BLUE LIGHT POLICE EMERGENCY REPORTING TELEPHONES (PERT)

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Project Objectives

- To study the placement of Emergency Poles on college campuses.
- To provide a way to verify that pole placement satisfies safety requirements using system engineering principles.
- To determine the minimum number of poles required to achieve safety requirements.

Goals and Scenarios

- **Goal 1.** System must be easy to locate in case of emergency.

  Scenario 1.1 Blue poles must be on the line of sight of the user.

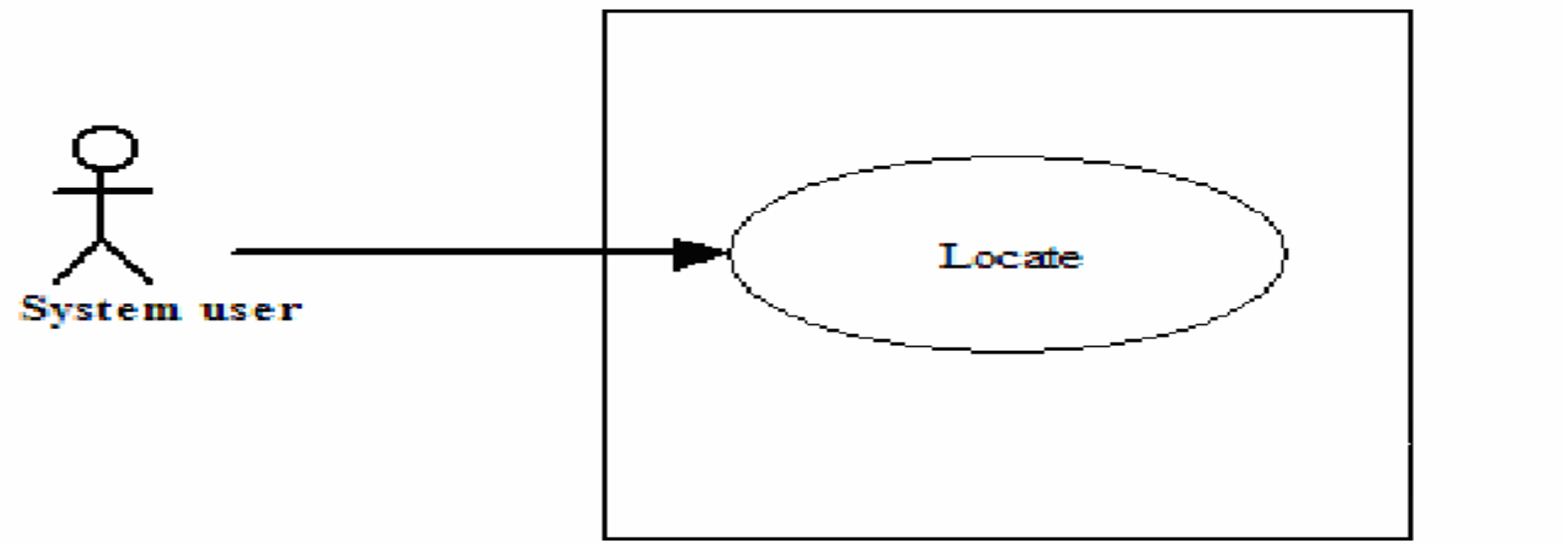
  Scenario 1.2 Blue poles must be within a reasonable distance from the user, which is < 50 ft.

- **Goal 2.** System must be cost effective.

  Scenario 2.1 Minimize the number of cameras used to satisfy safety requirements on campus.

Use Case

The system boundary is defined by the location of the poles themselves and the surrounding spatial area.



Use Case Description

Use Case: Locate

Description: The system user must be able to locate the blue pole location.

The user maybe any person on campus, and the user maybe one person or multiple people.

Primary Actor(s): System user and his spatial location.

Preconditions: We consider portion of the campus area with 2 buildings and a few blue poles.

Flow of Events: When the system user will feel he will face an incident or any suspicious behavior he will try to locate the nearest blue pole or emergency system.

Alternative Flow of Events: None

Post Condition:

