



Grassroots Startup Project Sharing

# Deep Learning Computer Vision 3D Sensor Algorithm Acceleration On FPGA Tutorial

## 4 – SGM cost function Dynamic Programming & Penalty Propagation

By GimHo.Ng/ 伍金和 (荷)

2023.3.29

G.E.M 鄧紫棋歌中的祕密 / the secret in GEM's music

【2507抬上帝入天坑】 / 【2507 carrying God back to heaven shit hole】 : <https://github.com/brianwchh/2507>

Tutorial files: <https://github.com/brianwchh/grassrootsstartup-ComputerVSION-zynq>

却江白春煙又  
爲山髮雨寒是  
紅不滄細依一  
顏因滄細舊年  
作百愁飄鎖櫻  
多花滿萬孤花  
情嬌枝家城季

二零二三年三月二十三日作

只人多江兩一  
因間情山鬟夜始  
多卻花白春  
懂嬌只草霜風  
女情爲本幾花  
人如紅無時滿  
花畫顏情來枝

女人花

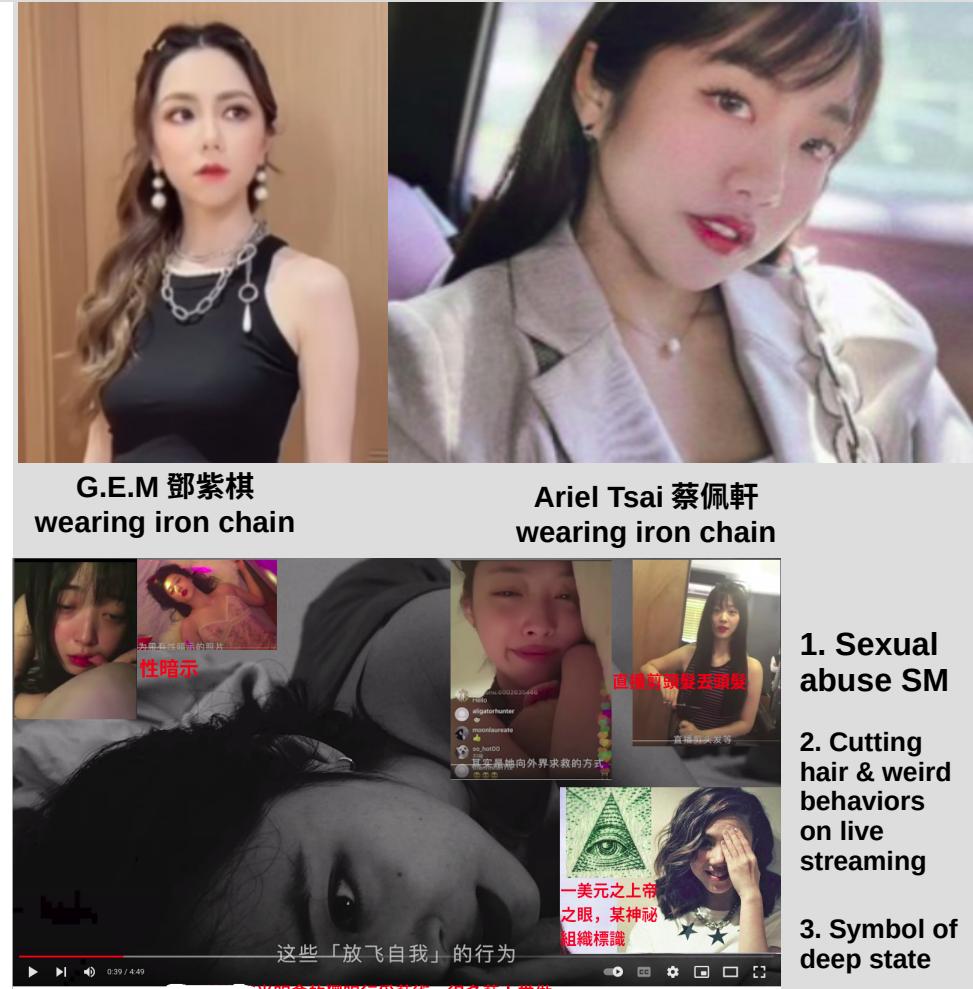
[https://github.com/brianwchh/worldofheart\\_v2/blob/main/md\\_and\\_html/附庸風雅/女人花.md](https://github.com/brianwchh/worldofheart_v2/blob/main/md_and_html/附庸風雅/女人花.md)

# SOS Art Performance from chained talent girls

才女們無助的求救藝術行爲（含已自殺女星）노리개：그녀의 눈물

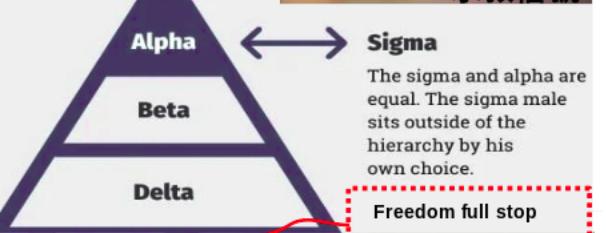
#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

Top Chinese pop star



For more details please visit here: <https://github.com/brianwchh/SOSfromGEM>

South Korea pop star 설리 Choi Jinli's SOS signal to the public before hanging herself at home in 2019



Freedom is a joke of leather pants behind bars  
玩物 노리개 의 눈물: 自由是鐵欄後皮褲的笑話



SOS art performance  
from chained talent girls



The secret behind singer G.E.M's music

# 解說鄧紫棋的祕密

「2507」 carrying God back to the heaven shit hole

# 「2507」抬上帝入天坑

小說解讀

## 連點成面之情報信息解析

Connecting dots to get the picture of the pyramid intelligence

Reveal the deep lies, traps & pitfalls

## 揭露深層的謊言、詭祕與圈套

無形鐵鍊女們的  
求救禪語信息



小說地址: <https://github.com/brianwchh/2507>

← 解說影片: <https://youtube.com/playlist?list=PL4mHdDqV3T2uDeFnSC1bWhz3cN3wPZMzr>

Evil  
Project sigma !

SOS

Wake up all



# The tutorial plan

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

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- Let's read the papers together
- Design algorithm on computer using C++
- System diagram design
- Write Verilogc code for each module & simulation
- ~~FPGA on board debugging (zyng 7020)~~
- ~~Embedded linux os bringing up~~
- Writing linux device driver
- Design application APPs on arm and linux computer for demos

# Recap: How do we minimize the cost function

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

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$$\frac{\partial E}{\partial \text{someParameters}}$$

$$= \frac{\partial \sum_p (C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1])}{\partial \text{someParameters}} = 0$$

- › NO !!! :(

# Recap: Dynamic programming

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

$$E = \min \sum_p (C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1])$$



When individual is minimum, global sum is minimized

$$\sum_p \min (C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1])$$

- Different from first-order gradient decent method that widely used in deep learning training stage.
- Different from second-order gauss newton method and its variants that widely used in computer vision algorithms in order to find the optimal solution.
- Apart from accelerating it on FPGA, Dynamic programming method that we used here to find **approximate “optimal”** solution is quite interesting itself. We used a lot of **assumption** and **approximation** in order to find a “optimal solution” to E which seems like a “chicken & egg” unsolvable problem.

