

# Drone Detect System

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# A - Proposal System Description

- Principle Operation
- Hardware
- Software and Operation System

# A.1 – Principle Operation

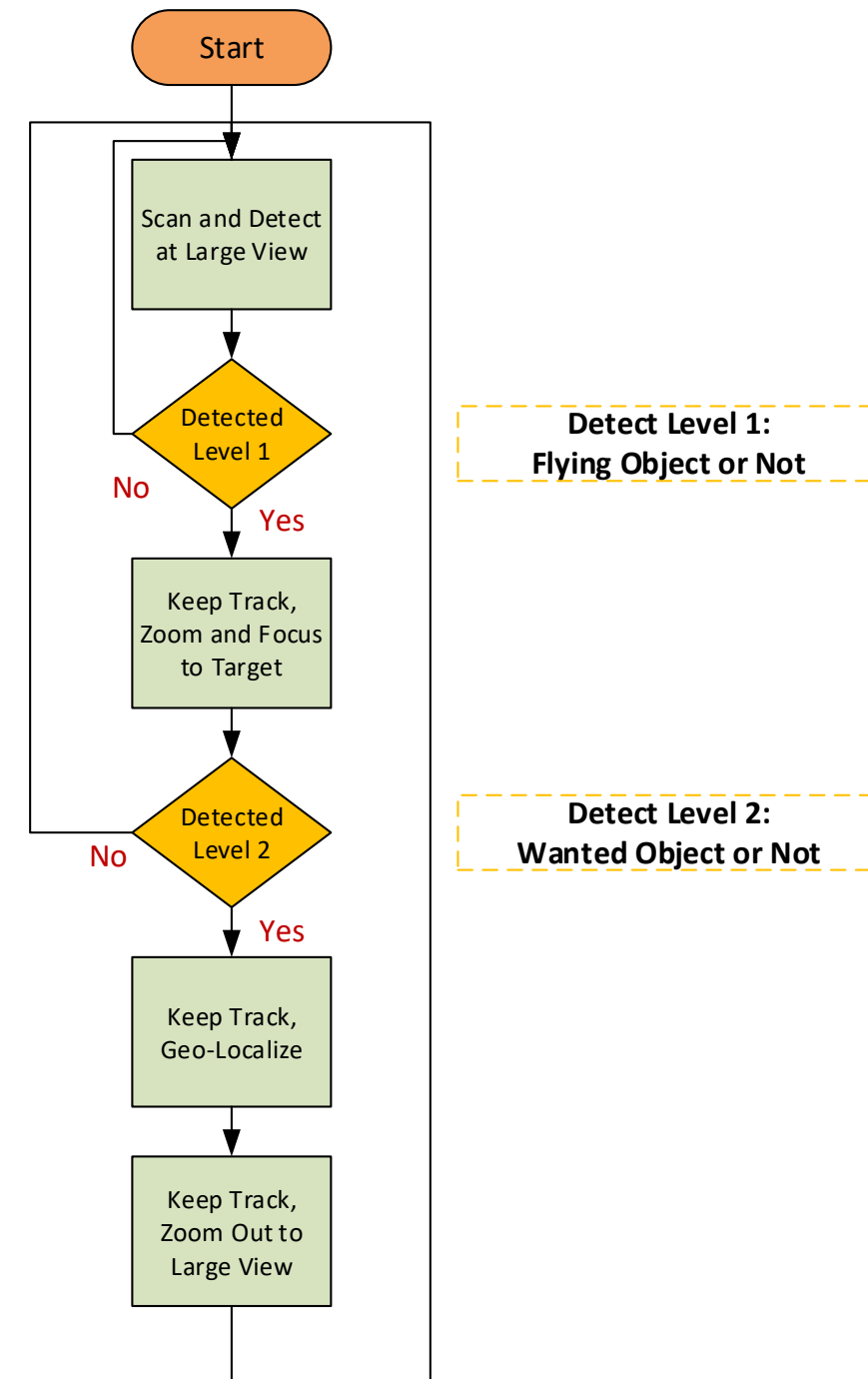
- Goal:
  - Can operation (detect, track and localize) at both day/night condition
  - Can detect and track multi object
  - Can auto or manual select target for localization