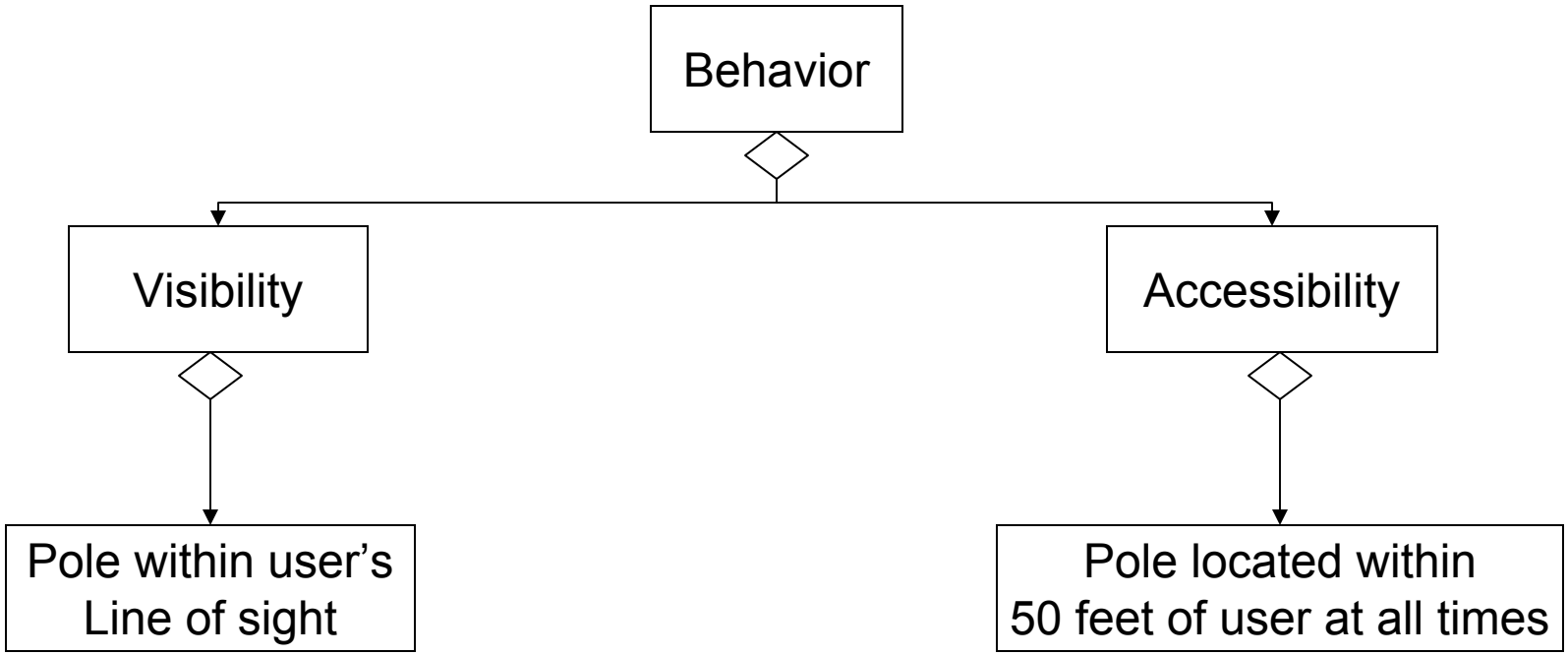
Requirement:

- Blue pole is within line of sight of the user.
- Blue pole is within reasonable distance of the user, < 50 ft.

