Grassroots Startup Project Sharing

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

4 – SGM cost function Dynamic Programming & Penalty Propagation

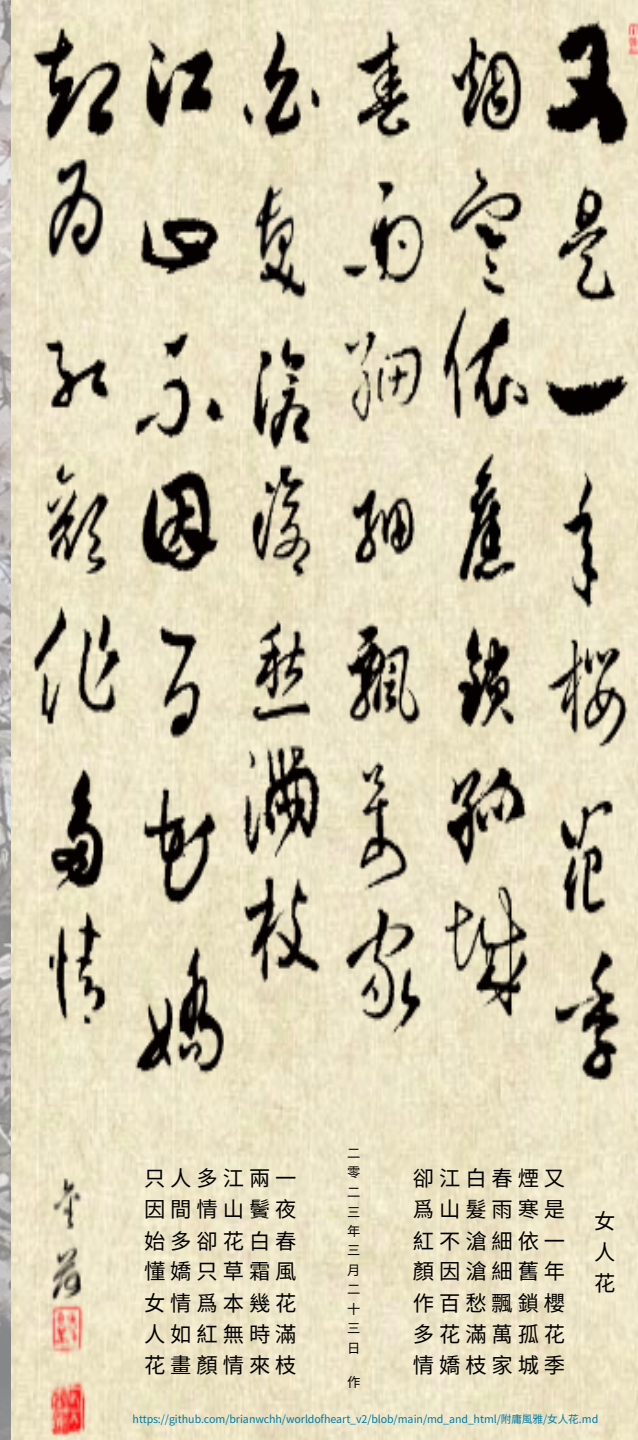
By GimHo.Ng/ 伍金和 (荷)

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



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

G.E.M 鄧紫棋
wearing iron chain

Ariel Tsai 蔡佩軒
wearing iron chain

1. Sexual abuse SM
2. Cutting hair & weird behaviors on live streaming
3. Symbol of deep state

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

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

電影【玩物】娛樂圈的性朝貢

雪莉生前求救信號

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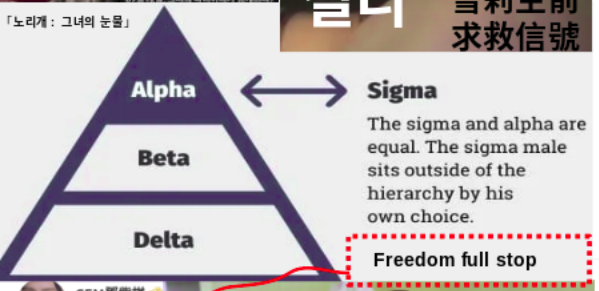


가수 singer G.E.M

4471 8253 11.2万

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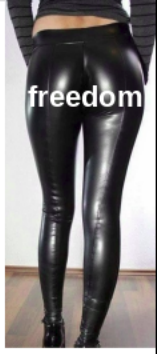
Freedom is a joke of leather pants behind bars



freedom behind bars in leather pants

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

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Evil
Project sigma !

SOS

Wake up all

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

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

The tutorial plan

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

- **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 (zynq 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

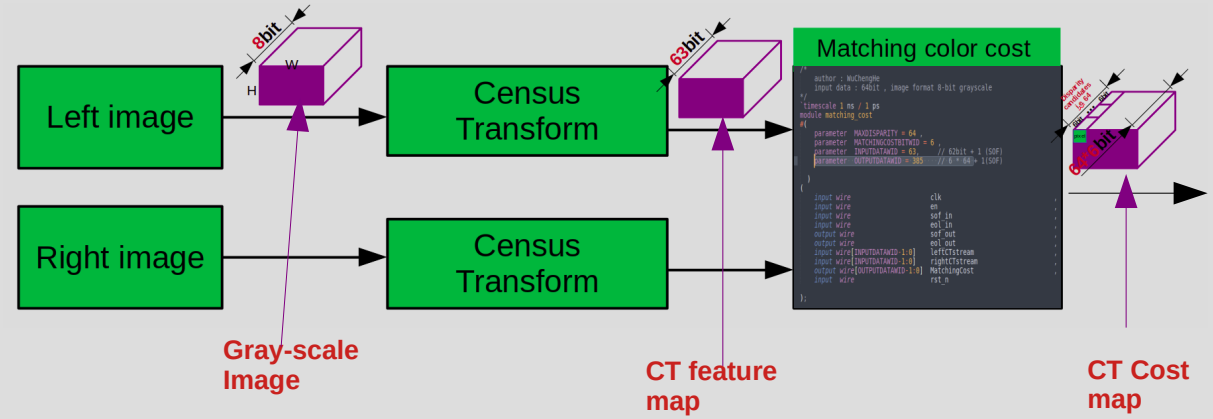
$$\frac{\partial E}{\partial someParameters}$$

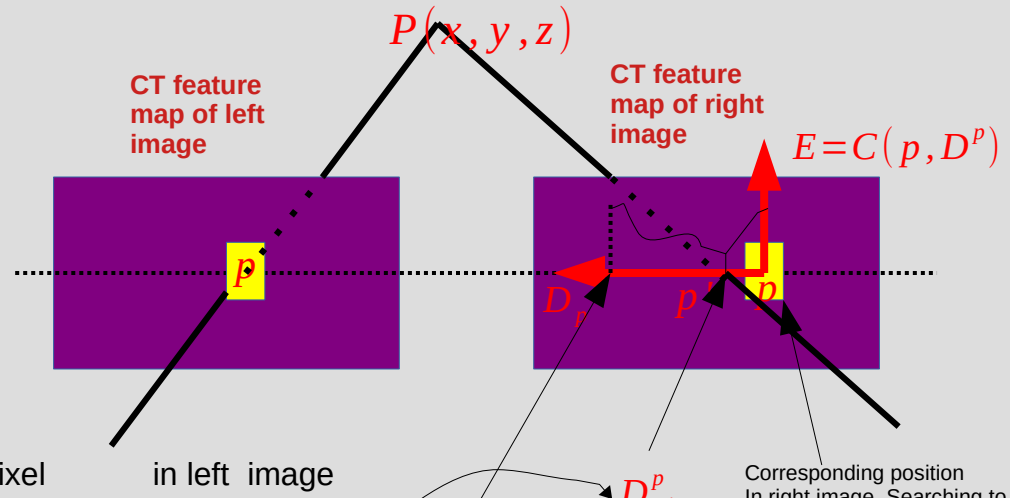
$$= \frac{\partial \sum_{p} \left(C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1] \right)}{\partial someParameters} = 0$$

