**Formulas and Derivation for stereo camera rig**

Figure from \Dissertation\My Papers\Figures\JEI\_Stereo.ai:

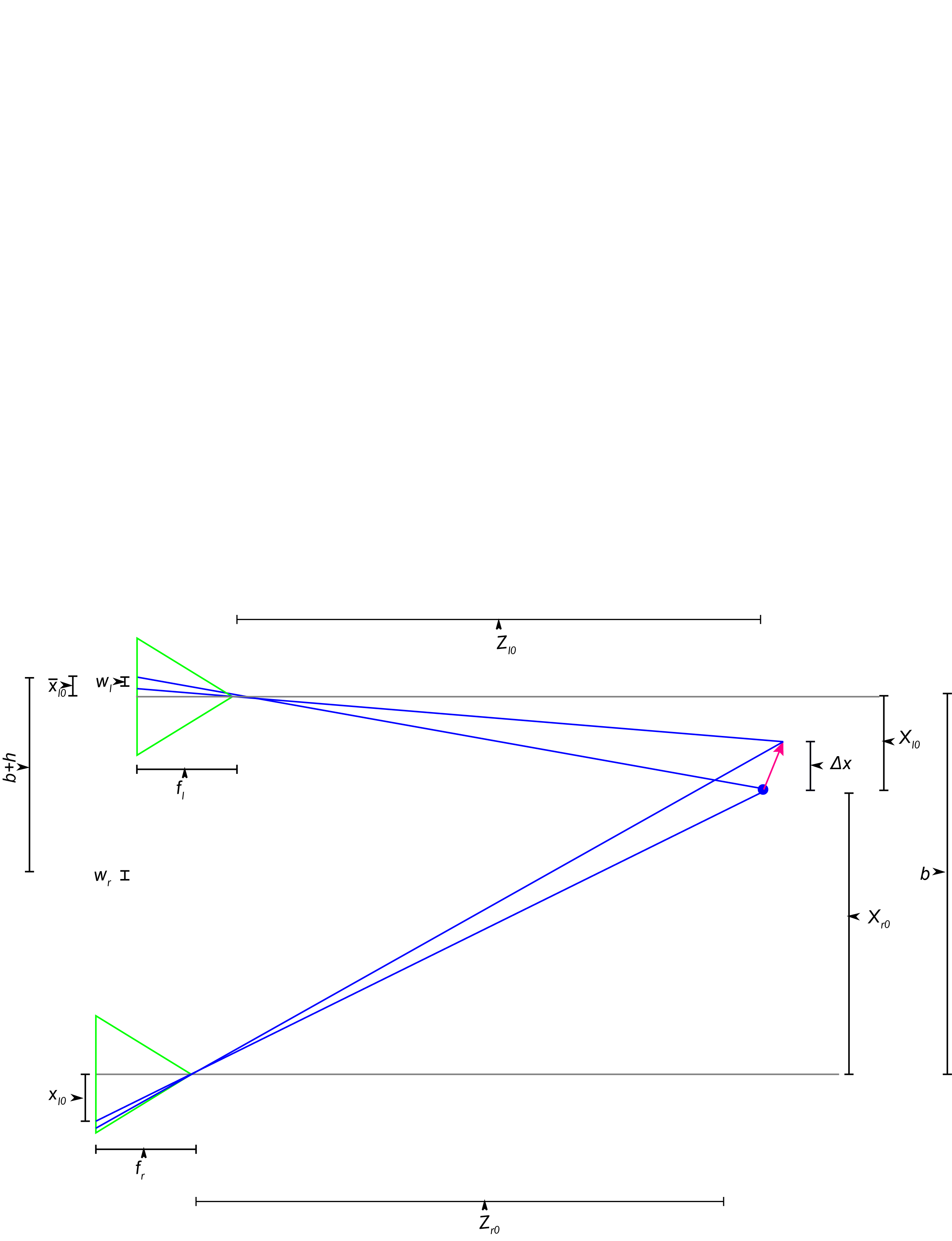


Figure Binocular Stereo X-Z view

First derive equations for which is the disparity in and with the left image being the reference image. Notice that disparity does not depend on the change in Z (W). First do the direction.