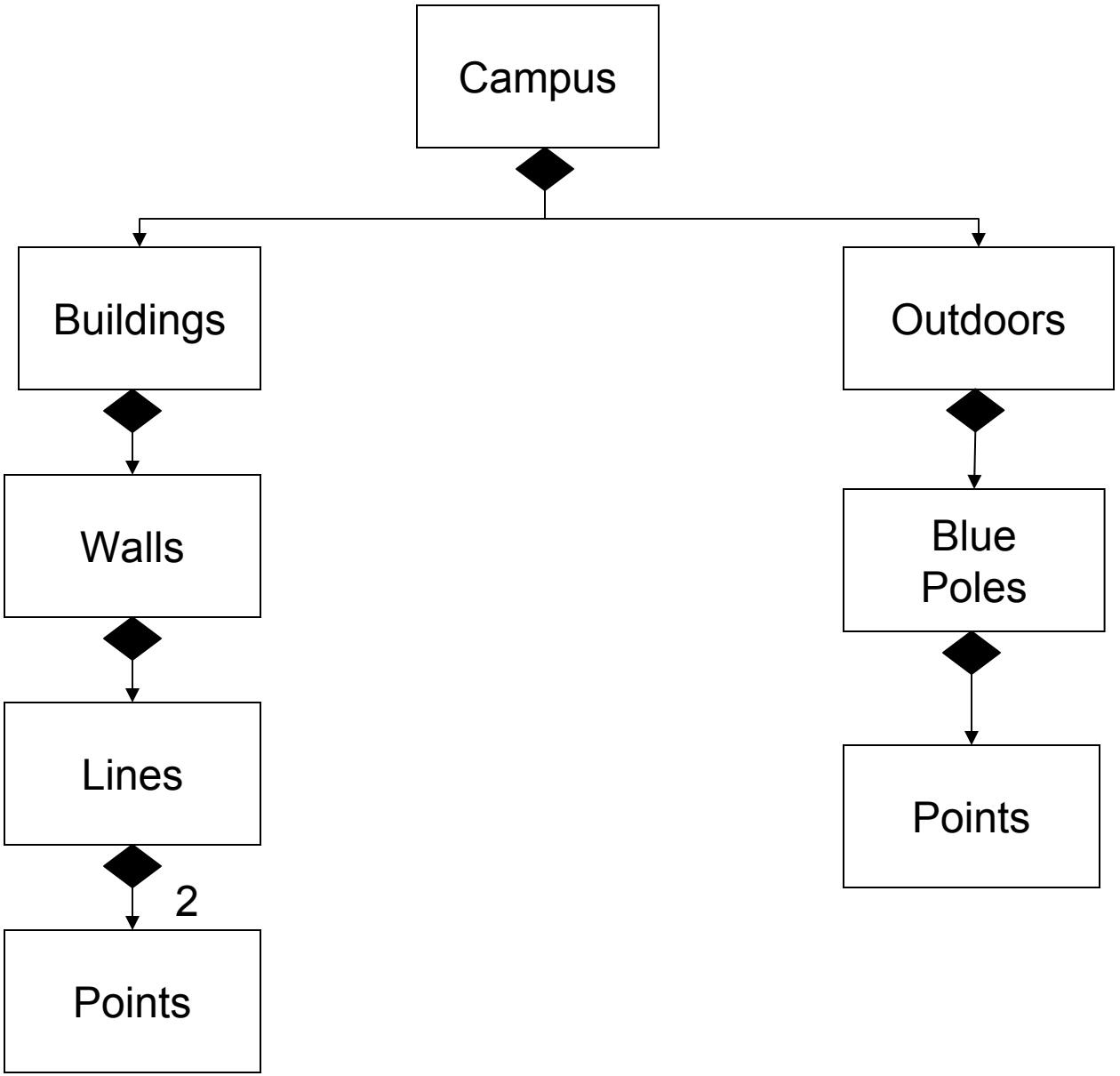
Requirements

Requirement	**Structure**	**Behavior**
Req. 1.0: A user must always be able to see a blue pole.	Camera, cameraLocation Building, buildingLocation	lineOfSight()
Req. 2.0: A user must always be within a reasonable distance of a blue pole.	Camera, cameraLocation	Distance ≤ 50 feet