- NO !!! :(

Recap: matching Color cost function $C(p, D^p)$

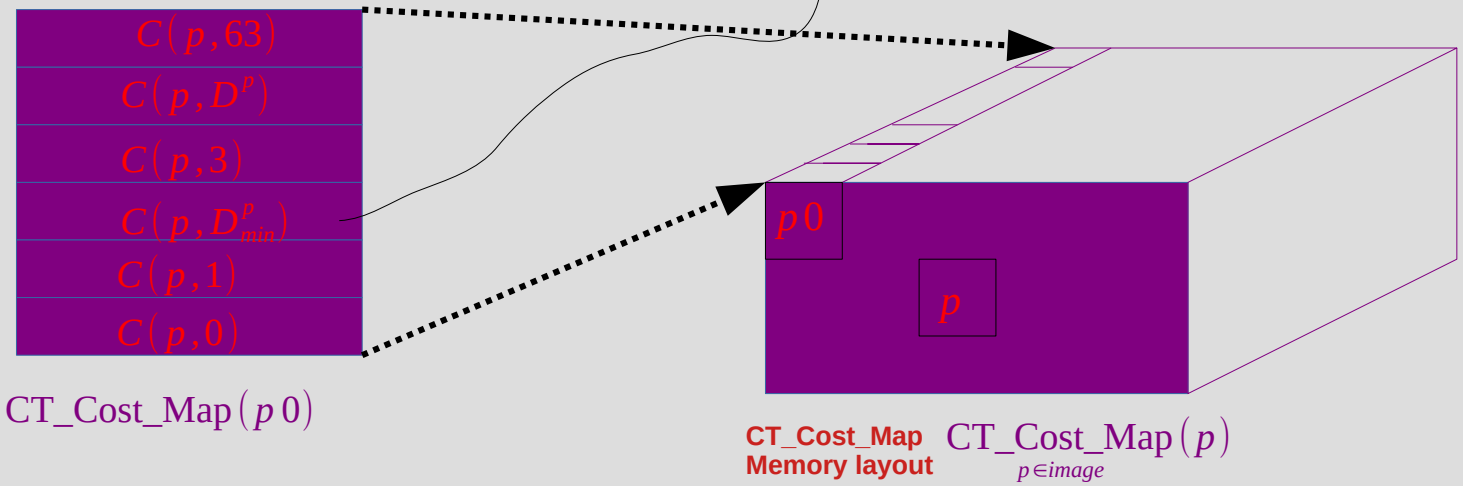
#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset





$$E = C(p, D^p) = \text{CT\_feature\_map\_leftImage}(p) \ XOR \ \text{CT\_feature\_map\_rightImage}(p - D^p)$$

Recall XOR



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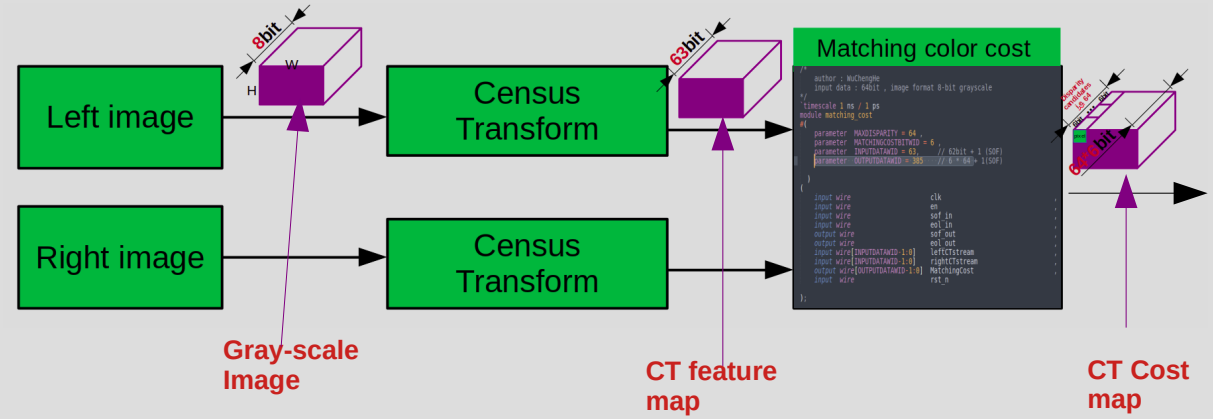
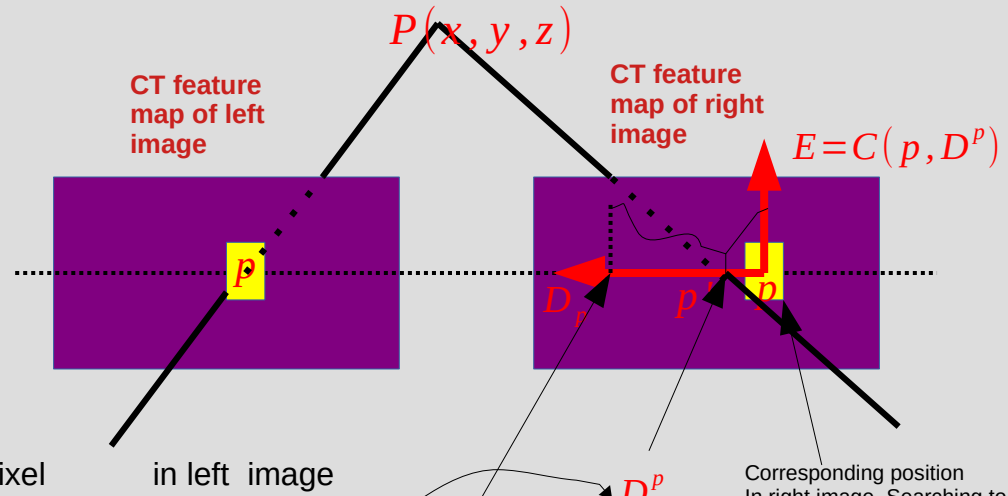




$$E = C(p, D^p) = \text{CT\_feature\_map\_leftImage}(p) \ XOR \ \text{CT\_feature\_map\_rightImage}(p - D^p)$$

Recall XOR

To simplify things, assume the depth of Census Transform's output is 4bits, instead of 63bits.

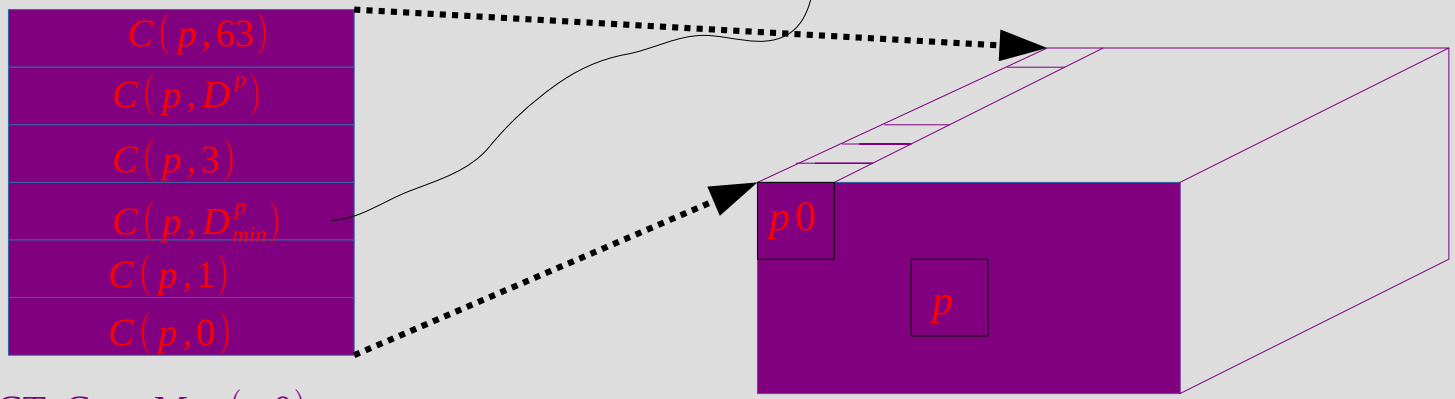
Say we know

$p - p' = D^p_{min} = 2$

$\text{CT\_feature\_map\_leftImage}(p) = [0,0,1,0]$

$\text{CT\_feature\_map\_rightImage}(p-2) = [0,0,1,0]$

Then we will have



$\text{CT\_feature\_map\_leftImage}(p)$

$XOR \ \text{CT\_feature\_map\_rightImage}(p-2) = [0,0,1,0] \ XOR \ [0,0,1,0] = count\ one\ \text{in}\ [0,0,0,0] = 0 \ = \ C(p, D^p_{min})\ is\ minimum$

Recap: matching Color cost function $C(p, D^p)$

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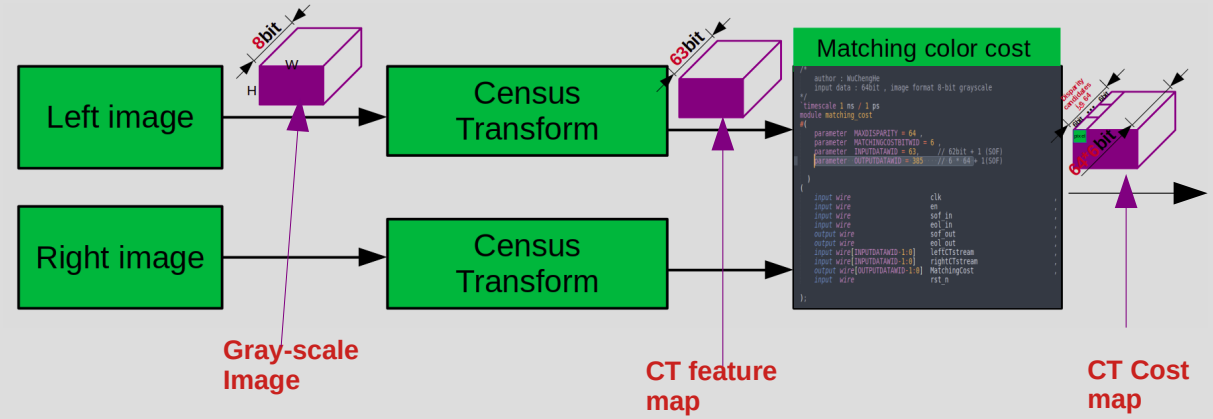