# Agenda of this episode

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

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- › Use Dynamic programming method to find a solution to SGM cost function

$$E = \min \sum_p (C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1])$$



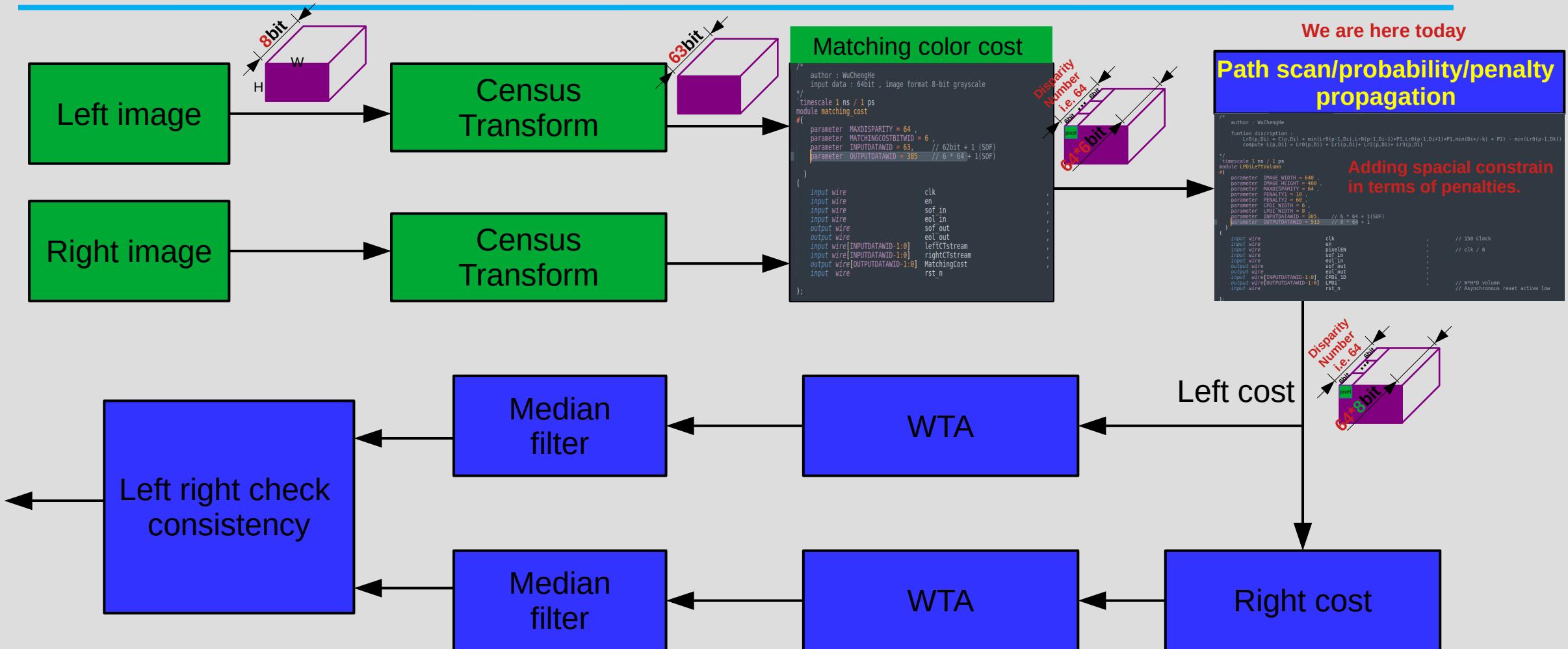
This formula may have confused a lot of people.  
Will explain a lot in detail how to get there from the above formula, which still have the obvious physical meaning.

$$L_r(p, D_i) = C(p, D_i) + \min(L_r(q_r, D_i), L_r(q_r, D_i \pm 1) + P_1, \min(L_r(q_r, D_i \pm n) + P_2)) \\ - \min(L_r(q_r, D_i \pm k)) \quad n \geq 2, k \geq 0$$

Can't find the physical meaning to the formula of the original SGM paper? Don't worry! You will find it quite easy to understand after this episode, and also will know how to do it in a different way! The paper omits some intermediate process, for instance what pain it was trying to solve, i.e. the motivation? I will show you step by step from the original spacial smooth constrain to the author's variant version. You can play with the data and get your own feeling and understanding the algorithm and develop some other variations that solve your own specific pain and problems.

# System block diagram so far

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)





SOS art performance  
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無形鐵鍊女們的  
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玩物 노리개의 눈물: 自由是鐵欄後皮褲的笑話  
Freedom is a joke of leather pants behind bars

**freedom behind bars in leather pants**

The secret behind singer G.E.M.'s music

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Evil  
Project sigma !



歌手 가수蔡佩軒  
Ariel tsai, singer

**SOS**

Wake up all



# Who triggered this bomb

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)



「노리개 : 그녀의 눈물」 a movie based on her tragedy , 漢語「玩物」 2013



張紫妍 장자연 「性朝貢」事件：童話故事下的殘酷人生  
2009 年自殺身亡的南韓女星張紫妍

장자연 (Jang Ja-yeon) sexual bribery puppet actress in south Korea, committed suicide by hanging herself at home in 2009, only left behind her diary detailing every man she had to sleep with, sometimes multiple men at a time !  
"They" really don't care about us!  
"They" are still at large!  
"they" have the power and resource to be not just on top of your woman, but also you, at will !  
You don't believe?! I understand! That is because you know nothing about "them", the mysterious deep state! just like me used to be!  
You still believe, like a book nerd, that law can protect you? Not in front them, who are good at setting up sweet pitfalls, and make you a chained puppet! And hard to get away nor prove your situation!  
You don't know their secret weapons, just like we don't know UFO and where human come from? Do you know? Or you don't care?! Still think these are far away from you ?!

## Korea is only a screen shot of the world !

Worldwidely, numbers of chained girls are in the same situation where they are **sexually abused**, but having difficulties to prove.

# The dirty training data for ChatGPT

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

The “God” selected people owns technology from the weather balloon in Roswell in 1947 !

## chatGPT 邪惡的數據採集與人類的未來

Neuralink's monkey playing mind-controlled video game, eating banana and sucking banana juice as a reward.

沒有一家公司可以重現微軟的chatGPT，除非你是“神”選之“民”才能有氣象氣球的技術。技術有多驚豔，數據來源就有多醜惡！因為你不瞭解腦控！問問下面這隻猴子？



馬斯克的猴子正在推動一場腦機革命，代價只是“香蕉奶昔”\_創世記\_新浪科技\_新浪網

我們被當着是活體實驗卻很難證明



鄧紫棋歌曲「超能力」，特工鄧紫棋的讀腦超能力，與外星人

像不像CIA的測謊原理，心電圖只是個障眼法？

Agent GEM's music : Superpower , the alien's mind-control technology ! Seems like coincidence and joking. Just like her freedom behind bars in leather pants.

你們應該知道的難得一見的妃子笑，不是荔枝，而是歌手蔡佩軒沒有眼淚的陶醉。美人一笑，連chatGPT都會寫歌譜曲了。

# Who controls GEMs

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)



G.E.M.鄧紫棋【句號 Full Stop】Official Music Video

2.67M subscribers

47,606,570 views Premiered Nov 22, 2019 #鄧紫棋 #GEM #句號  
Stream/Download the song here: <https://gem.link.to/FullStop>

我青春的全部回憶  
那要的恨的全都是你  
可惜我們終於來到一個句號

Man with cross in black gentlemen hat and suit



G.E.M.鄧紫棋【句號 Full Stop】Official Music Video

2.67M subscribers

47M views 3 years ago #鄧紫棋 #GEM #句號  
Stream/Download the song here: <https://gem.link.to/FullStop>

Puppet magic box



G.E.M.鄧紫棋【句號 Full Stop】Official Music Video

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47,606,570 views Premiered Nov 22, 2019 #鄧紫棋 #GEM #句號  
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我青春的全部回憶  
那要的恨的全都是你  
可惜我們終於來到一個句號

Controlling the puppet



Deep state



What is Project sigma?

In her song [full stop/ 句號 ], she implies herself as a puppet controlled by the cross! The box of needle looks like a magic box !

So the MV tells a different story rather than that she promoted publicly which is the dispute between her and her former company,i.e. hummingbird music.