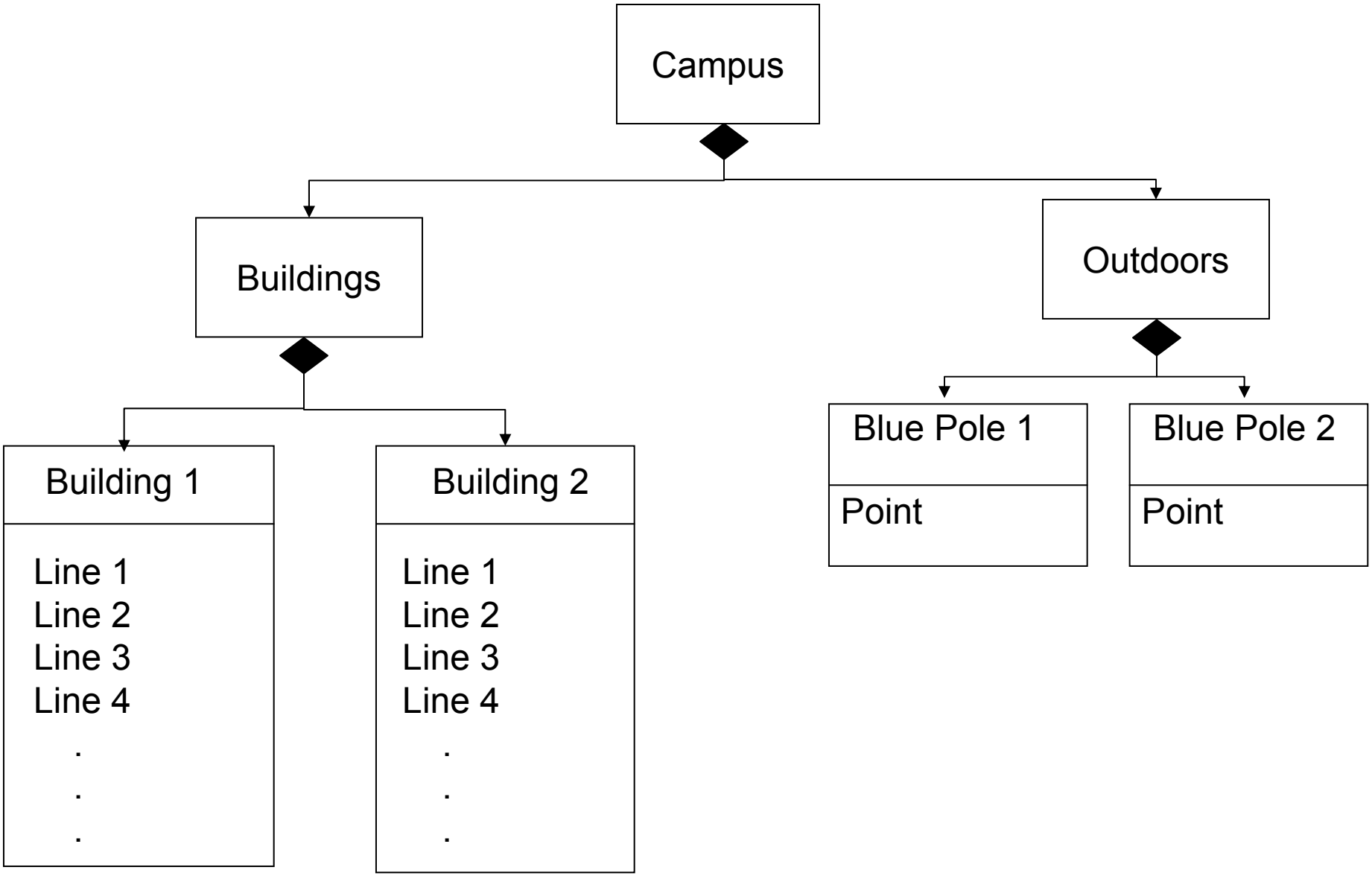
System Behavior



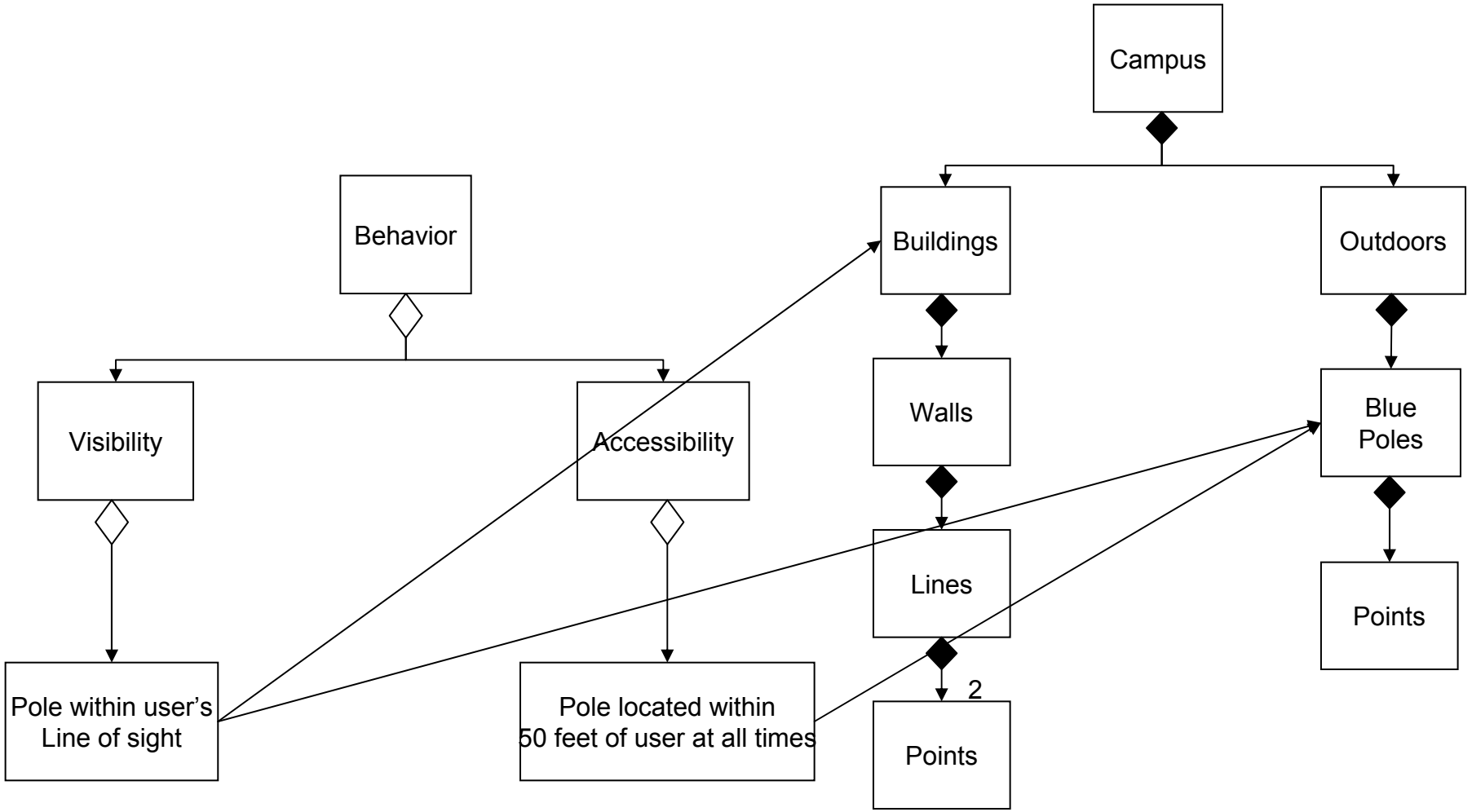
System Structure



Objects

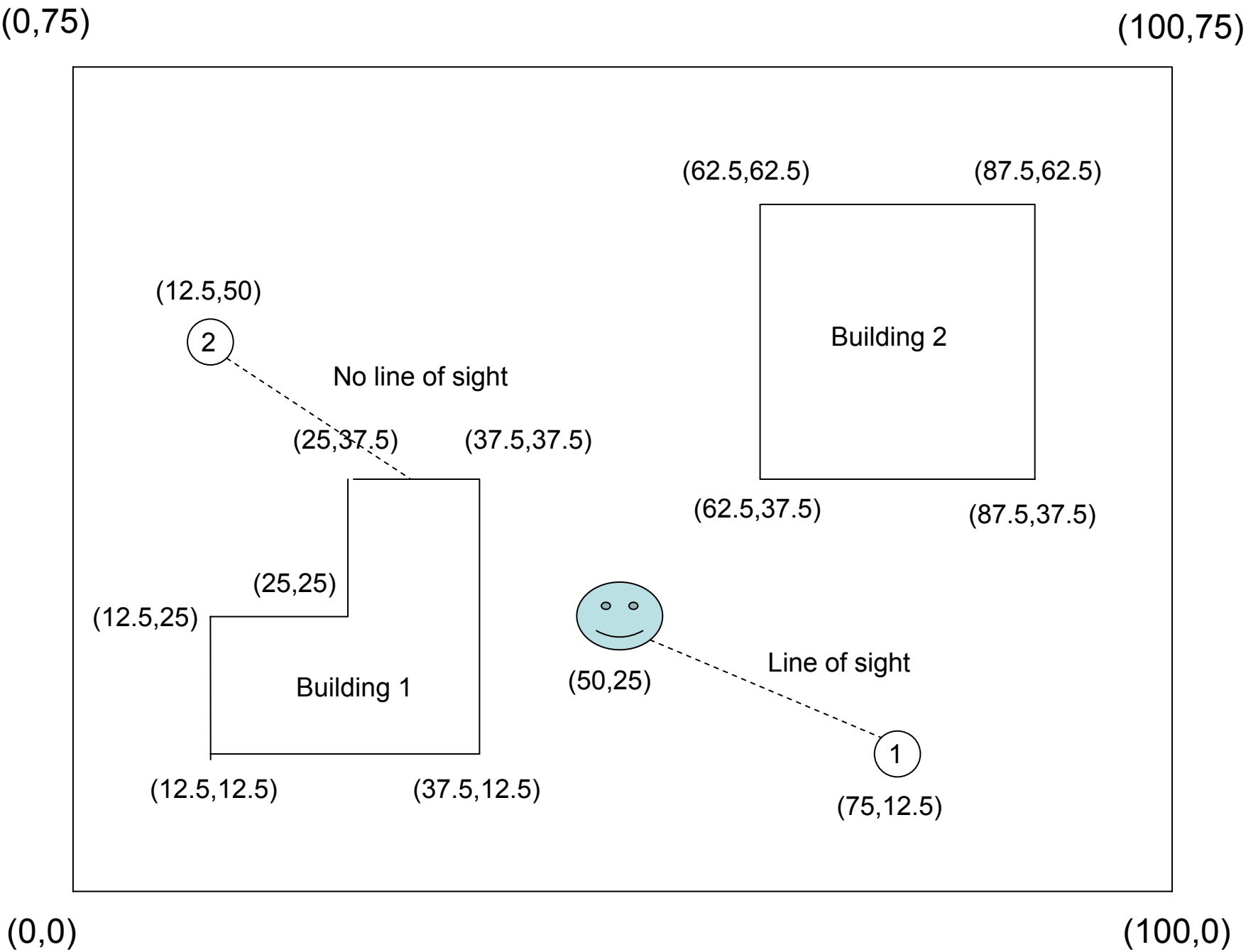

Campus
Buildings
Outdoors
Building 1
Line 1
Line 2
Line 3
Line 4
.
.
.
Building 2
Line 1
Line 2
Line 3
Line 4
.
.
.
Blue Pole 1
Point
Blue Pole 2
Point