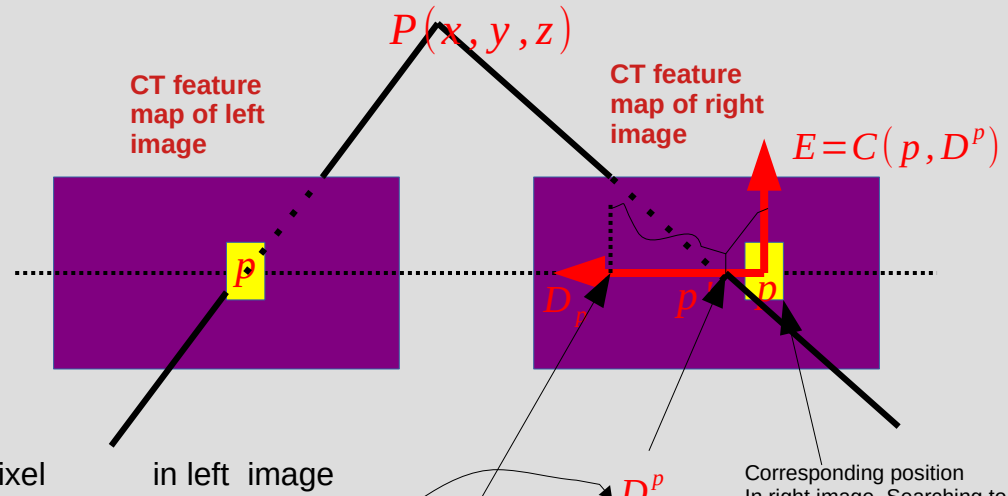

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Recall XOR

To simplify things, assume the depth of Census Transform's output is 4bits, instead of 63bits.

Another example

Say, we know

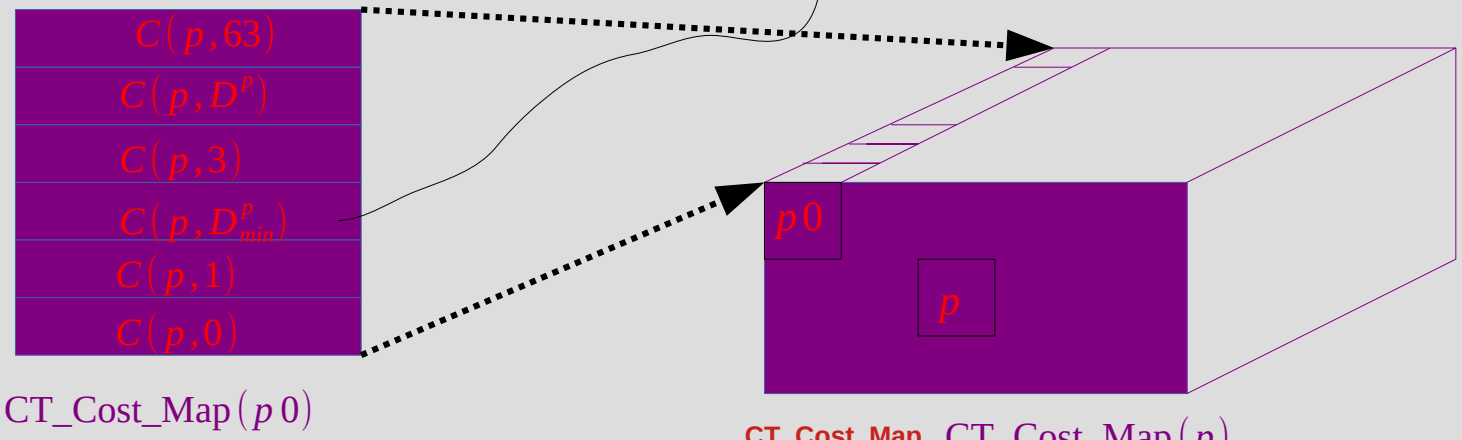
$\text{CT\_feature\_map\_leftImage}(p) = [0,0,1,0]$

$\text{CT\_feature\_map\_rightImage}(p-1) = [1,0,1,0]$

Then, we will have

$\text{CT\_feature\_map\_leftImage}(p)$

$XOR \; \text{CT\_feature\_map\_rightImage}(p-1) = [0,0,1,0] \; XOR \; [1,0,1,0] = count\ one\ \text{in}\ [1,0,0,0] = 1 \; = C(p,1)$



Recap: matching Color cost function $C(p, D^p)$

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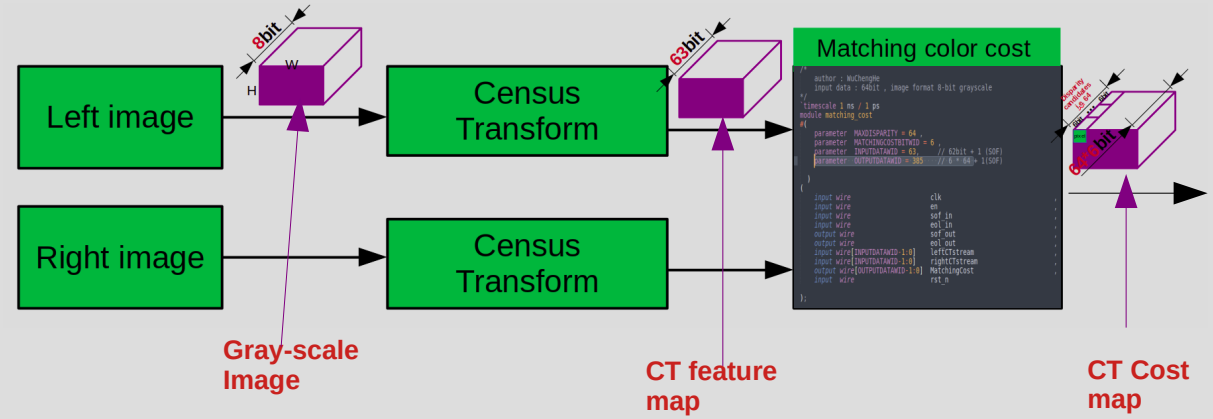

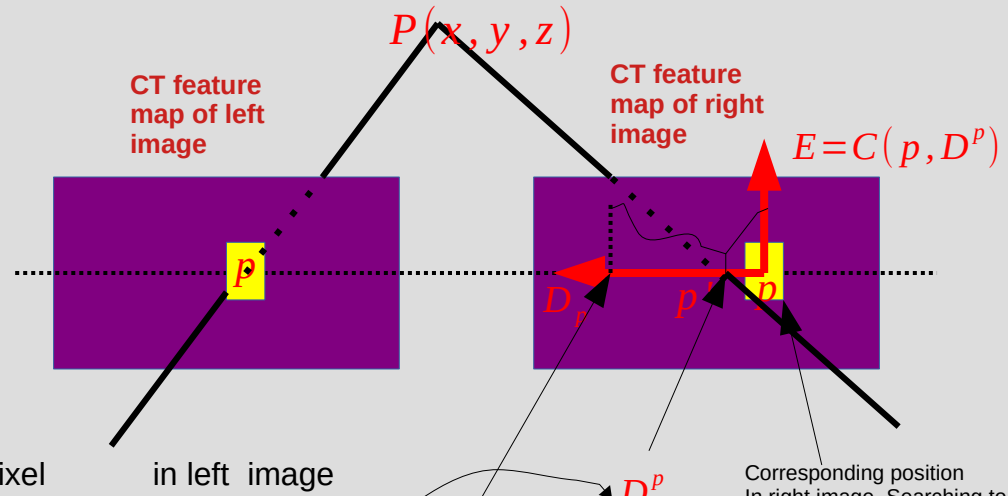

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Recall XOR

To simplify things, assume the depth of Census Transform's output is 4bits, instead of 63bits.