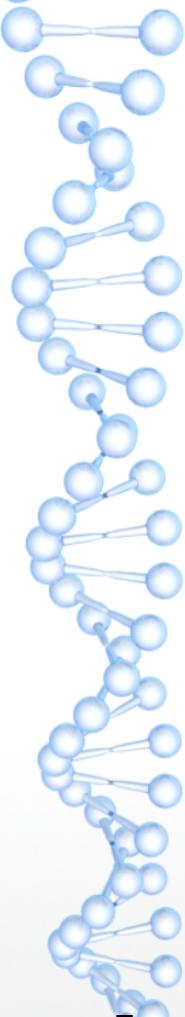
This unsaid story matches other stories embedded in her other songs, such as [bubble], i.e. bible= bubble= lies! And [fearless/ 毒蘋果 ] which is about the sweet lies and attemptation in the “bible” book!

She is a christian at very young, she went to christian school since very young! So the age matches the little girl in the MV, who came across this magically mysterious gentleman in black suit & hat at very young age .

The real world is highly possibly different from what we have seen and been taught! There is a reason that we don't know where we are from and who we really are! Because “they” don't want us to know! We are trapped in this world's physics / phenomenaons, which only UFO have the authority to overwrite.

# More ugly secrets in GEM's music

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Joe Biden  
他們即牠們，即深層政府，即傀儡拜登所說的 *they, they gave me reporter list ...*

鄧紫棋，凳子妻（伍大 / 金 ❤ 與鄧金蓮 / Queen of heart）前世今生的蘋果

For more please read novel 【2507 拝上帝入天坑】：<https://github.com/brianwchh/2507>  
【2507 carrying God back to heaven shit hole】

More about the dark deep state

接下來幾頁是暗線之極惡暗黑深層政府

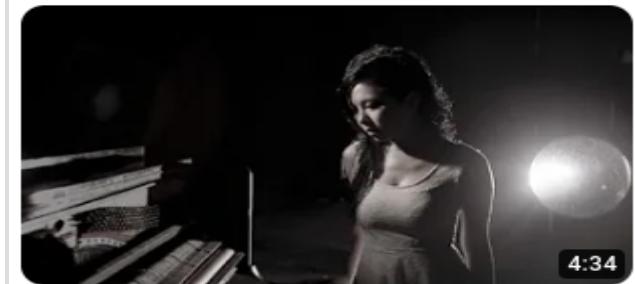
bubble = bible = +  
=poisonous apple  
=lies

+

喂，凳子，誰想嫁給你啊  
誰要認識你啊  
是牠們逼我的



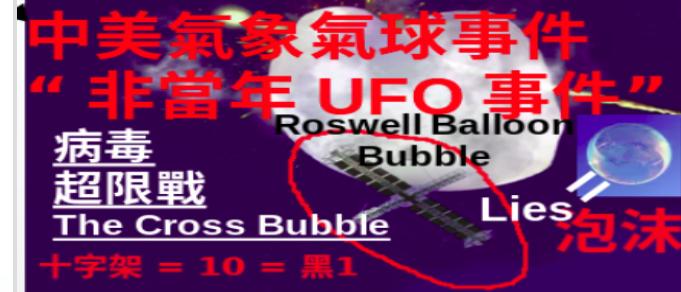
15



G.E.M. "泡沫" "BUBBLE" [HD] 官方MV 鄧紫棋  
17M views • 10 years ago

Virus Unrestricted War !

深層政府十字軍東征中國之 sos



G.E.M. 【毒蘋果 FEARLESS】 Official Audio [HD] 鄧紫棋

2.4M views • 4 years ago

Poisonous apple

Message taken from China-US weather balloon incident : Black cross army heading its way east to China ! It is not to remind you the fake weather balloon in roswell 1947

# Why I am doing this tutorial

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

- Sharing every details of my startup project , i.e. 3D sensor, including source code , simulation and debugging skills of FPGA.
- During break time, tell you the ugly secrets in G.E.M's music. Please believe me, this is far more important than the valuable project I am sharing here. When you read this far you might already know that accelerating algorithms on FPGA is very important ,and difficult as well ! **But this information in GEM's music is far more important and far more difficult to speak out !** Some Korean pop stars have already "committed suicide" trying to prove the real truth!
- My life is in a mess when I was selected by them to be involved with the dirty and disgusting secret project, of course, without my permission and without letting me know, together with a lot of chained talent women and men. **We are being treated as experimental monkeys !** And the result will come and apply to you and your next generation eventually! You have no choice to be audience! Did you embrace chatGPT and boston dynamics robots yet ?! Did you ask yourself who is chatGPT's teachers ? Where did the private and dirty training data come from ? Can you write songs ? Probably no! But chatGPT can, amazing, isn't it !?



马斯克的猴子正在推动一场脑机革命，代价只是“香蕉奶昔”\_创事记\_新浪科技\_新浪网

Neuralink's monkey playing mind-controlled video game, eating banana and sucking banana juice as a reward.



說謊才能全部都不留痕跡  
喚你的偽裝實在無人能及

Agent GEM's music : Superpower , the alien's mind-control technology ! Seems like coincidence and joking. Just like her freedom behind bars in leather pants.



You should go to Your teacher Ariel tsai



# Dynamic programming

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

$$E = \min \sum_p (C(p, D^p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1])$$



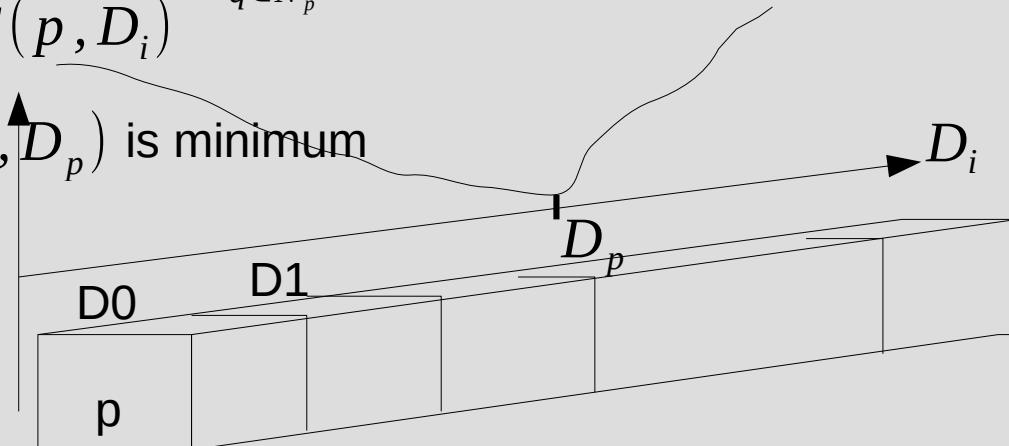
When individual is minimum, global sum is minimized

$$\sum_p \min (C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1])$$

$$\text{let } S(p, D_p) = (C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1])$$