Mapping Behavior to Structure

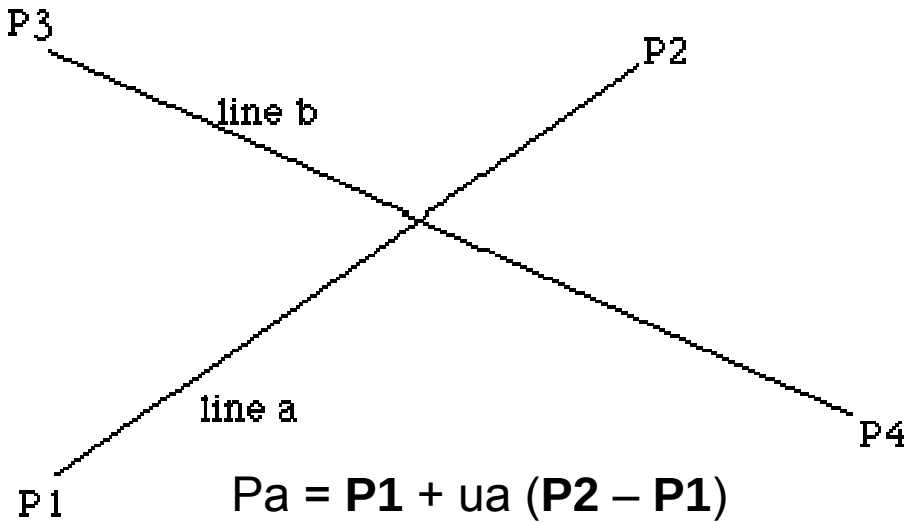


Brute Force Validation

- Use MATLab to create a matrix that represents the buildings, cameras, and open space within the sample area.
- Test the line of sight and distance requirements at every point that isn't within a building or a camera.
- If all points satisfy both requirements, camera setup is valid.
- After initial model is verified, a random number generator can be used to place cameras and multiple iterations can be run to determine a minimum number of cameras needed and their placement.


(0,75)
(100,75)
(62.5,62.5)
(87.5,62.5)
(12.5,50)
2
Building 2
No line of sight
(25,37.5)
(37.5,37.5)
(62.5,37.5)
(87.5,37.5)
(25,25)
(12.5,25)
Building 1
(50,25)
Line of sight
1
(12.5,12.5)
(37.5,12.5)
(75,12.5)
(0,0)
(100,0)

Line of Sight Algorithm



Pa = **P1** + ua (**P2** – **P1**)

Pb = **P3 +** ub **(P4 - P3)**

Solve for Pa=Pb:

x1 + ua (x2 - x1) = x3 + ub (x4 - x3)

y1 + ua (y2 - y1) = y3 + ub (y4 - y3)

$$u_a = \frac{(x4 - x3)(y1 - y3) - (y4 - y3)(x1 - x3)}{(y4 - y3)(x2 - x1) - (x4 - x3)(y2 - y1)}$$