(1)

(2)

(3)

(4)

(5)

(6)

(7)

(8)

(9)

(10)

(11)

(12)

Test by setting d=0 and :

(13)

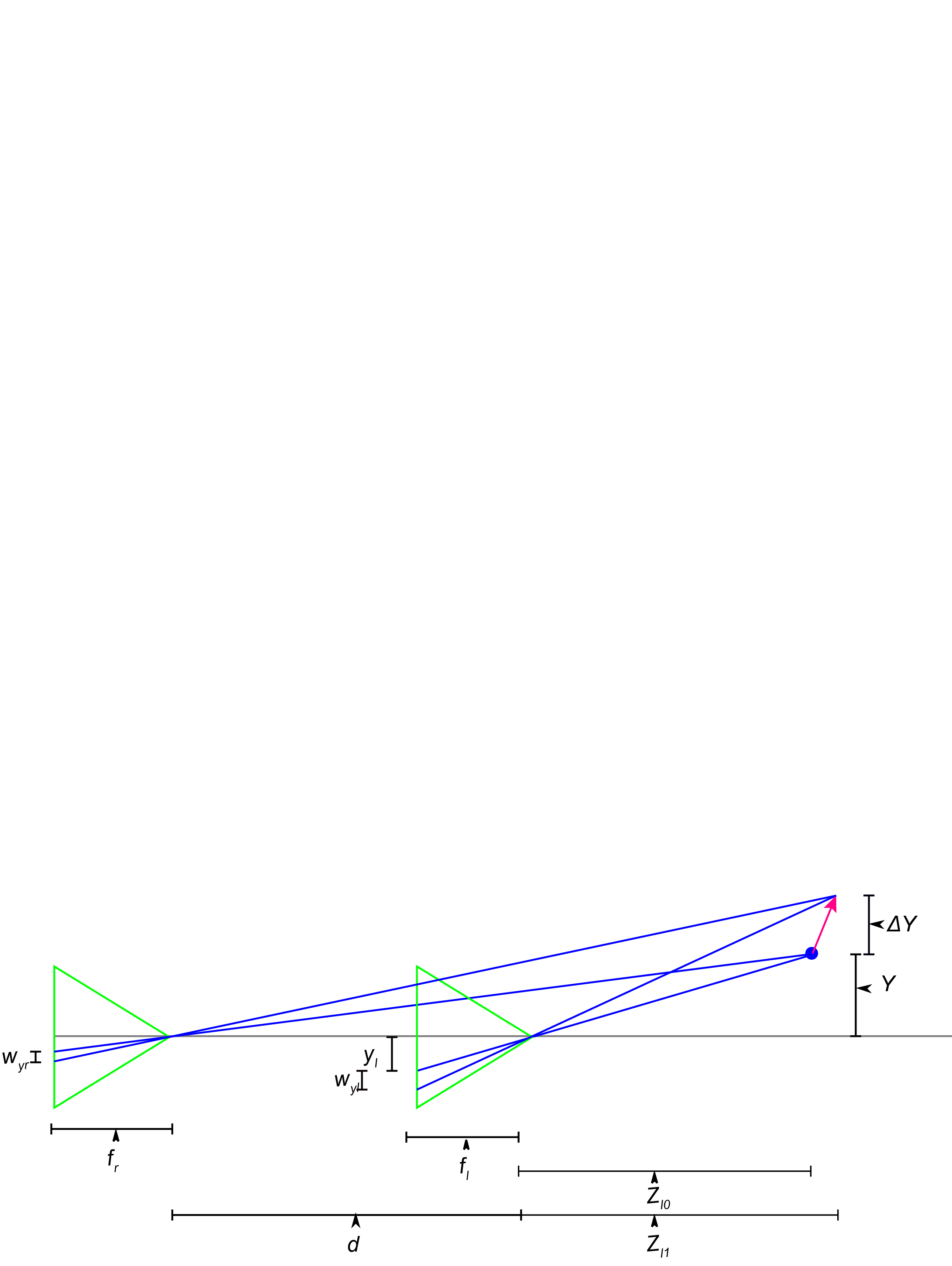


Figure Binocular Stereo Y-Z View

Repeat derivation for :

(14)

(15)

(16)

(17)

Note that due to coaxial geometry set :

(18)

(19)

(20)

(21)

(22)

if and then .

Now find the relationship between the magnitude of the flow, which does depend on .

Projection Equations

(23)

(24)

where X, Y, and Z are coordinates in the scene and x and y are image coordinates.

Differentiate to get optical flow (also can be done geometrically page 110):

(25)

(26)

(27)

(28)

(29)

(30)

(31)

(32)

(33)

(34)

(35)

For a discrete implementation with cameras with different focal lengths and at different distances from the scene:

(36)

(37)

(38)

(39)

Solving for the optical flow:

(40)

(41)

reducing gives:

(42)

(43)

Solve 42 and 43 for and set equal to each other:

(44)

and

(45)

(45)

(45)

or

(45)

where:

(45)

(45)

when then .

The energy equation is then:

(23)

We find or using the following energy equation along a radial line:  
 (32)

(33)  
 (34)

Z and W are estimated simultaneously using graph cuts. Once we have Z and W we can estimate U and V.