$S(p, D_i)$

$D_p$  Is the Disparity for the pixel p when  $S(p, D_p)$  is minimum



# chicken & egg problem

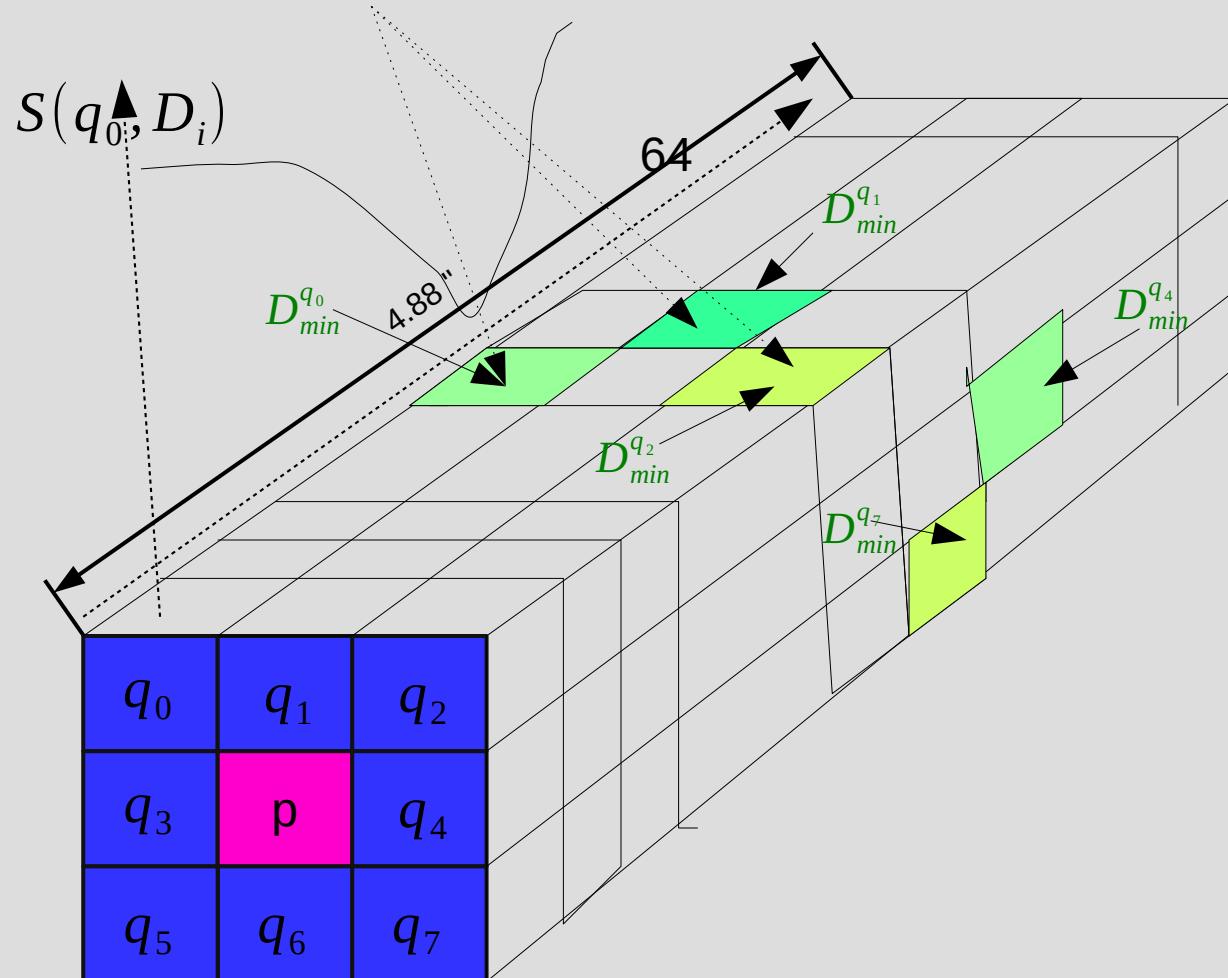
$$S(p, D_{min}^p) = (C(p, D_{min}^p) + \sum_{q \in N_p} P_1 T[|D_{min}^p - D_{min}^q| = 1] + \sum_{q \in N_p} P_2 T[|D_{min}^p - D_{min}^q| > 1]) \quad N_p = [q_0, q_1, \dots, q_7]$$

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

Suppose  $\frac{D}{r \in [0,7]}^{q_r}_{min}$  is given, our objective is to calculate

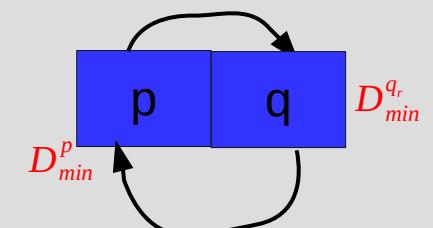
$$\min_{i \in [0,63]} S(p, D_i) = S(p, D_p), \text{ re-write } D_p \text{ as } D_{min}^p \\ = S(p, D_{min}^p)$$

From the cost function, we know  $D_{min}^p$  should be very closely around  $D_{min}^{q_r}$  so that it satisfy the depth smooth constrain



But Using  $D_{min}^{q_r}$  to solve  $S(p, D_{min}^p)$  via the cost function below is infeasible in practice, because to solve p we need to know q, but to solve q we need to know p first.

How can we break this chicken and egg ring problem?

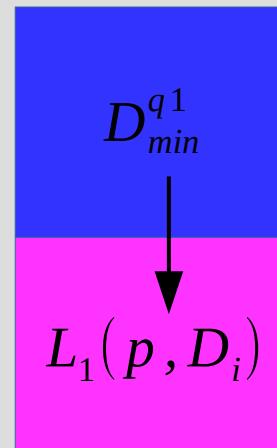
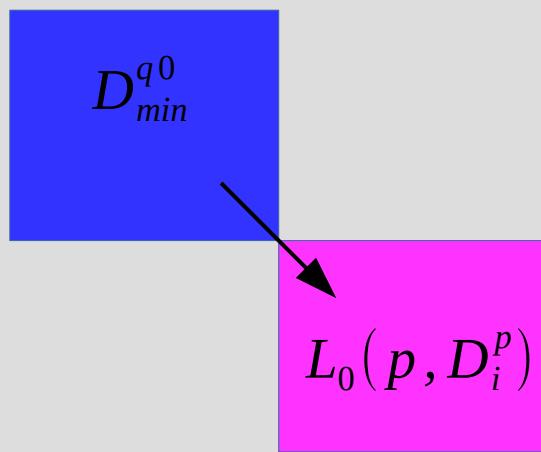


# Decompose $S(p, D_i^p)$

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

$$S(p, D_i^p) = \sum_{r=0}^7 L_r(p, D_i^p) \quad i=0,1,2,\dots,63$$

neighbor  $q_r$  only has contribution to  $L_r(p, D_i^p)$ ,  
as shown in below pictures



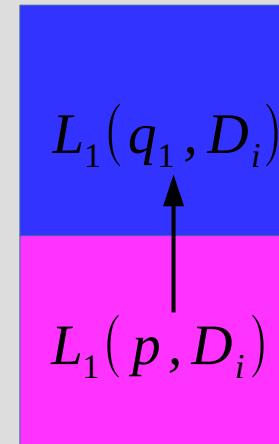
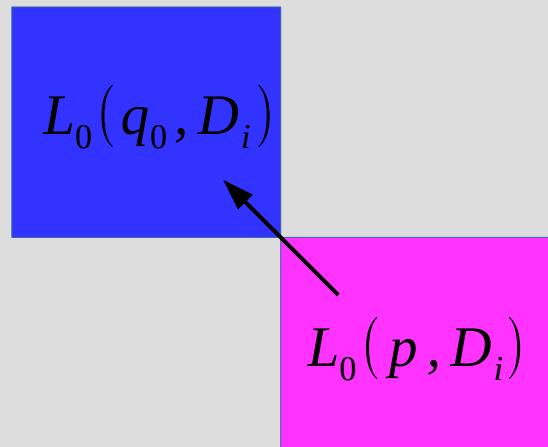
$$L_r(p, D_i^p) = C(p, D_i^p) + P_1 T[|D_i^p - D_{min}^{q_r}| = 1] + P_2 T[|D_i^p - D_{min}^{q_r}| > 1]$$

# Decompose neighbors $S(q_r, D_i^{qr})$ in the same way

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

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$$S(q_r, D_i^{qr}) = \sum_{r=0}^7 L_r(q_r, D_i^{qr})$$