# A.1 – Principle Operation (cont.)

Ideal condition (*do not have loss tracking issue*)

(*Use for some calculation later in Session B*)

- State 1: Scan and Detect at Large View
- State 2: Keep Track, Zoom in and Focus to Target
- State 3: Keep Track, Geo-localize
- State 4: Keep Track, Zoom Out to Large View
- State 5: Keep Track, Back to State 1

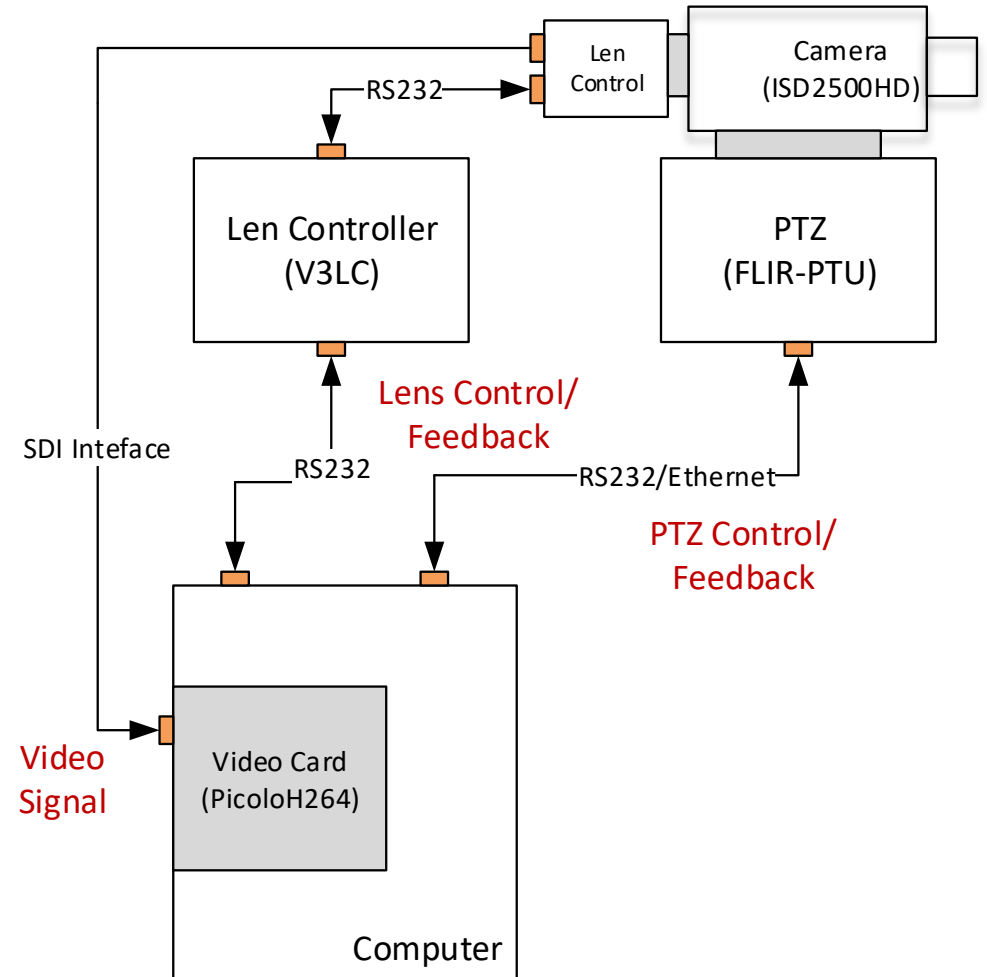


# A.1 – Principle Operation (cont.)

- Difficulty
  - Control Multi-Thread (See detail in Session A.3)
  - A huge of computation for operating algorithms (Track, Geo-localize using DeepNet)
  - Hardware issue (camera noise, loss connection, hardware delay)