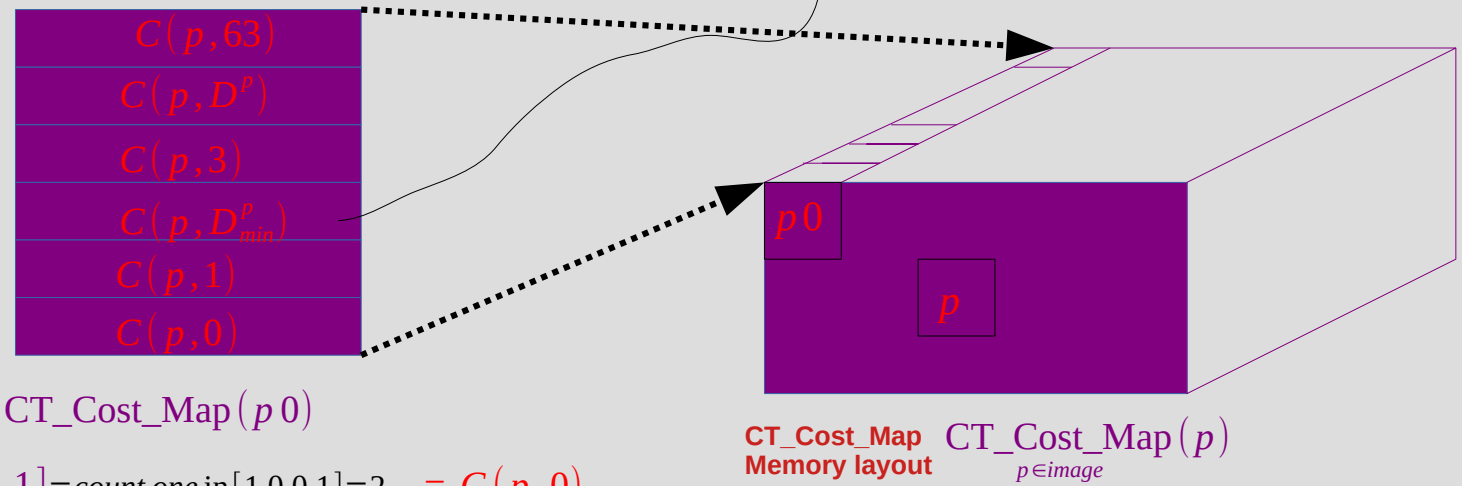
Another more

Say, we know

$$\text{CT\_feature\_map\_leftImage}(p) = [0,0,1,0]$$
$$\text{CT\_feature\_map\_rightImage}(p-0) = [1,0,1,1]$$

Then, we will have

$$\text{CT\_feature\_map\_leftImage}(p)$$
$$XOR \; \text{CT\_feature\_map\_rightImage}(p-0) = [0,0,1,0] \; XOR \; [1,0,1,1] = count\ one\ \text{in}\ [1,0,0,1] = 2 \quad = C(p,0)$$



Recap: the C++ code for matching color cost

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

```
void matchingCost_cpu(const uint64_t* h_left, const uint64_t* h_right, uint8_t* h_matching_cost, int width, int height)
{
        for(int r=0; r < height; r++)
            for(int c=0; c<width; c++)
            {
                int ptr = r * width + c ;
                uint64_t baseVal = h_left[ptr];
                //for each pixel in the left image,  compare to 64  candidates in the right image
                for(int i= 0; i< disparity_size_ ; i++)
                {
                   int destPtr = r *(width * disparity_size_) +  c * disparity_size_  +  i  ;
                   if(c - i < 0 ){     //compared element is  out of bounds
                        h_matching_cost[destPtr] = 62 ;
                   }
                   else {
                        uint64_t comparedVal = h_right[ptr - i] ;
                        uint64_t  xor_result = baseVal ^ comparedVal ;
                        uint64_t  pattern = 0x01 ;
                        uint8_t bit1count = 0 ;
                        for(int k=0; k< 64;k++)    // counting # of 1s
                        {
                            if(xor_result & pattern ){
                                bit1count ++ ;
                            }
                            xor_result = xor_result >> 1 ;
                        }
                        h_matching_cost[destPtr] = bit1count  ;
                    }
                }
            }
}
```

1. Bit-wise compare

XOR

2. Counting number of 1s in the compared result

Will talk in more detail in later episodes, we use uint64_t here, because CPU doesn't support 63bit fixed point data type, unlike FPGA, so 64bit integer is the closest data type you can select.

Recap: Dynamic programming

#hohy #metoo #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

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

When individual is minimum, global sum is minimized

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

- 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 #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

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

$$E=min\sum_{p}\left(C\left(p,D_p\right)+\sum_{q\in N_p}P_1T\left[\left|D_p-D_q\right|=1\right]+\sum_{q\in N_p}P_2T\left[\left|D_p-D_q\right|>1\right]\right)$$

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.

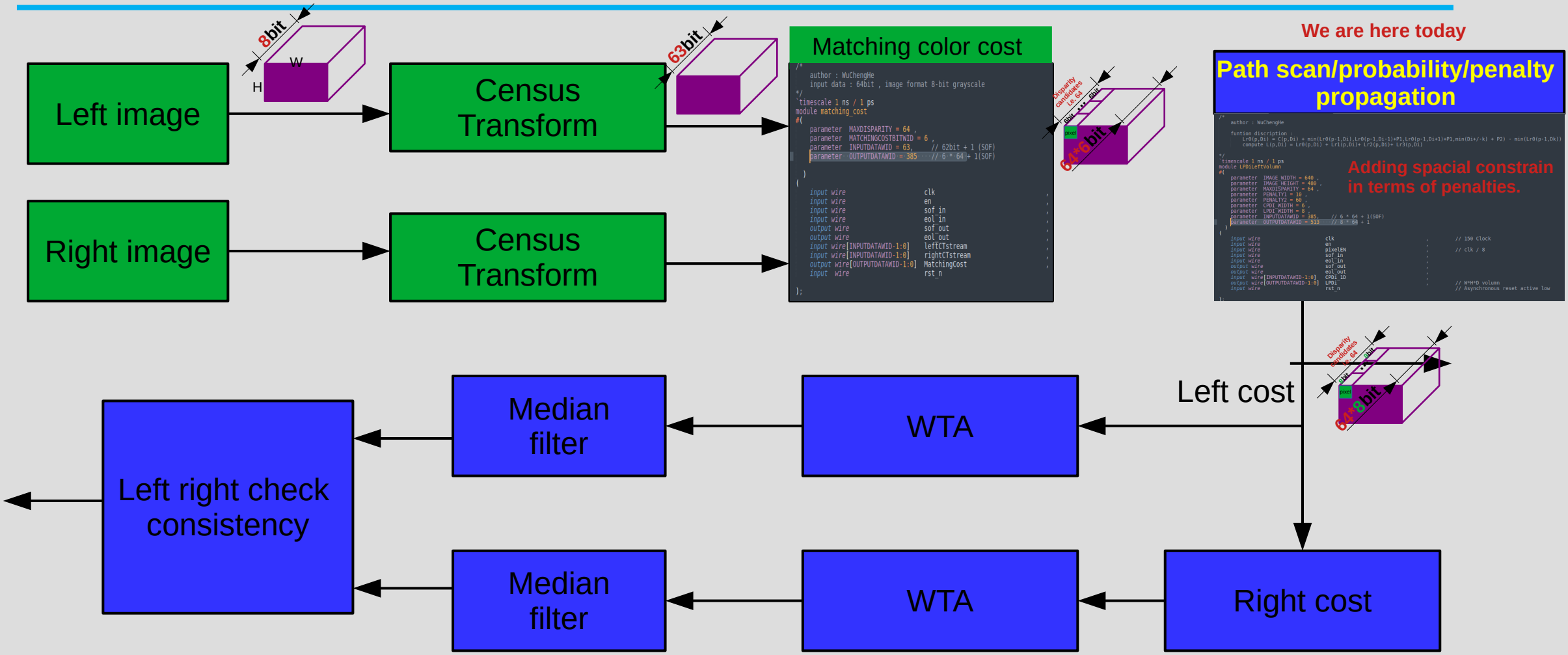
$$L_r\left(p,D^{p_r}\right)=C\left(p,D^{p_r}\right)+min\left(L_r\left(q,D^{p_r}\right),L_r\left(q,D^{p_r}\pm1\right)+P1,min\left(L_r\left(q,D^{p_r}\pm n\right)+P2\right)\right)$$

$$-min\left(L_r\left(q,D^{p_r}\pm k\right)\right)\qquad\qquad n\geq2\ ,k\geq0$$

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 #MeToo Movement https://github.com/brianwchh/ChatGPT_mindControl_dataset



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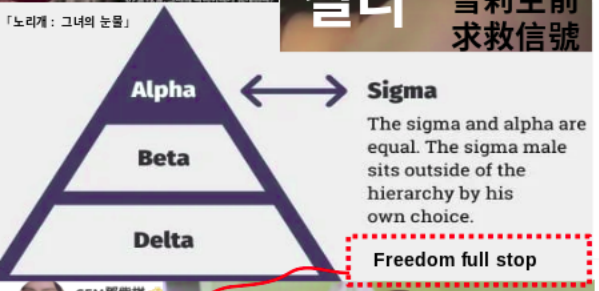


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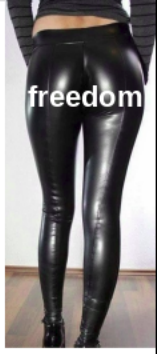

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Who triggered this bomb

#hohy #metoo #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

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 ?!

「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

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

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

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！ 因爲你不瞭解腦控！ 問問下面這隻猴子?

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

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

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?