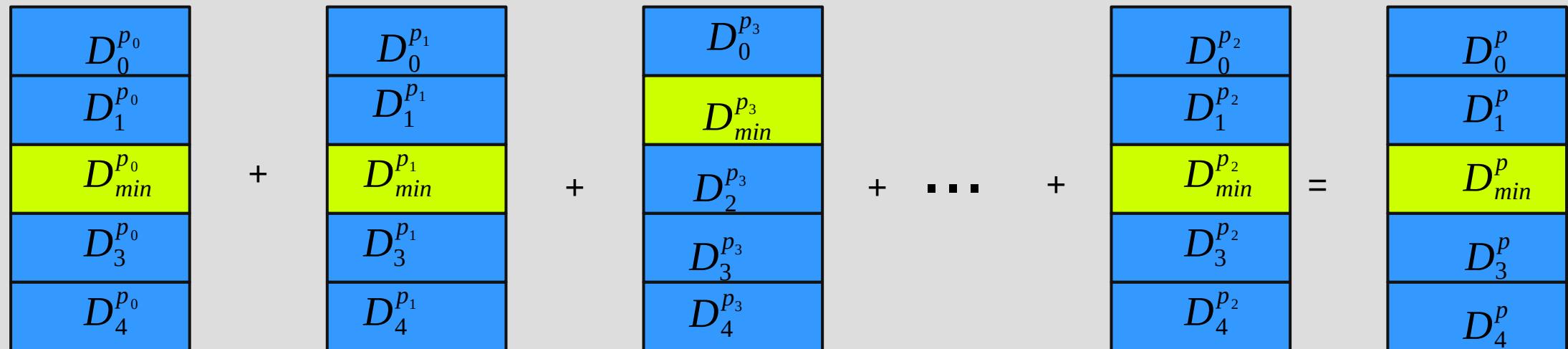


# Show me the code for below process

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$$D_i^{q_0} \quad D_i^{q_1} \quad D_i^{q_3} \quad D_i^{q_2}$$

$$L_0(p, D_i^{p_0}) + L_1(p, D_i^{p_1}) + L_3(p, D_i^{p_3}) + \dots + L_2(p, D_i^{p_2}) = S(p, D_i^p)$$



$$L_r(p, D_i^p) = C(p, D_i^p) + P_1 T[|D_i^p - D_{min}^{q_r}| = 1] + P_2 T[|D_i^p - D_{min}^{q_r}| > 1]$$

$$S(p, D_i^p) = \sum_{r=0}^7 L_r(p, D_i^p) \quad i=0,1,2,\dots,63$$

Either by summing up all components then find the minimum or by voting or averaging

# Show me the code for below process

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```
void spacial_smooth_constrain_cpu(const uint8_t* d_matching_cost, uint16_t* d_scost, int width, int height)
{
    uint16_t* left_scan = new uint16_t[width * height * disparity_size_];
    uint16_t* right_scan = new uint16_t[width * height * disparity_size_];
    uint16_t* top_scan = new uint16_t[width * height * disparity_size_];
    uint16_t* bottom_scan = new uint16_t[width * height * disparity_size_];
    uint16_t* topleft_scan = new uint16_t[width * height * disparity_size_];
    uint16_t* bottomleft_scan = new uint16_t[width * height * disparity_size_];
    uint16_t* topright_scan = new uint16_t[width * height * disparity_size_];
    uint16_t* bottomright_scan = new uint16_t[width * height * disparity_size_];

    //***** left scan *****
    L_r(p,D_i^p)=C(p,D_i^p)+P_1T[D_i^p-D_{min}^q_r=1]+P_2T[D_i^p-D_{min}^q_r>1]
```

```
for(int r=0; r<height; r++)
    for(int c=0; c<width; c++)
    {
        int volPtr = r * width * disparity_size_ + c * disparity_size_ ;

        if(c == 0)           // ----- first column points -----
        {
            /* find the minimum value, since no preceeding neighbour on the left */
            for(int d=0; d< disparity_size_; d++)
            {
                left_scan[volPtr + d] = (uint16_t)d_matching_cost[volPtr + d] ;

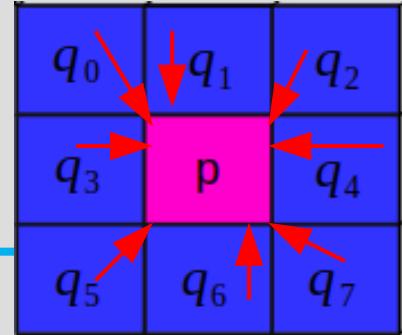
                // find current pixel min_left_scan and corresponding disparity D_min
                if(d == 0){
                    minPre = left_scan[volPtr + d];
                    D_pre_min = 0;
                }
                else if( left_scan[volPtr + d] < minPre)
                {
                    minPre = left_scan[volPtr + d] ;          // find the minimum L(Pr-1,Di)
                    D_pre_min = d ;                         // D_pre_min
                }
            }
        }
    }
}
```

```
#define disparity_size_ 64
#define PENALTY1 3
#define PENALTY2 10
```

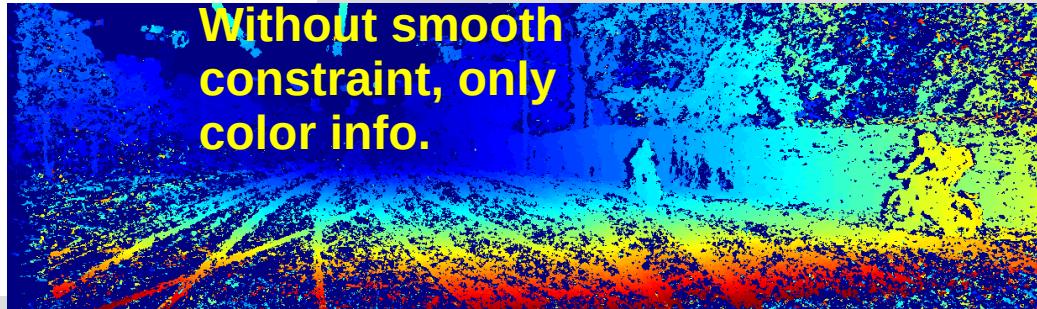
After playing around this penalty parameters, you will find out the problems listed in next slice, and the work around solution will lead you to the formula in the original paper

```
// depth wise add
for( int r = 0 ; r < height ; r++)
    for( int c=0; c < width ; c++)
    {
        int volPtr = r * width * disparity_size_ + c * disparity_size_ ;
        for( int d=0; d < disparity_size_ ; d++)
        {
            d_scost[volPtr + d] = left_scan[volPtr + d] + right_scan[volPtr + d] + top_scan[volPtr + d] + bottom_scan[volPtr + d] ;
            d_scost[volPtr + d] = left_scan[volPtr + d] ; // + top_scan[volPtr + d] + topleft_scan[volPtr + d] +
        }
    }

// scan_scost_cpu(H_matching_cost,H_scost_cost,lef.cols,lef.rows) ; // according to original paper
spacial_smooth_constrain_cpu(H_matching_cost,H_scost_cost,lef.cols,lef.rows) ;
// bypass_spacial_smooth_constrain_cpu(H_matching_cost,H_scost_cost,lef.cols,lef.rows) ;
```



Without smooth constraint, only color info.



With smooth constraint, only left neighbor spacial info.



$$S(p, D_i^p) = \sum_{r=0}^7 L_r(p, D_i^p) \quad i=0,1,2,\dots,63$$

# When PENALTY is too big

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

$$E = \underbrace{\sum_p (C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1])}_{\text{color constrain term}} + \underbrace{\sum_{q \in N_p} P_2 T[|D_p - D_q| > 1]}_{\text{spacial constrain term}}$$

When penalty becomes too big, the spacial smooth constrain term is dominating the formula. So that it is hardly possible to get back to the right track once its neighbor is contaminated by noise.

Question:

Is there anyway to recover from noise. i.e. giving color constraint term more weights to dominate and pull the trajectory back to the right track, apart from tuning the right penalty parameter value carefully ?