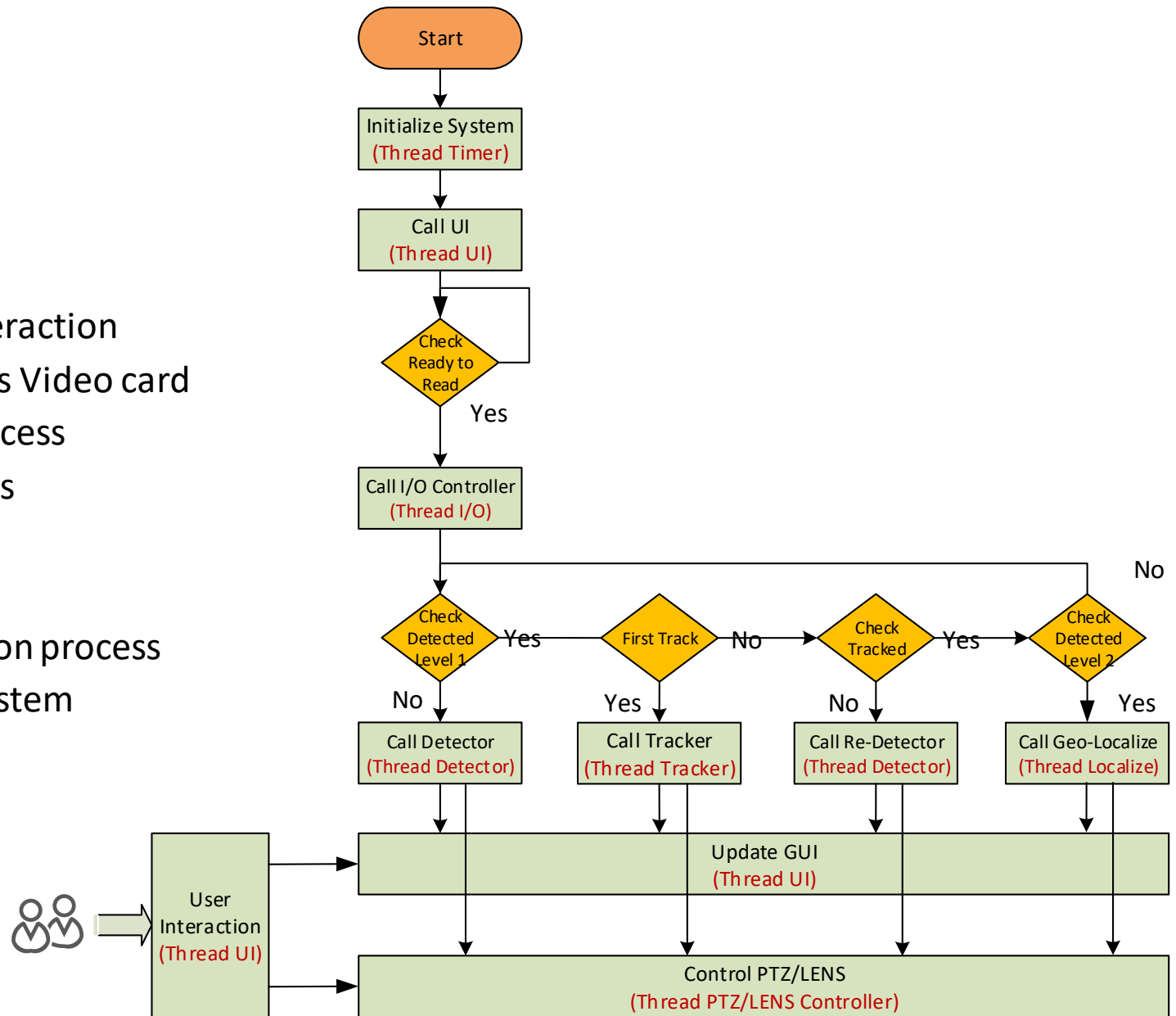
## A.2 – Hardware

- Camera (Ikegami ISD2500HD)
  - High Sensitive (Good for night condition)
  - Sensor size 2/3 inch (not match with lens)
- Lens (FujinonD32X10HD4R)
  - Focal length: 10 – 320 mm
  - Zoom Speed: approx. 4s
  - Focus Speed: approx. 4s
  - Only compatible with 1/2", 1/3", and 1/4" image sensors
- PTZ (FLIR-PTU D300E)
  - Speed Range: 0.006 to 50 degree/second
  - Pan Range: 360 degree
  - Tilt Range: +30 to -90 degree
- Video Card (Picolo H264)
  - Video resolution 1280x720, 1920x1080
