeker output as a 2D image from the 3D VR-viewer at every frame was a big challenge.

(c) In VRML only a limited number of depth frames can be rendered at one time. Therefore, during simulation controlling the VRML depth resolution for the changing missile-target range was another area which required lots of effort.

(d) In the 3D virtual world, controlling "*translation*" and "*rotation*" fields of the target, flare and the missile to simulate the missile-target engagement and the countermeasure dispensation was a challenge. The position and direction of all the moving objects in the virtual world were calculated at every frame and the field values were updated accordingly.

(e) The modelling of the missile lateral acceleration, gimballed seeker head and the centroid tracker are areas which required significant effort.

10.5 Limitations

Although, maximum efforts were made to refine the algorithm and increase the fidelity of the model. However, there are still some areas which need improvement, but due to the shortage of time these could not be undertaken at present. The following are the limitation of the algorithm which needs to be resolved in future work.

(a) In some cases of crossing targets, the hit-criterion is not working properly because when the missile target gets very close and the target fills the full FOV, the seeker takes it as if no target was present and terminates the simulation loop.

(b) The actual recording feature of VR viewer is not working properly. Presently, the simulations are recorded manually by storing the output of each frame as image files and using video-making software to replay the simulations.

(c) Selecting 128x128 pixel resolution for the imaging seeker is not resolvable by the VR-viewer. Presently 256x256 or any higher resolution can be used.

(d) The missile guidance and auto-pilot algorithm is working well in 3D for all cases except when the target goes behind the missile. In that case the missile stops steering towards the target.

(e) Irrespective of the location of the target, at the start of the simulation, the missile-LOS is always towards the negative Z-axis. In the surface-to-air missile mode the missile can not look directly towards the target.

(f) In MATLAB, the VR-viewer refreshes the VR world field values once the MATLAB is idle and no function is being performed. However, for running simulations the VR-viewer output is captured within the "*while*" function of MATLAB. This causes problem as the virtual world was not updated in each frame. To refresh the VR field values a delay of 0.04 sec is added using the "pause" function of MATLAB. The value of 0.04 sec selected as below this value the data was not updated correctly.

10.6 Recommendations for Future Research Work

Although, a number of research objectives have been accomplished, the extent of the research work is ambitious and a substantial amount of simulation code verification is leftover. Throughout this work references has been made to areas warranting improvements in the existing algorithm or future validations. The suggested evolution of the work in each area is presented as follows:

10.6.1 IR Signature Modelling

(a) Increasing the fidelity of the IR signature model by modelling the total radiance of the target by adding the reflection effects and the path-radiance and modelling earth-shine, sky-shine, cloud-shine using diffused and specular reflections and modelling solar irradiance as a point light source in VRML which radiates equally in all directions.

(b) Generating look-up tables for sky-radiance and atmospheric transmission for several atmospheric conditions using LOWTRAN atmospheric transmission code.

(c) Integrating the Windows based commercial version of MODTRAN atmospheric transmission code like PcModWin-4.0 of Ontar Corporation Canada for atmospheric transmission.

(d) Adding scattering effects for atmospheric transmission.

(e) Modelling 3D clouds or multi-layer atmospheres by selecting more than one atmospheric condition in the path between the source and the seeker. The clouds will have effects in the foreground (attenuating the energy of the target as it passes through the clouds) as well as in the background (as a background or source) which needs to be modelled separately.

(f) Modelling higher order backgrounds by considering multiple ground in 3D virtual world.

(g) For the IR signature the dominant parameters are temperature and the emissivity. Whereas, in the visible range the reflectivity and the external source irradiance are dominant. The "day-and-night" mode may be modelled by using the "*light-sources*" and "*diffuseColor*" of VRML for output in the visible spectrum and using the "*emissive-colour*" with no "*light-source*" for the night vision.