```
#define disparity_size_ 64  
#define PENALTY1 3  
#define PENALTY2 60
```

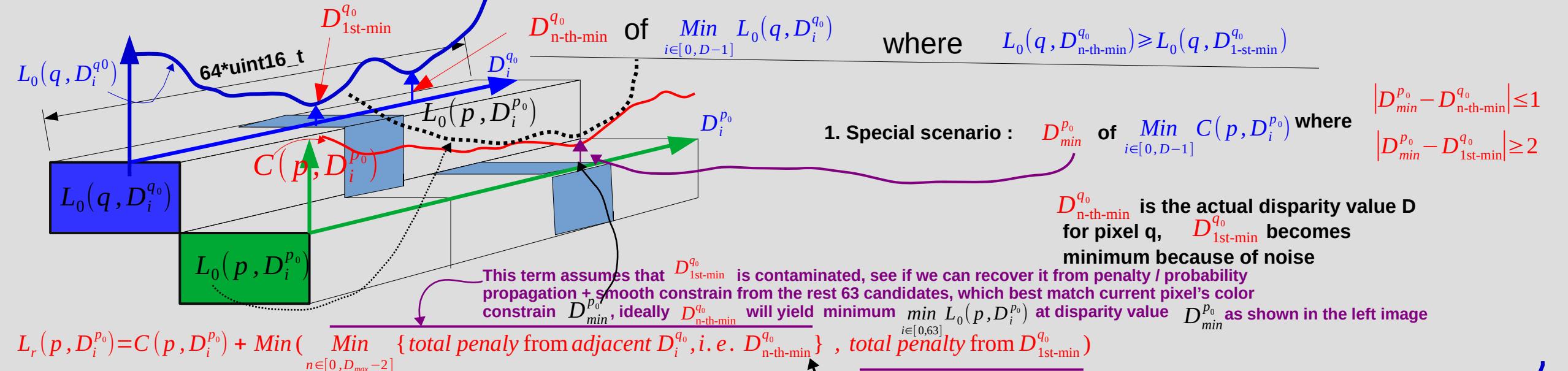


With smooth constraint, only left neighbor spacial info.

# Analyze a special scenario for solution

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

$$L_r(p, D_i^p) = C(p, D_i^p) + P1[|D_i^p - D_{min}^q| = 1] + P2[|D_i^p - D_{min}^q| \geq 2]$$



#### 4. The result :

Then  $D_{n-th-min}^{q_0}$  is chosen when penalty from  $D_{n-th-min}^{q_0}$  is bigger than that from  $D_{1st-min}^{q_0}$

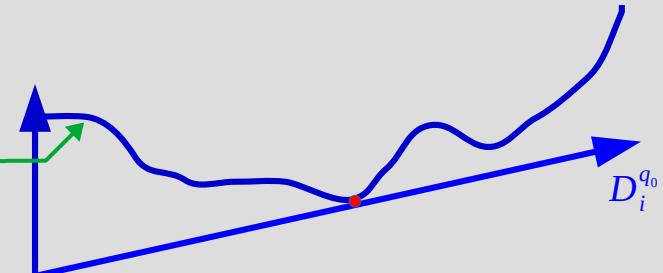
#### 2. Question ? :

how do we tell the algorithm to choose  $D_{n-th-min}^{q_0}$  over  $D_{1st-min}^{q_0}$

Previously we only compare this term, now P2 will make this term larger, so will no longer be considered as smooth constrain item

#### 3.Solution :

Introducing possibility propagation, using  $L_0(q, D_i^{q_0}) - \text{Min}_{i \in [0, D-1]} L_0(q, D_i^{q_0})$  to represent the inverse-possibility of each  $D_i^{q_0}$  being the right disparity for pixel q . and also used as penalty information as well, which is kind of a information from the history, i.e. accumulated from its predecessors. Let  $\text{PENALTY\_PROPAGATE}(q, D_i^{q_0}) = L_0(q, D_i^{q_0}) - \text{Min}_{i \in [0, D-1]} L_0(q, D_i^{q_0})$



# Cost function from SGM paper

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

$$L_r(p, D_i^{p_0}) = C(p, D_i^{p_0}) + \text{Min}(\underset{n \in [0, D_{\max} - 2]}{\text{Min}} \{ \text{total penalty from adjacent } D_i^{q_0}, i.e. D_{n\text{-th-min}}^{q_0} \}, \text{total penalty from } D_{1\text{st-min}}^{q_0})$$

**TOTAL \_PENALTY = PENALTY \_PROPAGATE ( $q, D_i^{q_0}$ ) + spacial smooth constrain term**

$$L_r(p, D_i) = C(p, D_i) + \min(L_r(q_r, D_i) + 0, L_r(q_r, D_i \pm 1) + P1, \min(L_r(q_r, D_i \pm n) + P2))$$

-  $\min(L_r(q_r, D_i \pm k))$        $n \geq 2, k \geq 0$

By now it should be quite easy to understand the physical meaning of the formula given by the original SGM paper, repeat again, the motivation is to recover the right disparity information of the neighboring pixel if it is contaminated by noise. So that the spacial constrain tern will not dominate the cost function, and lead to a disaster result as shown in below image.

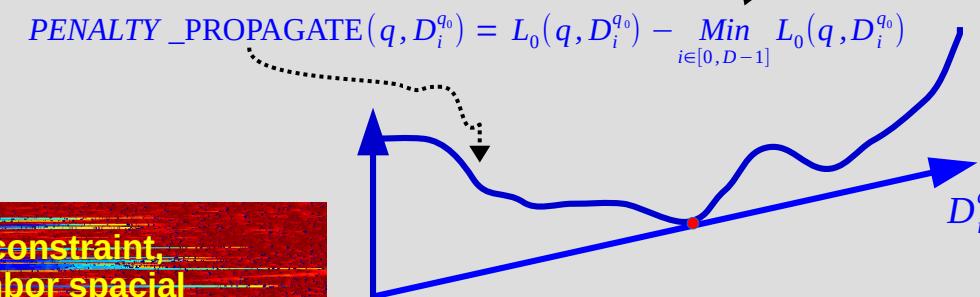
The price we have to pay is the exhaustive searching in all candidates, i.e. the rest 63 disparity positions.

Worth to point out here is that, now our penalty has two terms, one is the traditional spacial smooth constrains, the second is the neighbors probability information accumulative along the path, consider it as kind of history information.

To make ARM computation faster or save FPGA resource (if FPGA resource is not shared via higher clock rate), you can also only search the least N candidates, no need to search all candidates as the paper does. Of course you can also come up with other methods to recover it from noise contamination, for instance changing the weight according to neighboring texture information, to down weight the less texture neighbors.



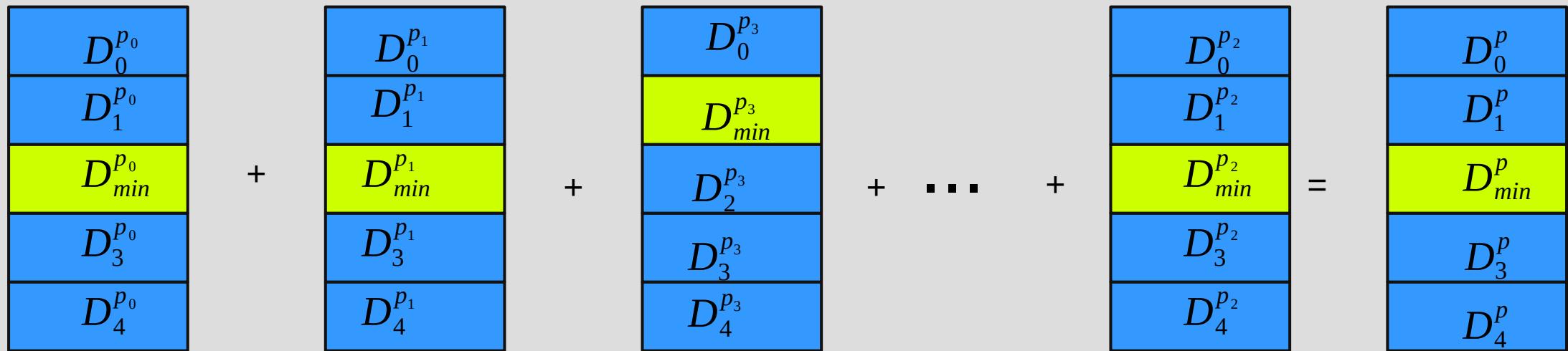
Big spacial smooth penalty without  
PENALTY\_PROPAGATE ( $q, D_i^{q_0}$ ) information



# Show me the code for below process

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

$$\begin{array}{ccccccccc}
 \cancel{D_i^{q_0}} & L_0(q, D_i^{q_0}) & \cancel{D_i^{q_1}} & L_1(q, D_i^{q_1}) & \cancel{D_i^{q_3}} & L_3(q, D_i^{q_3}) & \cancel{D_i^{q_2}} & L_2(q, D_i^{q_2}) & \\
 & \searrow & & \downarrow & & \rightarrow & & \swarrow & \\
 L_0(p, D_i^{p_0}) & + & L_1(p, D_i^{p_1}) & + & L_3(p, D_i^{p_3}) & + & \dots & + & L_2(p, D_i^{p_2}) = S(p, D_i^p)
 \end{array}$$



$$\begin{aligned}
 L_r(p, D_i) &= C(p, D_i) + \min(L_r(q_r, D_i) + 0, L_r(q_r, D_i \pm 1) + P1, \min(L_r(q_r, D_i \pm n) + P2)) \\
 &\quad - \min(L_r(q_r, D_i \pm k))
 \end{aligned}
 \quad n \geq 2, k \geq 0$$

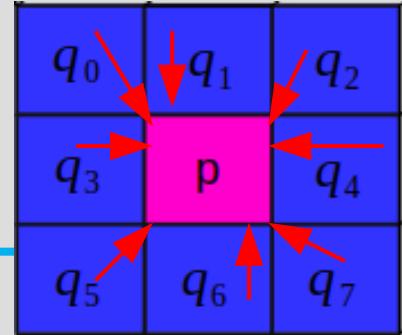
Either by summing up all components then find the minimum or by voting or averaging

# Show me the code for below process 2

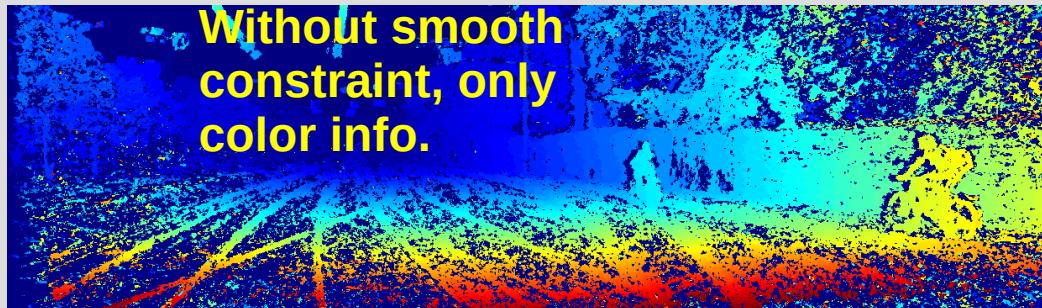
#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