  - Frame rate: 30 frame/sec



# A.3 – Software and Operation System

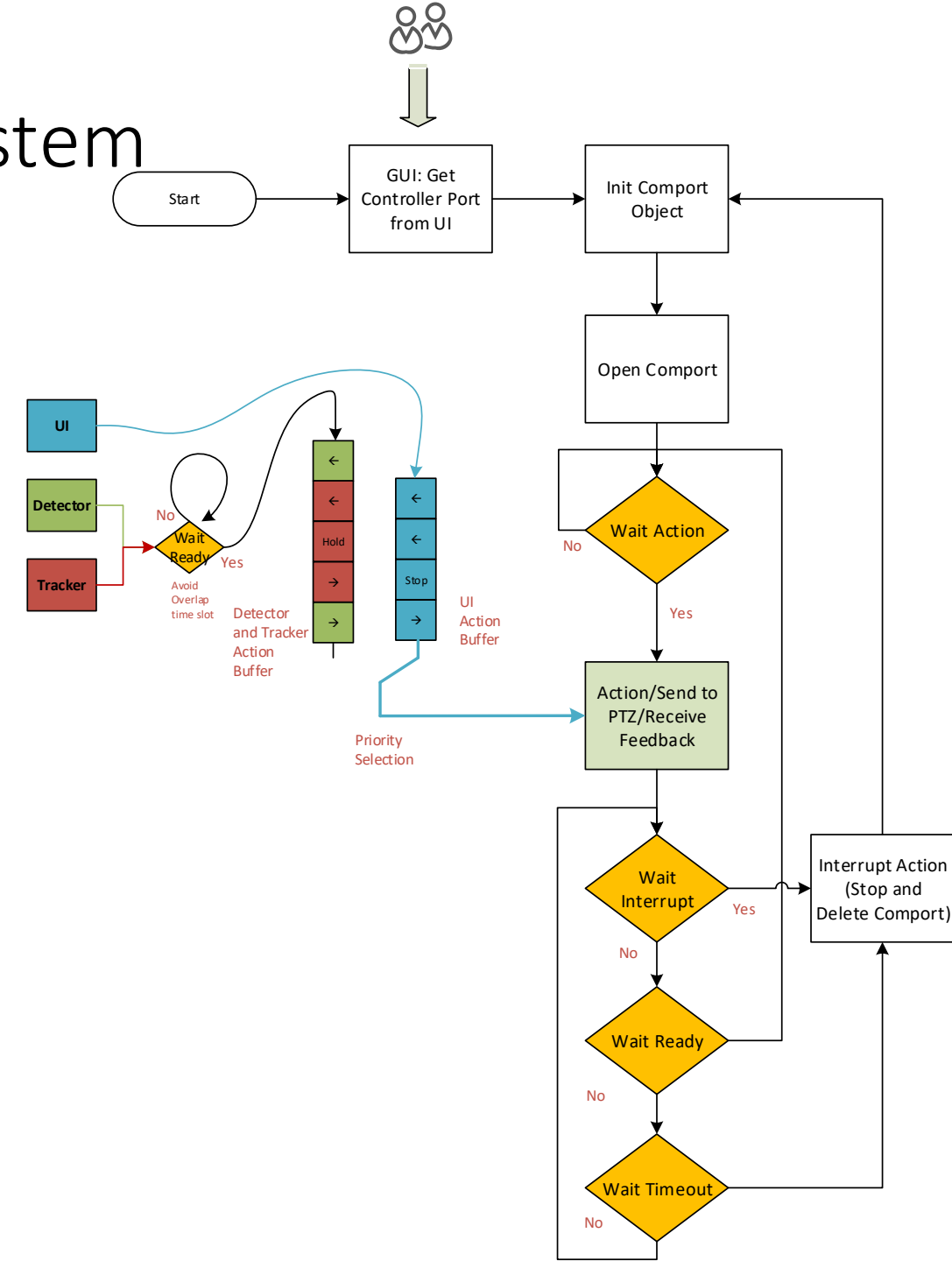
- Run multi-thread to control:
  - Thread UI for user display and interaction
  - Thread I/O for reading and process Video card
  - Thread Detector for Detection process
  - Thread Tracker for Tracking process
  - Thread PTZ for PTZ Controlling
  - Thread LENS for LENS Controlling
  - Thread Localize for Geo-Localization process
  - Thread Timer for control whole system
- Run real-time processing