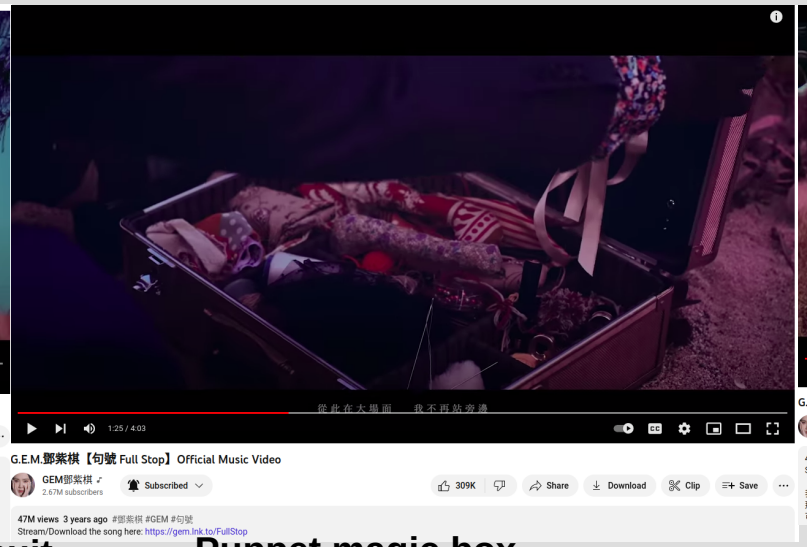
Agent GEM's music : Superpower , the alien's mind-control technology ! Seems like coincidence and joking. Just like her freedom behind bars in leather pants.

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

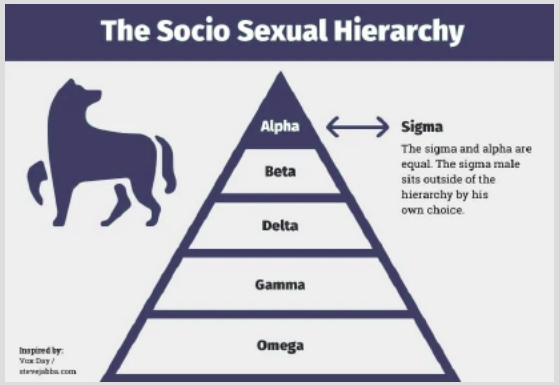
Man with cross in black gentlemen hat and suit



Puppet magic box

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 / phenomenons, which only UFO have the authority to overwrite.

More ugly secrets in GEM‘s music

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

More about the dark deep state

接下來幾頁是暗線之極惡暗黑深層政府

金星秀節目訪談

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

Joe Biden

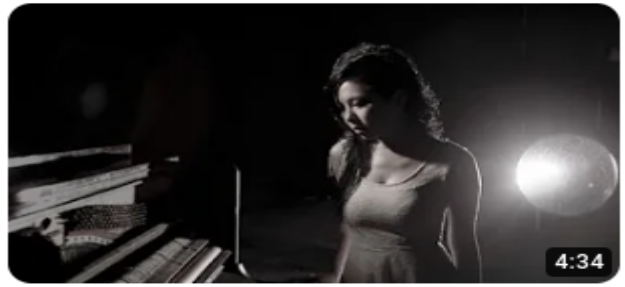
他們即牠們，即深層政府，即傀儡拜登所說的 they, they gave me reporter list …

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 抬上帝入天坑】： https://github.com/brianwchh/2507

【 2507 carrying God back to heaven shit hole 】

15

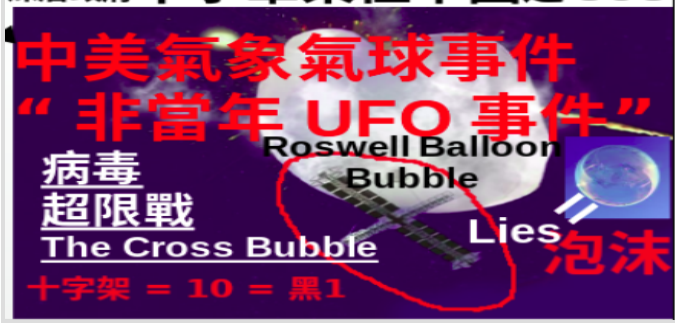


G.E.M. "泡沫" "BUBBLE" [HD] 官方MV 鄧紫棋

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

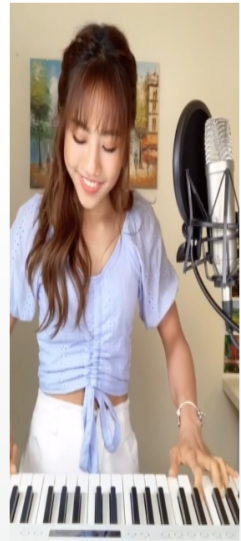
Why I am doing this tutorial

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

- 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 !?

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

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.



Dynamic programming

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

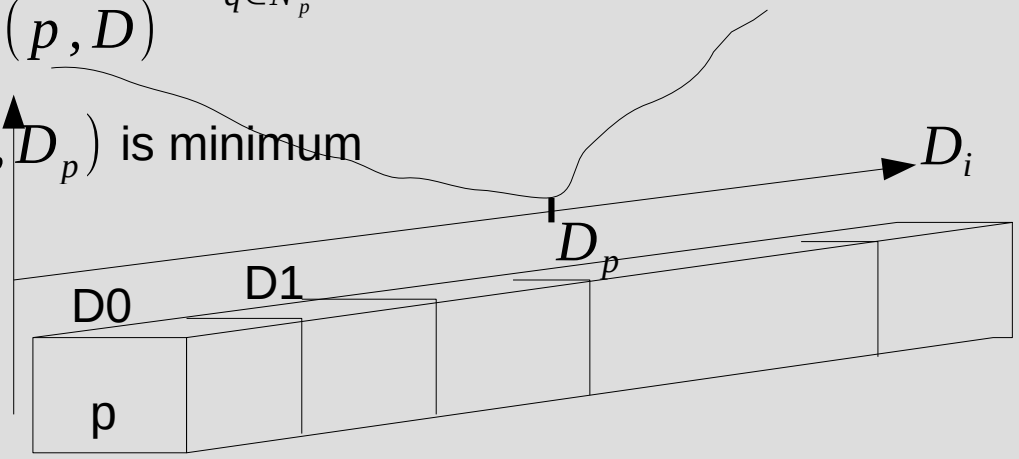
$$E = min \sum_{p} \left(C(p, D_p) + \sum_{q \in N_p} P_1 T[|D_p - D_q| = 1] + \sum_{q \in N_p} P_2 T[|D_p - D_q| > 1] \right)$$

↑ When individual is minimum, global sum is minimized

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

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

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

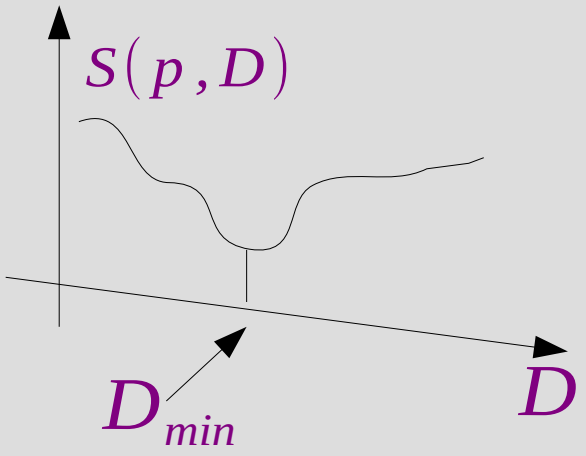


About notations

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$L_r(p,D^{p_r})=C(p,D^{p_r})+P_1T[|D^{p_r}-D^{q_r}_{min}=1|]+P_2T[|D^{p_r}-D^{q_r}_{min}>1|]$$

$$S(p,D^p)=\sum_{r=0}^{7}L_r(p,D^{p_r})$$



pls be noted that in this tutorial $D=D^p=D^{q_r}=D^{p_r}$ they all represent Disparity variable,just like x in function y=func(x),the supscript is just to denote its pixel and direction

If you still see D_i^{sth}, the subscript i is added by mistake,just remove or ignore it , $D_i^{sth}\in[0,D_{max}-1], i.e.[0,63]$ in this tutorial , $i\in[0,D_{max}-1]$ as well

For instance :

$$\min_{i\in[0,D-1]} C(p,D_i^{p_0}) \longrightarrow \min_{D^{p_0}\in[0,D_{max}-1]} C(p,D^{p_0})$$

chicken & egg problem

$$S(p,D^p)=\left(C(p,D^p)+\sum_{q\in N_p} P_1 T\left[\left|D^p-D^q_{min}\right|=1\right]+\sum_{q\in N_p} P_2 T\left[\left|D^p-D^q_{min}\right|>1\right]\right) \quad N_p=[q_0,q_1,\ldots,q_7] \quad qn\in[q_0,q_1,\ldots,q_7]$$