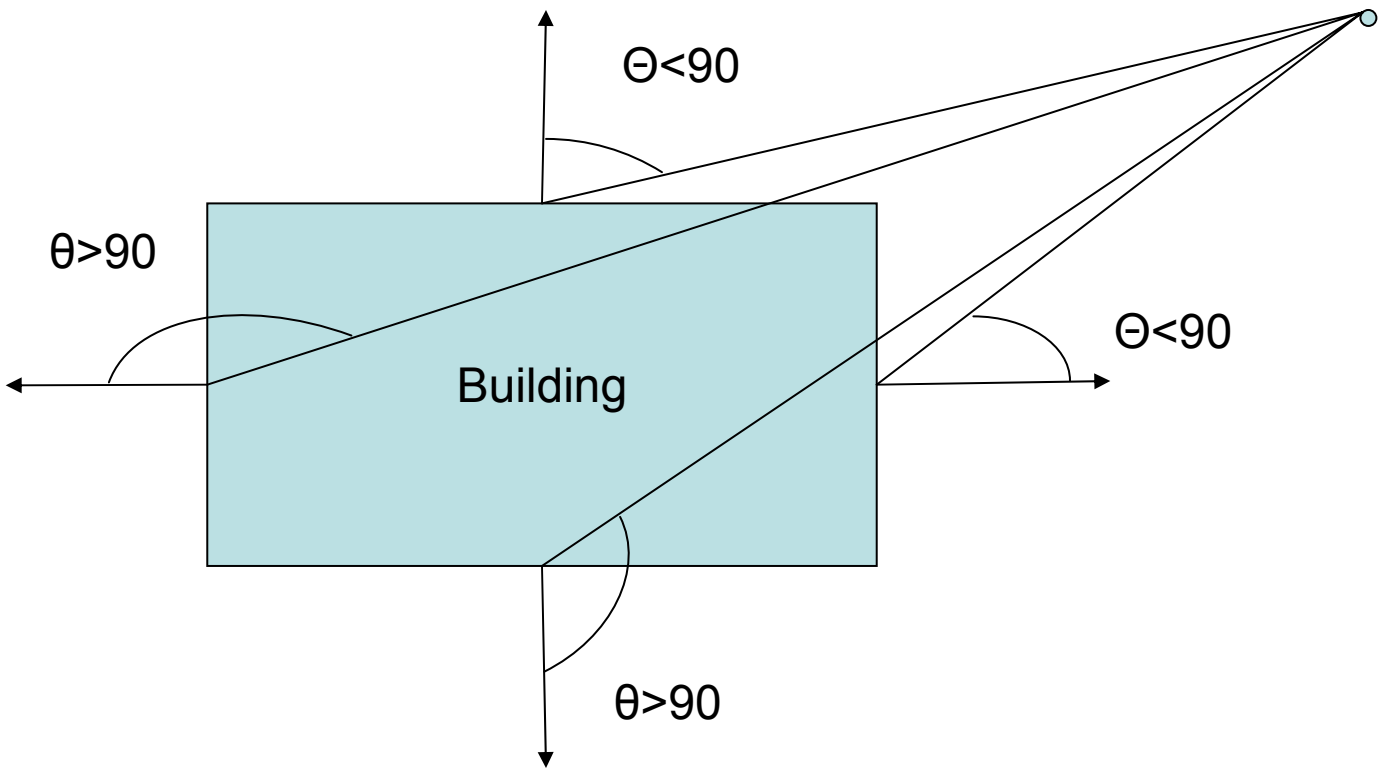
$$u_b = \frac{(x2 - x1)(y1 - y3) - (y2 - y1)(x1 - x3)}{(y4 - y3)(x2 - x1) - (x4 - x3)(y2 - y1)}$$

The equations apply to lines, if the intersection of line segments is required then it is only necessary to test if ua and ub lie between 0 and 1. Whichever one lies within that range then the corresponding line segment contains the intersection point. If both lie within the range of 0 to 1 then the intersection point is within both line segments.

Distance Algorithm

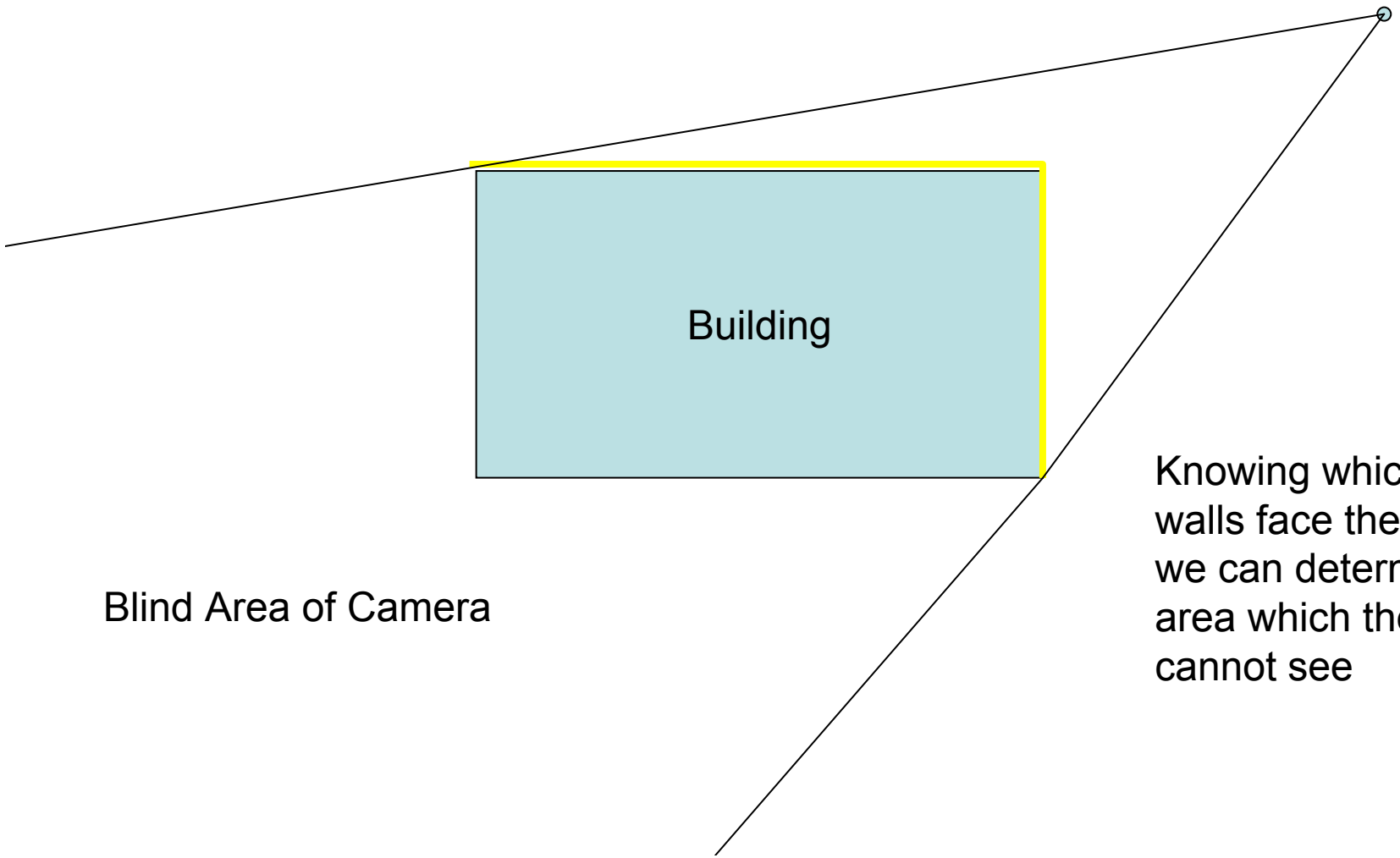
- Xd=x2-x1
- Yd=y2-y1
- Distance=sqrt(xd^2+yd^2)
- Req2=(Distance≤50)