## A.3 – Software and Operation System (example: PTZ/Lens – Control Flow)

- Run on parallel thread
- PTZ and Lens have similar flow
- User has the highest priority for action



# B – Requirement Analysis

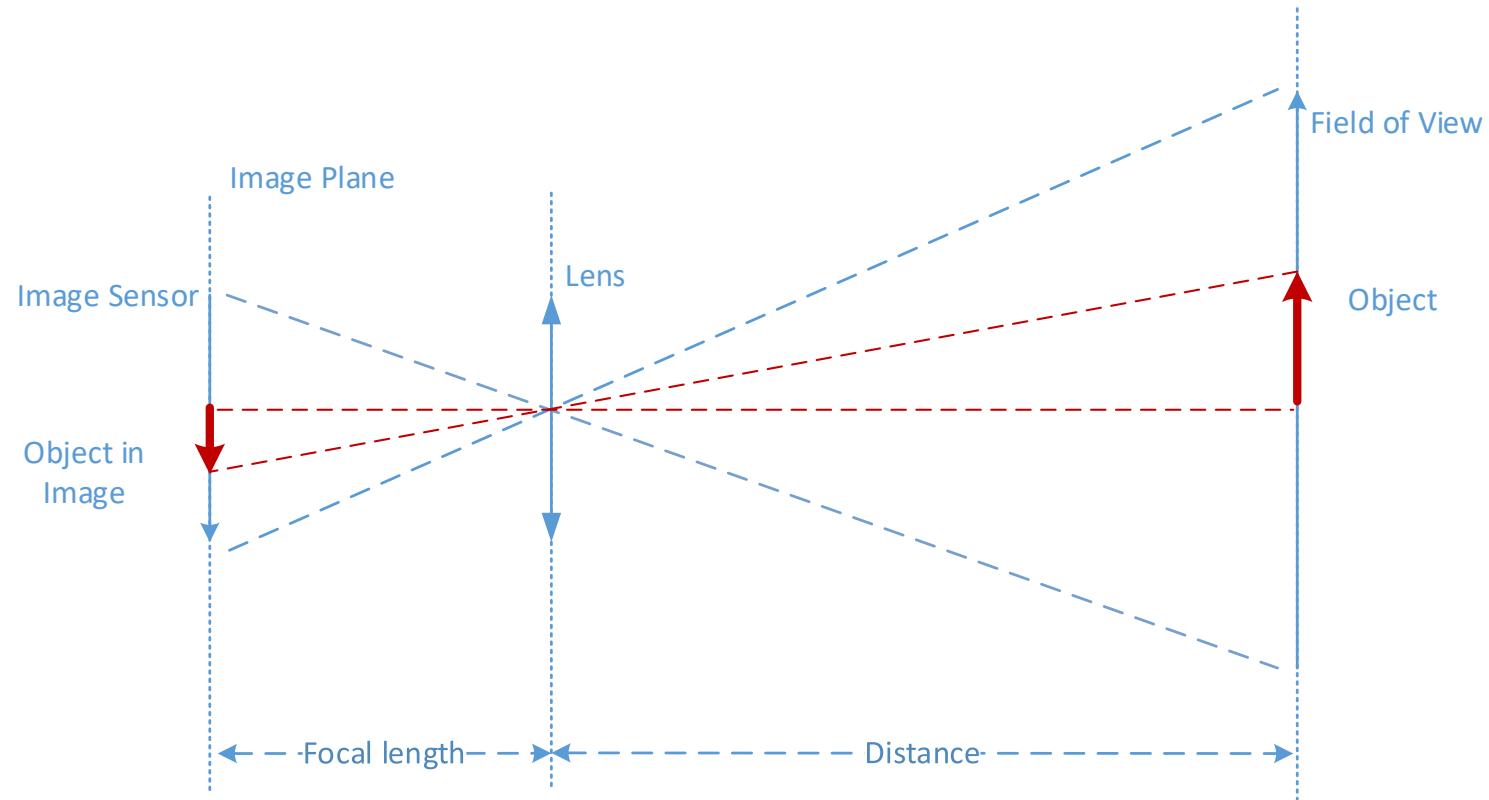
- Algorithm Requirement
- Analysis with Current System
- Propose requirement