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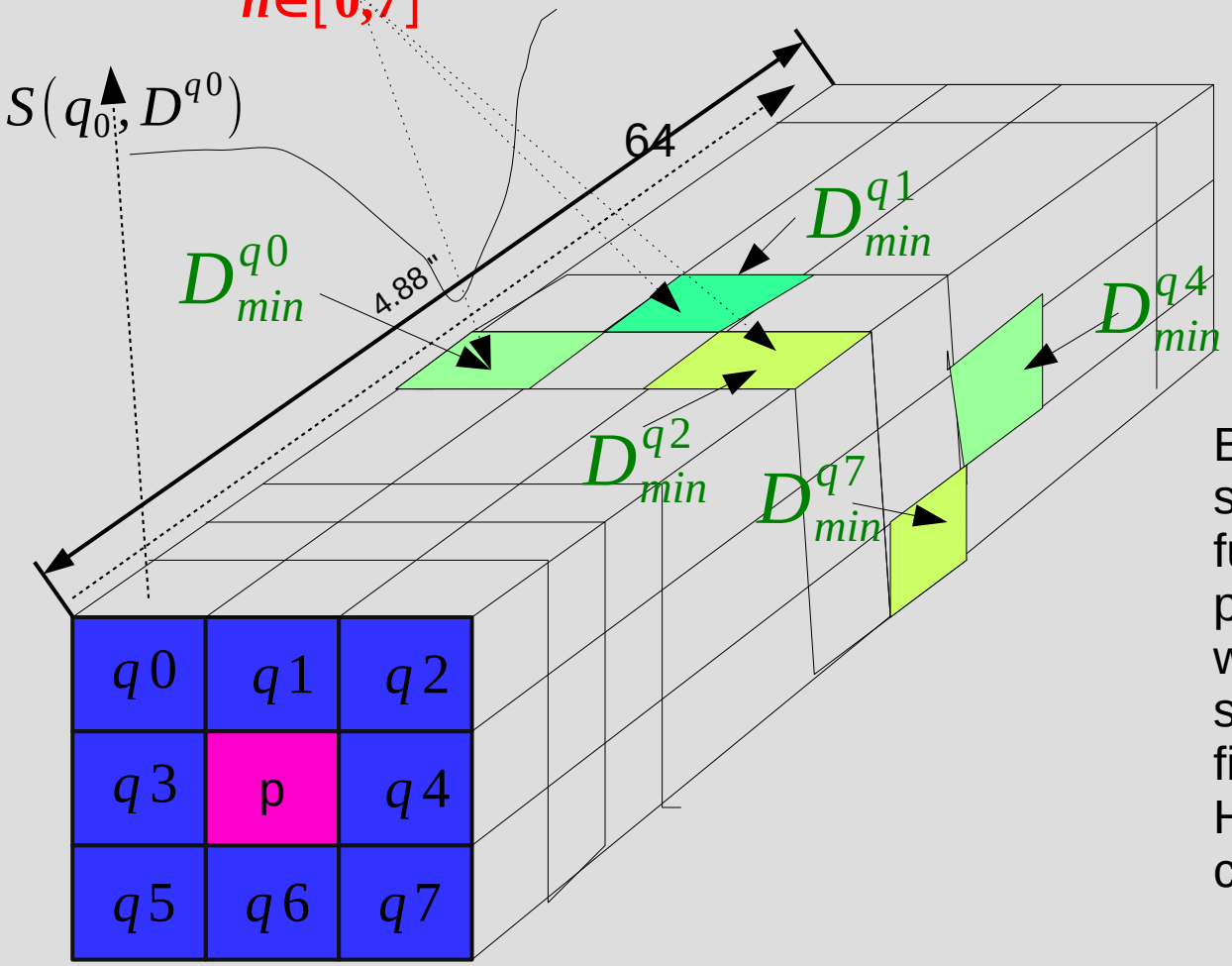
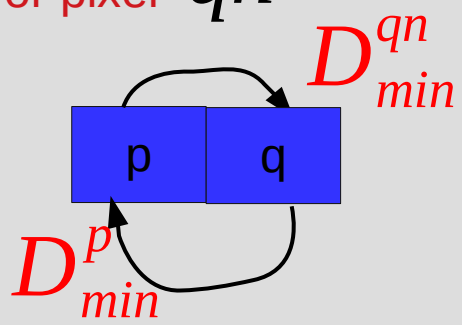
Suppose D^{qn}_{min} $_{n\in[0,7]}$ is given, our objective is to calculate $\min_{D\in[0,63]} S(p,D)=S(p,D_p)$, re-write D_p as D^p_{min}

$$= S(p,D^p_{min})$$

From the cost function, we know D^p_{min} should be very closely around D^{qr}_{min} so that it satisfy the depth smooth constrain



D^{qn}_{min} Denotes right disparity for pixel qn



But Using D^{qn}_{min} $_{n\in[0,7]}$ to solve $S(p,D^p_{min})$ 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?

Assumption 1

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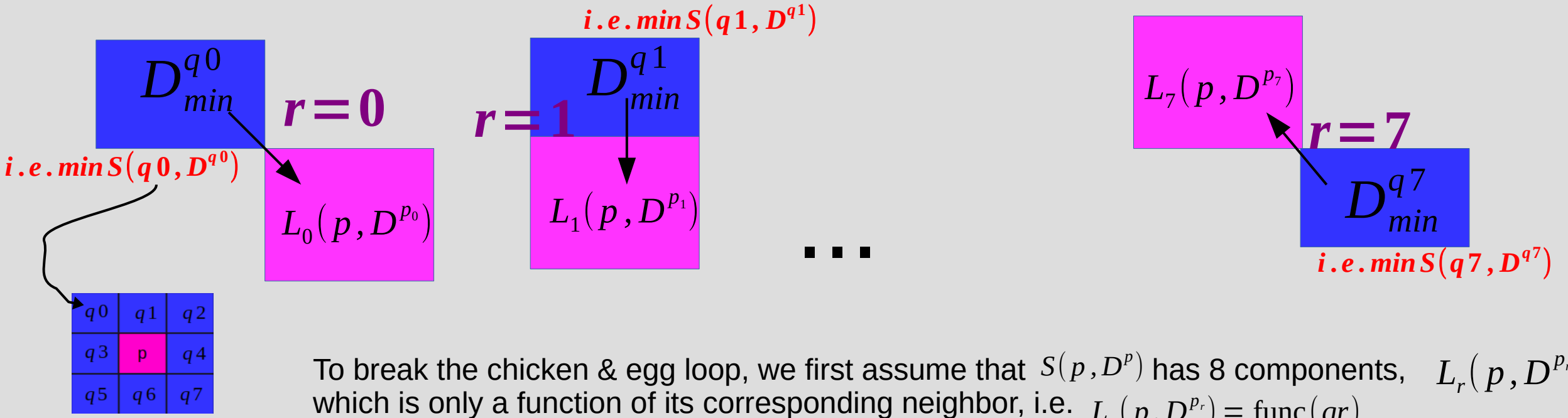
Assume :

$$S(p, D^p) = \sum_{r=0}^{7} L_r(p, D^{p_r}) \quad D^p \in [0,1,2,\dots,63] \quad D^{p_r} \in [0,1,2,\dots,63] \quad r \in [0,1,\dots,7] \; is\; the\; direction\; index$$



To break the chicken & egg loop, we first assume that $S(p, D^p)$ has 8 components, $L_r(p, D^{p_r})$ which is only a function of its corresponding neighbor, i.e. $L_r(p, D^{p_r}) = \text{func}(qr)$

If given we know D^{qr}_{min} then we can calculate $L_r(p, D^{p_r})$, then the problem is separable !

Unfortunately it is still a chicken & egg problem, because need to know D^{p}_{min} to be able to know D^{qr}_{min}, however inspired by this assumption,we can make a further assumption to break the loop finally.

Assumption 2

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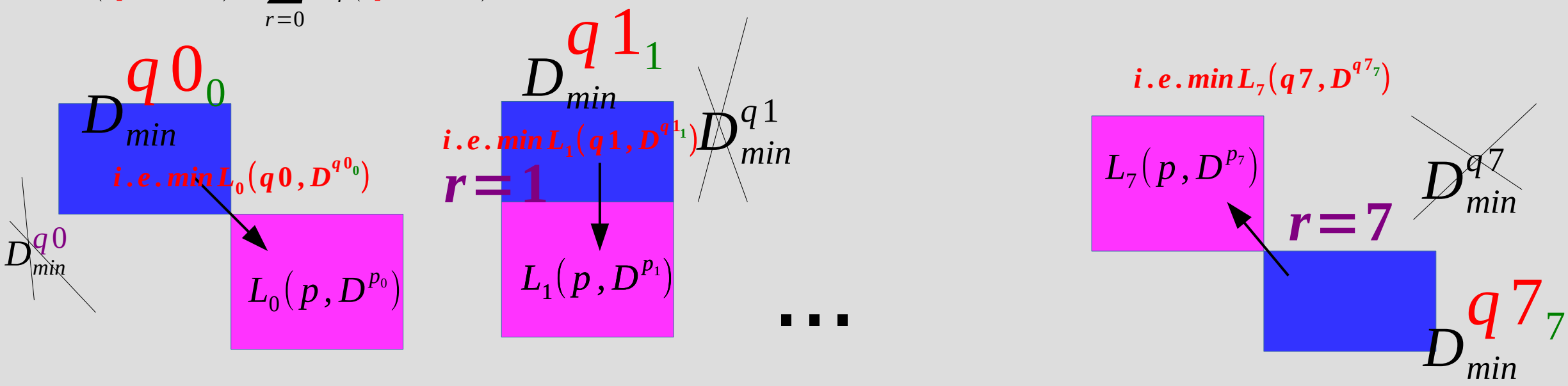
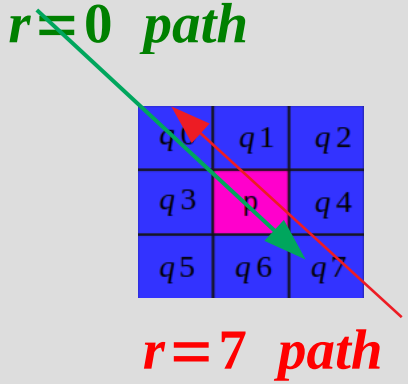
Assume:

$$S(qr, D^{qr_r}) = \sum_{r=0}^{7} L_r(qr, D^{qr_r}) \quad D^{qr_r} \in [0,1,2,\ldots,63] \quad r \in [0,1,\ldots,7] \text{ is the direction index}$$