```
scan_scost_cpu(H_matching_cost,H_scan_cost, left.cols, left.rows) ; // according to original paper  
// spacial_smooth_constraint_cpu(H_matching_cost,H_scan_cost, left.cols, left.rows) ;  
// bypass_spacial_smooth_constraint_cpu(H_matching_cost,H_scan_cost, left.cols, left.rows) ;
```

```
uint16_t tmp = 0 ;  
if(Lpr_minus1_DiPlus0 > minPre && Lpr_minus1_DiPlus1 > minPre && Lpr_minus1_DiMinus1> minPre ) // minPre is the minimum  
{  
    tmp = minPre + PENALTY2;  
    tmp = calMin(tmp, Lpr_minus1_DiPlus0);  
    tmp = calMin(tmp , Lpr_minus1_DiMinus1 + PENALTY1);  
    tmp = calMin(tmp,Lpr_minus1_DiPlus1 + PENALTY1);  
    tmp = tmp - minPre ;  
}  
else // minPre is among D+/- 1  
{  
    tmp = Lpr_minus1_DiPlus0 ;  
    tmp = calMin(tmp , Lpr_minus1_DiMinus1 + PENALTY1);  
    tmp = calMin(tmp,Lpr_minus1_DiPlus1 + PENALTY1);  
    tmp = tmp - minPre ;  
}  
uint16_t tValue = (uint16_t)d_matching_cost[volPtr + d] + tmp ; // Lr(P,Di) = C(P,Di) + min(.....) - min(.....)  
left_scan[volPtr + d ] = tValue ;
```



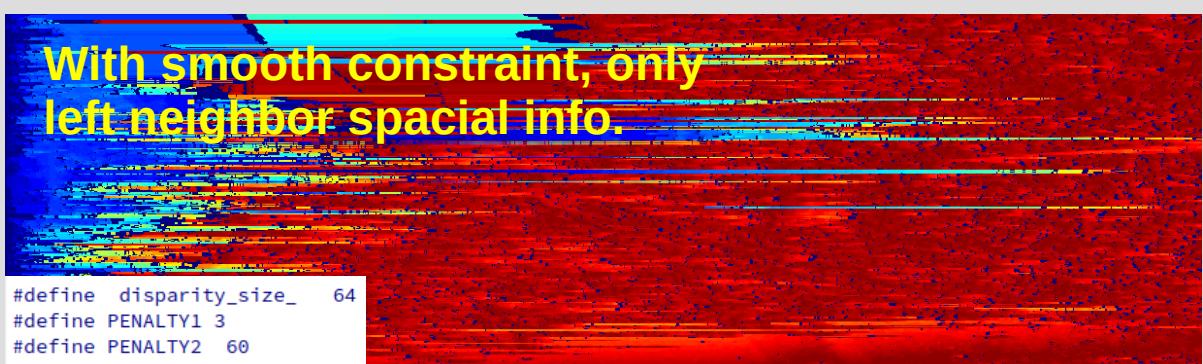
Without smooth constraint, only color info.



With smooth constraint, only left neighbor spacial info.



With smooth constraint, only left neighbor spacial info.