Improved Validation



If the angle between the camera line and perpendicular is Smaller than 90 degrees, the wall faces the camera

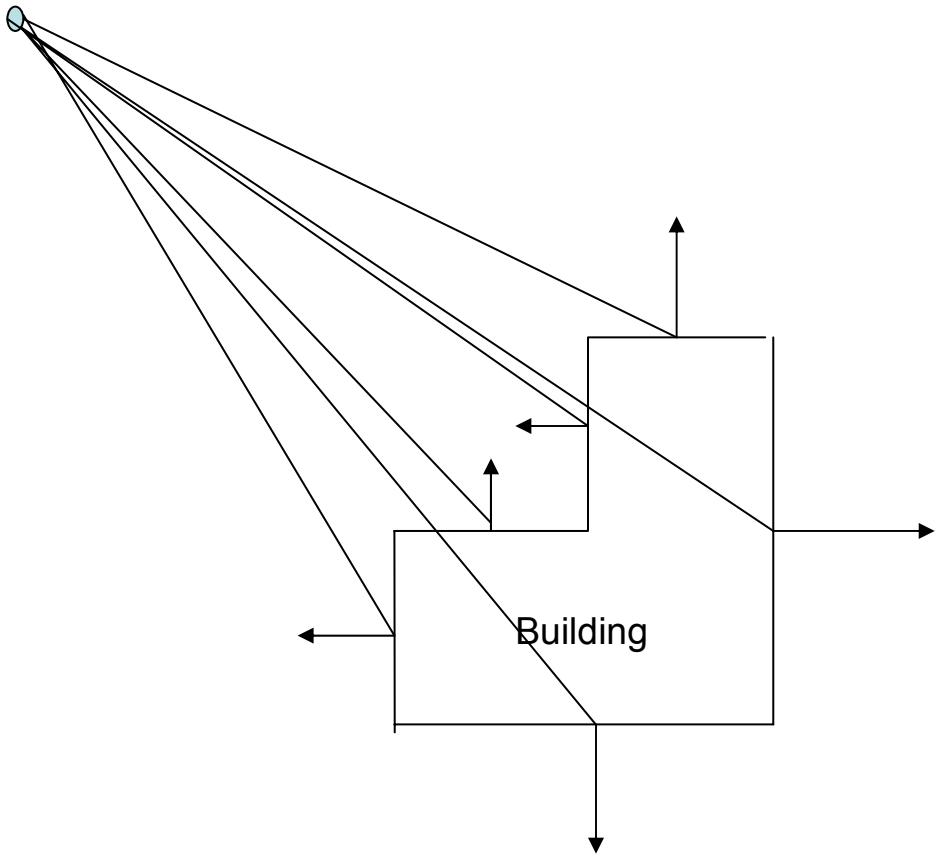
Improved Validation



Blind Area of Camera

Knowing which walls face the camera, we can determine the area which the camera cannot see

More Complicated Building



If more than two sides face the camera, then the two largest angles that are less than 90 degrees contain the blind area constraint lines.

Future Work

- Create and Verify model
- Use model to determine optimal camera placement for different locations.
- Provide user-friendly graphical output.