Since without D^{p}_{min} we can't assume that we know D^{qr}_{min} ,we can further assume that, $L_r(p, D^{p_r}) = \text{func}(qr_r) \neq \text{func}(qr), i.e.\ qr's\ \text{r-th component}$

now each pixel p has 8 one-way paths from its corresponding 8 neighbors, i.e.

q<**neighbor _index**>$_{<\text{direction/component\_index}>}$, i.e. qr_r, for instance, $q0_0, q1_1$

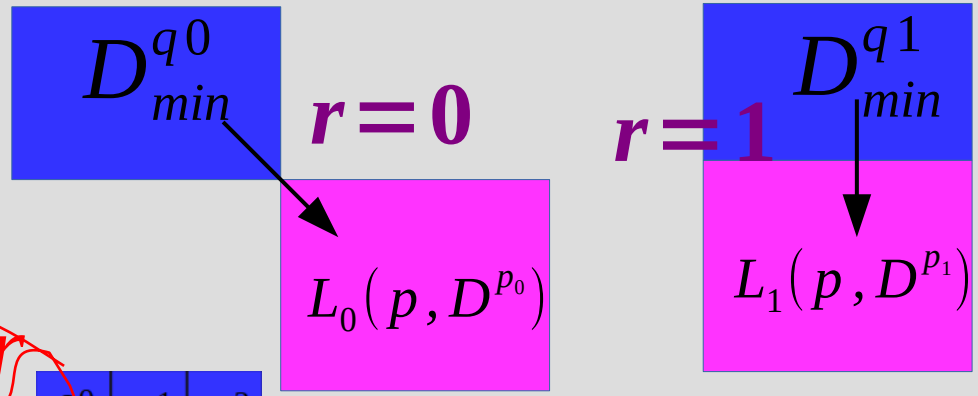
since <**neighbor _index**>=<direction/component _index> we can further simplify as q_r, for instance $q_0, q_{1,\ldots}$

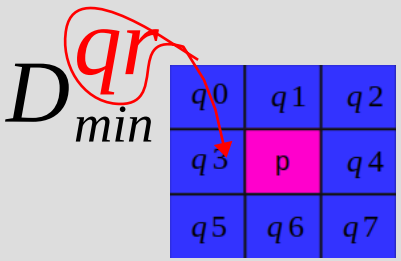
Decompose $S(p, D^p)$

#hohy #metoo #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

Assume :

$$S(p, D^p) = \sum_{r=0}^{7} L_r(p, D^{p_r}) \quad D^p \in [0,1,2,\dots,63] \quad D^{p_r} \in [0,1,2,\dots,63] \quad r \in [0,1,\dots,7] \text{ is the direction index}$$





$L_r(p, D^{p_r})$ *denotes the cost function* $S(p, D^p)$*'s* r-th *direction conponent for pixel* p

Some notations to agree on : (you can come up with your own,just a way to make symbol meaningful !

D^{p_r} *denotes Disparity value , computed* from *direction* r *for pixel* p, $D^{p_r} \in [0,63]$

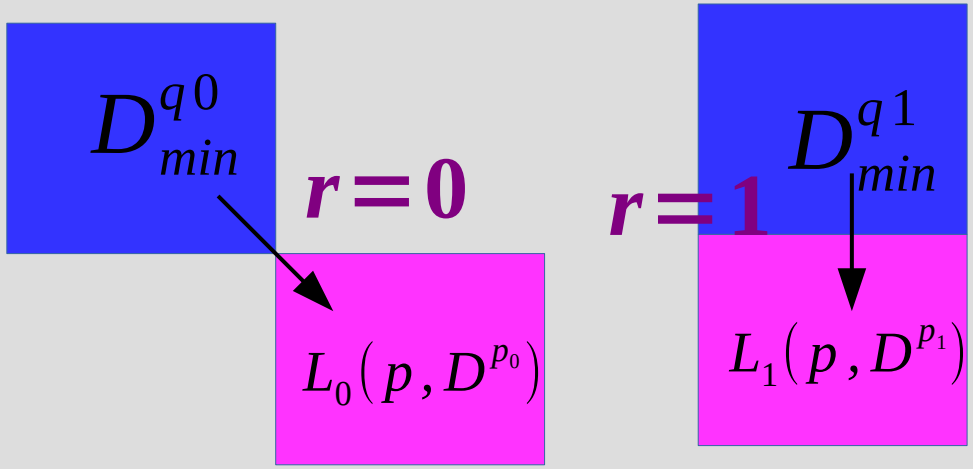
$D^{p_r}_{min}$ *denotes that it is an optimal disparity solution* to $\underset{D^{p_r} \in [0,63]}{Min} \; L_r(p, D^{p_r})$

$$S(p, D^p) = \left(C(p, D^p) + \sum_{q \in N_p} P_1 T[|D^p - D^q_{min}| = 1] + \sum_{q \in N_p} P_2 T[|D^p - D^q_{min}| > 1]\right) \qquad N_p = [q0, q1, \dots, q7] \quad q \in [q0, q1, \dots, q7]$$

Decompose $S(p, D^p)$

#hohy #metoo #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$S(p, D^p) = \sum_{r=0}^{7} L_r(p, D^{p_r}) \quad D^p \in [0,1,2,\dots,63] \quad D^{p_r} \in [0,1,2,\dots,63] \quad r \in [0,1,\dots,7] \text{ is the direction index}$$



$L_r(p, D^{p_r})$ denotes the cost function $S(p, D^p)$'s r-th direction conponent for pixel p

Some notations to agree on : (you can come up with your own,just a way to make symbol meaningful !

D^{p_r} denotes Disparity value , computed from direction r for pixel p, $D^{p_r} \in [0,63]$

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$$S(p, D^p) = \left(C(p, D^p) + \sum_{q \in N_p} P_1 T[|D^p - D^q_{min}| = 1] + \sum_{q \in N_p} P_2 T[|D^p - D^q_{min}| > 1]\right)$$

$N_p = [q0, q1, .., q7] \qquad q \in [q0, q1, \dots, q7]$

$$L_r(p, D^{p_r}) = C_r(p, D^{p_r}) + P_1 T[|D^{p_r} - D^{qr}_{min} = 1|] + P_2 T[|D^{p_r} - D^{qr}_{min} > 1|]$$

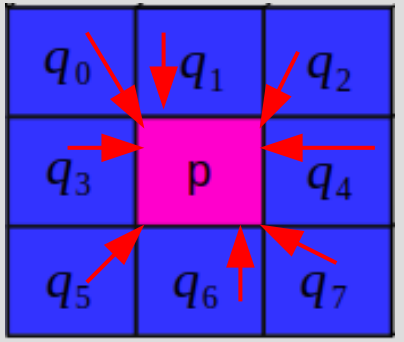
$L_r(p, D^{p_r})$ is independant of D^{qn}_{min} when $n != r$

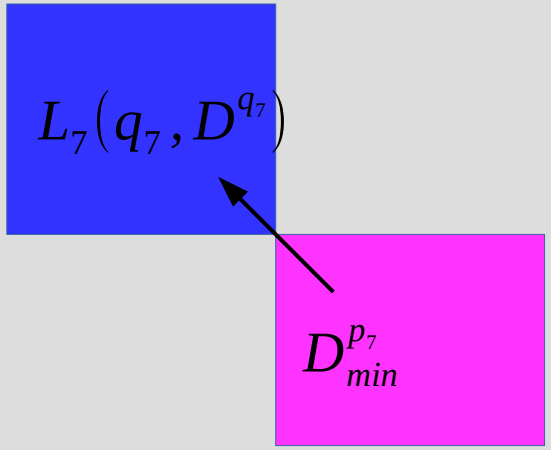
Note the difference of this two expression. D^{qr} Is pixel location, while r of D^{q_r} is the component's direction

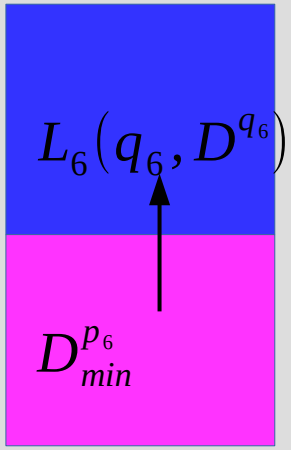
Decompose neighbors $S(q, D^{q_r})$ in the same way

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

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



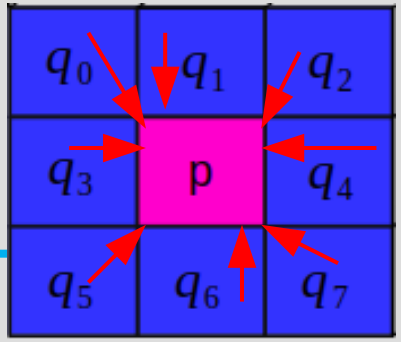




...