## B.1 – Algorithm Requirement

	<b>Object Size in Image (pixels)</b>	<b>Object Speed (pixels/frame)</b>
Detection and Tracking	15x15	20 - 30
Geo-localization	300x300	20 - 30

# B.2 – Current System Analysis

## Pinhole Camera



## B.2 – Current System Analysis

- Pinhole Camera Formula

$$\frac{\textit{Object Size in Image Sensor (mm)}}{\textit{Focal length (mm)}} = \frac{\textit{Object Size(m)}}{\textit{Distance (m)}} \quad (1)$$

$$\frac{\textit{Object Size in Image (pixels)}}{\textit{Image Resolution (pixels)}} = \frac{\textit{Object Size (m)}}{\textit{Field of View (m)}} \quad (2)$$

$$\textit{Field of View} = \frac{\textit{Image Sensor Size(mm)}}{\textit{Focal length (mm)}} * \textit{Distance (m)} \quad (3)$$

# B.2 – Current System Analysis (cont.)

## Estimation Example

- Current System:
  - Image Sensor Size: 2/3inch (8.8 x 6.6mm) ([Wikipedia](#))
  - Image resolution: 1280x720
  - Focal Length ([Fujinon D32X10HD4R](#)) : 10-320mm
- Estimation Example 1:
  - (3)  $\rightarrow \text{FoV}(at\ 736m) = \frac{8.8mm}{320mm} * 736m = 20.24m$
  - (2)  $\rightarrow \text{Size of object (when size in image 13 pixels)} = \frac{13pixels}{1280pixels} * 20.24m = 20.55cm$
- Estimation Example 2: Required Focal length for geo-localization object size 0.5m at 1000m (system requires object size in image is 300 pixels)
  - (2)  $\rightarrow \text{FoV}(at\ 1000m) = \frac{1280pixels}{300pixels} * 0.5m = 2.13m$
  - (3)  $\rightarrow \text{Focal length} = \frac{1000m}{2.13m} * 8.8mm = 4131mm$

## B.2 – Current System Analysis (cont.)

Real test to make sure the estimation

- Capture the standard folder (size 23x32cm) at distance 736m (as figure below)
- Test Result: Size in Image  $\cong$  13 pixels (as 23cm) (compare with 20.55cm in estimation example 1)