(h) Multi-sensors, like the human eye in the visible spectrum, near-IR for night-vision goggles (NVGs), MWIR for the missile sensor, LWIR for FLIR imaging system and MAWS in the UV band may be modelled using different colours of light to represent different wavebands.

(i) Modelling the IR atmosphere using the "*fog*" feature of VRML by selecting "fog-type" as "*exponential*" and altering the "*visibilityRange*" field. The VRML "*fog*" node may represent the atmospheric transmission in the 3-5 and 8-12 micron wavebands. This possibility may be explored in future work.

10.6.2 Missile Modelling

(a) Presently, the total transmission of the seeker optics is considered for calculating the power received at the detector. To increase the fidelity of the model the spectral response of the missile seeker optics and the seeker detector may be modelled.

(b) Modelling a missile launch from a moving or flying platform.

(c) Presently, the gated-video tracker (GVT) algorithm can model binary and intensity centroids. In future work the tracker algorithm may be modified to model the threshold-intensity centroid tracker also.

(d) Modelling a correlation tracker to lock-on to the aircraft glass canopy instead of the body or the exhaust plume.

(e) In the 3-5 micron band the missile typically locks-on to the exhaust gas plume. The lead-bias moves the missile bore-sight from the plume to the body. In future work the lead-bias feature may be incorporated in the missile tracker algorithm.

(f) Adding an aim-point for the current and last two frames to trace the change in the centroid tracker output.

(g) Presently, the missile guidance follows the pursuit-course. In future work the modelling of Proportional Navigation Guidance (PNG) and provision for selecting either pursuit course or PNG may be added.

(h) Improving the missile aerodynamics by modelling thrust, drag, gravitational and atmospheric effects on the missile acceleration.

(i) Presently, I have developed my own algorithm for missile guidance and tracker modelling. In the future work the possibility of using MATLAB "*Aerospace Blockset*" or "*AeroSim Blockset*" of Unmanned Dynamics LLC, USA for missile modelling and integrating it with VR-viewer may be explored.

(j) Modelling an electronic-gate around the target contour for IRCCM techniques using the "*regionprop*" function of the MATLAB.

(k) Some advanced seekers use dual-colour detectors for flare rejection. These effects may be modelled by adding another detector in my algorithm. This could be used for analysis of the flare rejection techniques such as monitoring the intensity ratio for dual bands or comparing the instantaneous intensity to the historical averages etc.

10.6.3 Target Modelling

(a) Generating a library of 3D models of different aerial and ground targets for the IR signature modelling by tailoring the 3D models available from open-sources.

(b) Using "*LOD*" (level of detail) and "*texture-map*" nodes of VRML for selecting a high resolution target model for short ranges and models with fewer details for long ranges.

(c) Presently, the target aircraft can perform 4-DOF. In future work the "*pitch*" and "*roll*" movement of the aircraft may be modelled.

(d) Modelling pull-up and pull-down movement of the aircraft in vertical turn.

(e) Modelling target aircraft evasive manoeuvres by generating B-spline curves using MATLAB Splines Toolbox.

10.6.4 IRCM Flare modelling

(a) Modelling fly-along or self-propelled flares by adding lift and thrust effects in the flare motion equation.

(b) Modelling IR signature suppression techniques such as IR smoke and obscurant cloud by modelling these in the 3D virtual world.

(c) Modelling multiple flare dispensation in sideways directions.

(d) Considering flare burn-out effects on the ballistic coefficient (changing mass, reference area and drag coefficient) and modelling flare trajectory as per the varying ballistic coefficient.

10.6.5 Running Simulation

The following improvements may be incorporated to make the simulator more efficient and user-friendly. These improvements are mostly related to the mission planning process and the running of the simulations.

(a) Developing an algorithm to generate batches of simulations with varying input settings for each single simulation run.

(b) Modelling two different refresh rates and selecting the faster rate as the missile approaches the target.

(c) Adding additional displays to observe the simulation outputs in multiple windows. For this purpose a graphics card with dual display feature may be required.