```
#define disparity_size_ 64  
#define PENALTY1 3  
#define PENALTY2 60
```

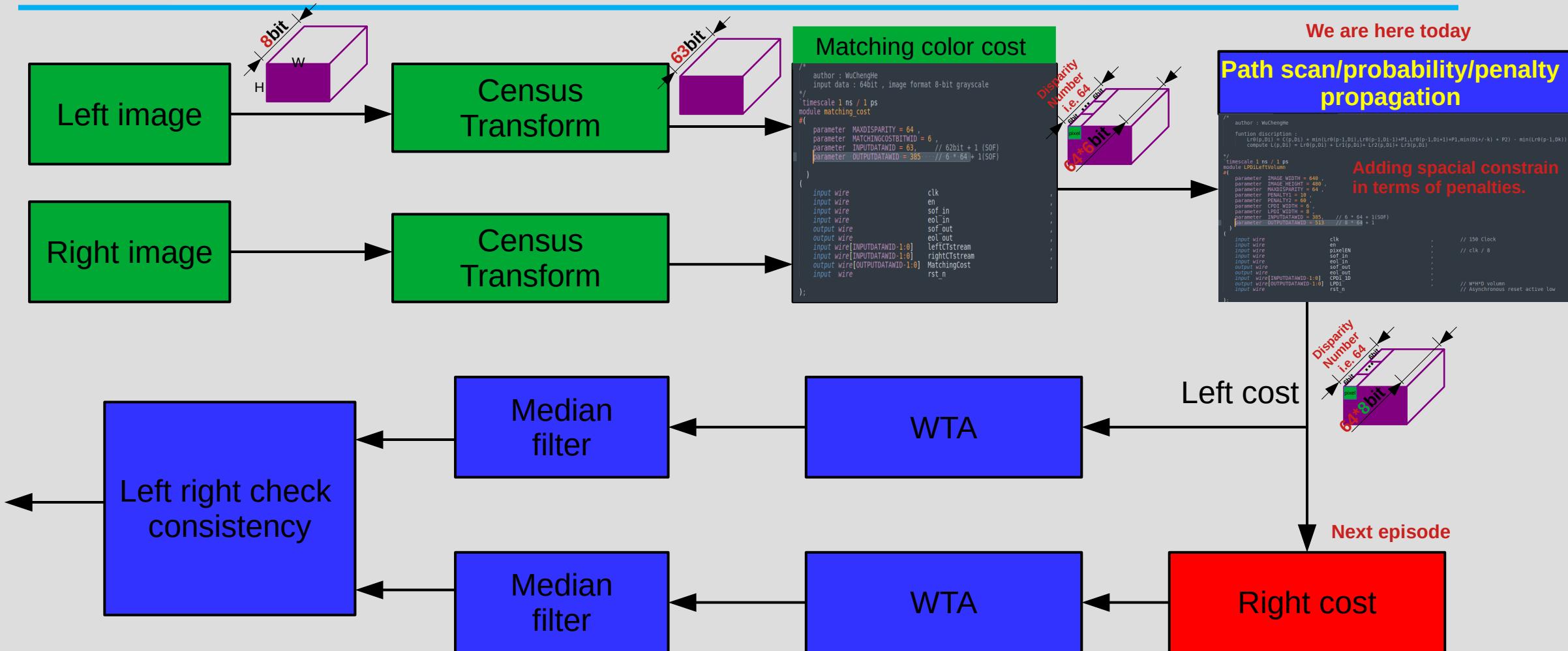
With smooth constraint, and penalty / probability propagation history info.



```
#define disparity_size_ 64  
#define PENALTY1 3  
#define PENALTY2 60
```

# Next: get Right\_cost from Left\_cost

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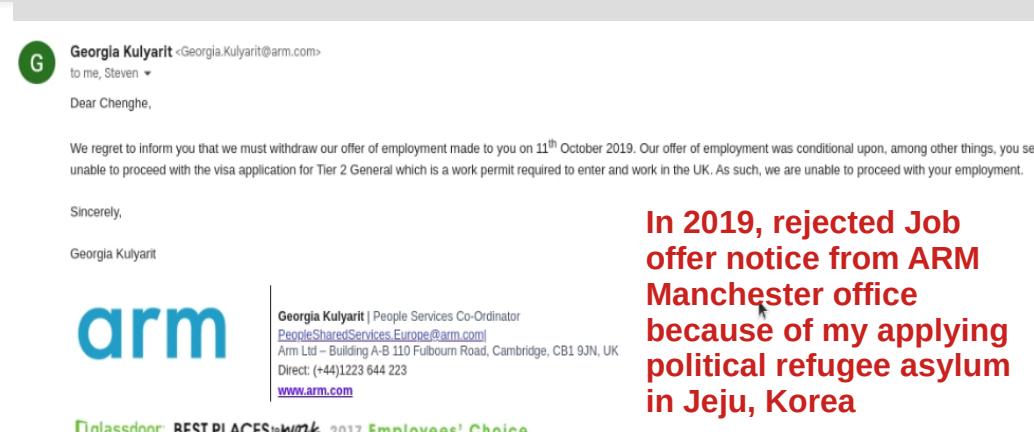
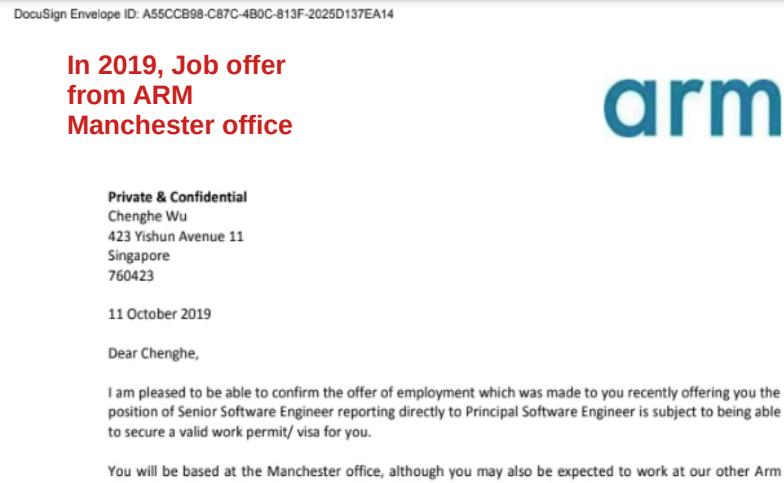
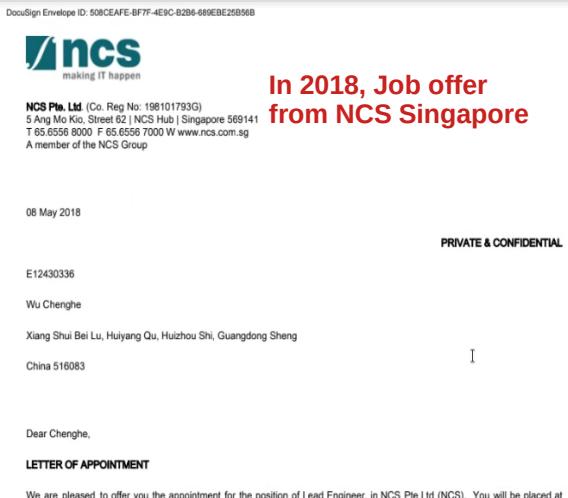


# Brief intro. about me

#hohy #metoo #MeTooMovement [https://github.com/brianwchh/ChatGPT\\_mindControl\\_dataset](https://github.com/brianwchh/ChatGPT_mindControl_dataset)

- Over 11+ years of R&D work experience, capable of designing and deploying computer vision and deep learning algorithms on embedded device like FPGA and ARM.
- Full stack web development with Django, React/Vue/Nextjs, MySQL, Nodejs, Golang, etc....
- skilled at FPGA / ZYNQ SOC design ( Verilog HDL )
- good at GPU ( CUDA + openGL )
- Good at programming languages: C/C++, python, javascript, Golang, verilog HDL
- Familiar with Deep learning libraries like Tensorflow, Darknet...
- rich work experience in : SLAM / Visual SLAM, ROS, VR, AR, 3D sensing (Stereo vision), object detection, motor control

More on LinkedIn : <https://www.linkedin.com/in/brianwchh/>



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# Thank you

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無形鐵鍊女們的  
求救禪語信息



小說地址: <https://github.com/brianwchh/2507>

← 解說影片: <https://youtube.com/playlist?list=PL4mHdDqV3T2uDeFnSC1bWhz3cN3wPZMzr>

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