# B.2 – Current System Analysis (cont.)

## Summary Table

	Focal length (mm)	Zoom	Distance (m)	Real Size (cm)	Size in Image (Pixels)	Sensor Size (mm) (Width)	Image Resolution (pixels)(Width)	Angle of View (degree)	Field of View (m) with this distance	Note
Current System (Ikegami ISD2500HD + FujinonD32X10 HD4R) Sensor Size: 2/3 inch (8.8x6.6 mm) Image Resolution: 1280x720 pixels	10	1x	4.18	340	1280	8.8	1280	44.26	3.4	Test In Lab
	320	32x	4.18	12.4	1280	8.8	1280	1.7	0.124	Test In Lab
	320	32x	736	20.55	13	8.8	1280	1.6	20.24	Estimation Example 2 using specification
	320	32x	736	23	13	8.8	1280	1.76	22.65	Test Out size (small error, using for below estimation)
	320	32x	1,386.67	50	15	8.8	1280	1.76	42.67	Max detect distance with current system
	320	32x	69.33	50	300	8.8	1280	1.76	2.13	Max geo-localize distance with current system
	4,615.38	460x	1000	50	300	8.8	1280	1.76	2.13	Focal length need for 1000m geo-localize
	4615.38	460x	20000	50	15	8.8	1280	1.76	42.67	Detect distance range when 1000m geo-localize



# B.3 – Propose Requirement

## CohuHD Camera Specification

- Sensor Size: 1/2.7"
- Focal length: 16.7 – 1000mm (33.4 – 2000mm with extender inserted)
- Sensitivity: Min 0.35 lux (1/8 Shutter) (lower sensitive compare with current camera)
- Zoom/Focus: Slow/Medium/Fast Speed mode (23/10/5 sec from fmax to fmin)
- Video resolution: 1080p, 720p
- Video Framerate: 30 frame/s
- Network Interface: Ethernet 802.3
- Announcement form manufacturer:
  - Detect Target 10x10 pixels: 130.176 km
  - Recognition Target 30x30 pixel: 40.670 km
  - Identification Target 120x120 pixel: 10.119 km

## B.3 – Propose Requirement (cont.)

### [FUJINON D60x Camera specification](#)

- Sensor size: 1/1.8''
- Focal length: 16.7-1000 (33.4 – 2000mm with extender inserted)
- Zoom ratio 60x
- Day and Night condition (do not have detail)

# B.3 – Propose Requirement (cont.)

## Summary Table

	Focal length (mm)	Zoom	Distance (m)	Real Size (cm)	Size in Image (Pixels)	Sensor Size (mm) (Width)	Image Resolution (pixels)(Width)	Angle of View (degree)	Field of View (m) with this distance	Note
<a href="#">Cohuhd 8800HD</a> <a href="#">Sensor Size: 1/2.7 inch (5.27x4.04mm)</a> <a href="#">Image Resolution 1920x1080 pixels</a>	1000 2000(2x with Extender)	60x	10119	187.65	120	5.27	1920	0.17	30.02	Announcement by manufacturer
	1000 2000(2x with Extender)	60x	1,078.51	50	300	5.27	1920	0.17	3.20	Rescale to our requirement
	1000 2000(2x with Extender)	60x	1,085.39	50	300	5.27	1920	0.17	3.20	Recalculation using information from current system (small error that mean the calculation is correct)
<a href="#">FUJINON D60x16.7SR4FE-ZP1C</a> <a href="#">Sensor Size: 1/1.8 (apply for 2/3 inch camera)</a> <a href="#">Resolution: 1920x1080 pixels</a>	1200 2400 (2x with Extender)	60x	1000	785 733	1920	8.8	1920	0.45	7.85 7.33	Estimate Field of View at 1000m (Using AoV) Estimate Field of View at 1000m (Using Eq.3 – maybe not exact in case 2x Extender)
	1200 2400 (2x with Extender)	60x	1000	50	122	8.8	1920	0.45	7.85	Estimate Size in Image of Object with size 50 cm at 1000m
	1200 2400 (2x with Extender)	60x	406.67	50	300	8.8	1920	0.45	7.85	Estimate max distance to geo-localization with Object size 50cm – 300 pixels

## C – First Approach Result (Video)