(d) Developing a Graphical User Interface (GUI) to make mission planning, input data feeding and results analyses a more user-friendly process. The GUI may be developed using the GUI building feature of MATLAB.

(e) Presently, the air-to-air or surface-to-air mode can be selected. The air-to-ground and surface-to-surface modes may be modelled.

(f) Integrating VR-viewer with MATLAB Simulink to simulate the missile target engagement in the Simulink block level environment.

(g) Modelling and simulating multiple target scenarios.

(h) Developing an IRCM simulator by integrating the FlightGear open source flight simulator with my algorithm and providing real-time controls of the target aircraft to the user. The simulator may be used for pilot training against heat seeking missile threats. They may use it for practising flare dispensation and planning evasive manoeuvres in a hostile environment.

10.6.6 IRCM Further Analysis

Some analysis has been done in this work and the following may be performed by making a few changes in the existing models.

(a) Analysing the effects of multiple flare dispensation in different directions on the IR seeker missile.

(b) Flare dispensation optimization for different target aircraft against specific missile threats.

(c) Analysing large-aircraft (e.g. C-130) vulnerability, survivability and recoverability against the MANPAD threat and to investigate ways to reduce that vulnerability.

(d) Analysing the effect of aircraft complex manoeuvres with flare dispensation on miss-distance.

(e) Analysing new types of flares and their dispensation sequence to determine the most suitable tactics in a hostile environment.

10.6.7 Directional-IRCM Modelling and Analysis

Presently, only the expendable flares have been modelled. In future, the Directional-IRCM (DIRCM) may also be added by modelling the single colour passive IR missile warning receiver. This may be done by adding the IR signature of the missile and the exhaust jet plume and modelling the IR sensors on the target aircraft. Modelling a turret based missile tracking and acquisition system, housing a directional high intensity IR source and calculating the IR source irradiance at the missile detector. The DIRCM models may be used for analysing the missile signatures in the UV/IR bands and MAWS performance effects on the DIRCM reliability. Analysing the damaging effects of the directed IR energy on the optics/detector of the IR seeking missile. Analysing the effectiveness of DIRCM against modern SAMs. Analysing home-on-jam effects on short range applications of DIRCM.

10.7 Further Validation

The imaging infrared threats are relatively new and are not commonly available, therefore, validation of the model against actual threats is difficult [COX04]. In future my work may be validated against the measured data or other computer models. The following are the few suggestions for further validations.

(a) Against Flyin-2000 imaging IR seeker model developed by the DSTL(UK) for IRCM analysis. [COX04].

(b) Live missile/aircraft (Stinger/C-130) test fire conducted by Naval Air System Command (NAVAIR) China Lake California under their Joint Live Fire (JLF) aircraft system programme [LAW03].

(c) Tactical Engagement Simulation Software (TESS) developed by Tactical Technologies Inc. Ontario, Canada for analysis of passive IR guided surface-to-air and air-to-air missiles.

The following validations could not be performed during this work due to the non-availability of the reference simulation data. These validations may be executed against any available simulation results.

(a) Validation of the analysis and results of the fast-jet aircraft deploying an aerodynamic flare C_D 0.1 in straight-and-level flight.

(b) Validation of the analysis and results of the fast-jet aircraft deploying an aerodynamic flare C_D 1.0 in level-turn.

(c) Validating of the strategy developed to model the IR signature of targets using the material properties of the VRML.

(d) Validation of the missile lateral acceleration algorithm.

10.8 Conclusions

Possibly, the best post-launch defence against an IR passive heat seeking missile may be the timely deployment of the correct type of flare at the correct firing angle. My work may help the IRCM designer and pilots to evaluate potential strategies to defeat the imaging seeker threat. An effort is made to provide a low-cost PC based platform for development of the IR signature modelling and simulation system. This work still needs lots of improvements, upgrading and validations against measured data sets. To continue research work in this field, the recommendation made should be considered in future work.