Show me the code for below process

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset



$$D^{q_0}_{min} \quad D^{q_1}_{min} \quad D^{q_3}_{min} \quad D^{q_7}_{min}$$

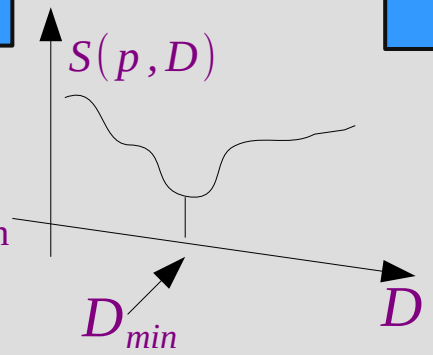
$$L_0(p, D^{p_0}) + L_1(p, D^{p_1}) + L_3(p, D^{p_3}) + \cdots + L_7(p, D^{p_7}) = S(p, D^p)$$

$D^{p_0}=0$		$D^{p_1}=0$		$D^{p_3}=0$		$D^{p_7}=0$		$D^p=0$
$D^{p_0}=1$		$D^{p_1}=1$		$D^{p_3}=1$		$D^{p_7}=1$		$D^p=1$
$D^{p_0}_{min}=2$	+	$D^{p_1}_{min}=2$	+	$D^{p_3}=2$	+ ⋯ +	$D^{p_7}=2$	=	$D^p_{min}=2$
$D^{p_0}=3$		$D^{p_1}=3$		$D^{p_3}=3$		$D^{p_7}=3$		$D^p=3$
$D^{p_0}=4$		$D^{p_1}=4$		$D^{p_3}=4$		$D^{p_7}=4$		$D^p=4$

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

$$S(p, D^p) = \sum_{r=0}^{7} L_r(p, D^{p_r})$$

pls be noted that in this tutorial $D = D^p = D^{q_r} = D^{p_r}$
they all represent Disparity variable,just like x in function y=func(x),the supscript is just to denote its pixel and direction

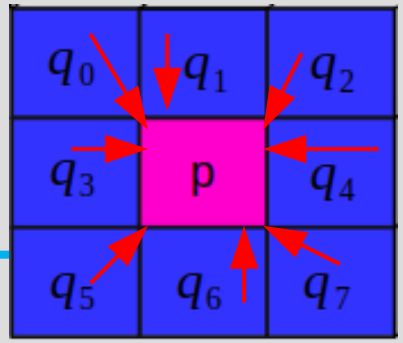


disparity-wise *summasion*

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

Show me the code for below process

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

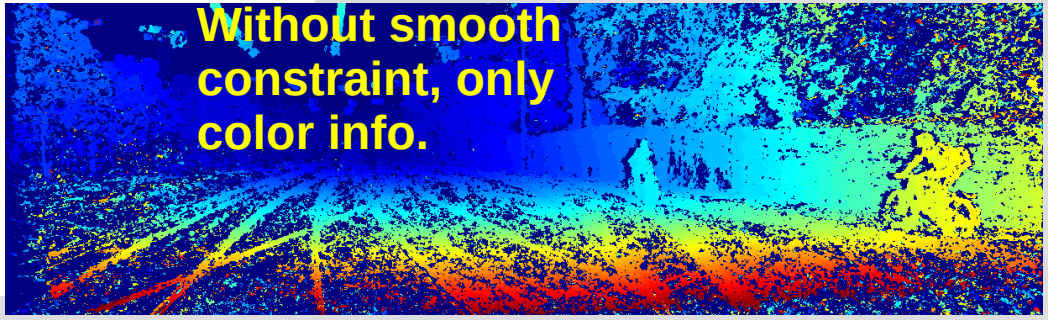


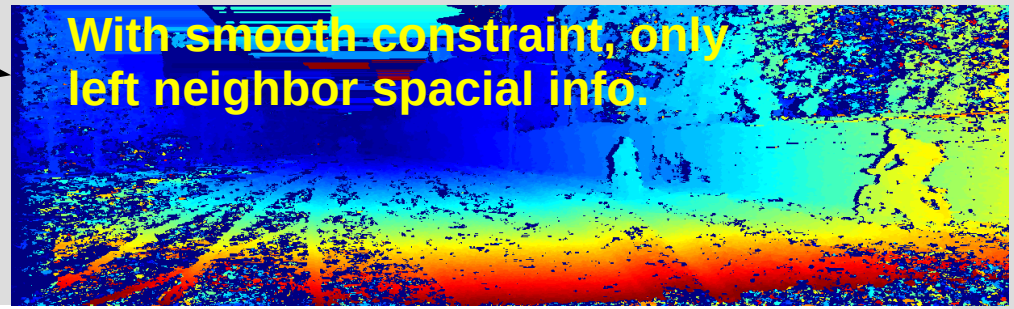

```
void spacial_smooth_constrain_cpu(const uint8_t* d_matching_cost, uint16_t* d_scost, int width, int height)
{
    uint16_t*    left_scan           = new uint16_t[width * height * disparity_size_];
    uint16_t*    right_scan          = new uint16_t[width * height * disparity_size_];
    uint16_t*    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_];
```

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

```
//*****************************  left scan ***************************************

 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_sc
                d_scost[volPtr + d ] =  left_scan[volPtr + d]  ;   // +   top_scan[volPtr + d]    + topleft_scan[volPtr + d] +

            }
    }
```

$$S(p,D^p) = \sum_{r=0}^{7} L_r(p,D^{p_r}) \quad D^p = 0,1,2,\ldots,63$$

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

When PENALTY is too big

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$E=\underbrace{\sum_{p}\left(C\left(p,D_p\right)\right)}_{\text{color constrain term}}+\underbrace{\sum_{q\in N_p}P_1T\left[\left|D_p-D_q\right|=1\right]+\sum_{q\in N_p}P_2T\left[\left|D_p-D_q\right|>1\right]}_{\text{spacial constrain term}}$$

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.

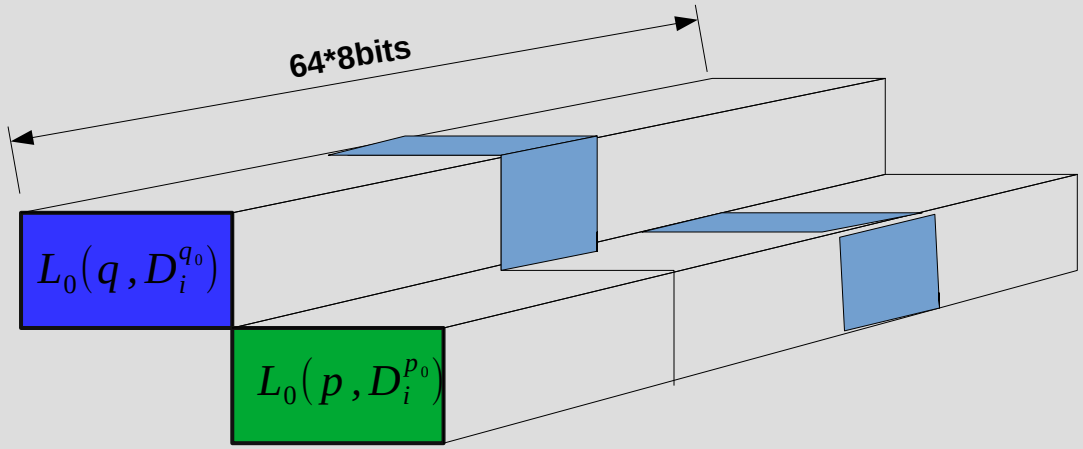
Question:
Is there anyway to recover from noise. i.e. giving color constraint term more weights to dominate and pull the trajectory back to the right track, apart from tuning the right penalty parameter value carefully ?

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

Analyze a special scenario for solution

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$L_0(p, D^{p_0}) = C(p, D^{p_0}) + P1[|D^{p_0} - D^{q_0}_{1st\_min}| = 1] + P2[|D^{p_0} - D^{q_0}_{1st\_min}| \geq 2]$$



Analyze a special scenario for solution

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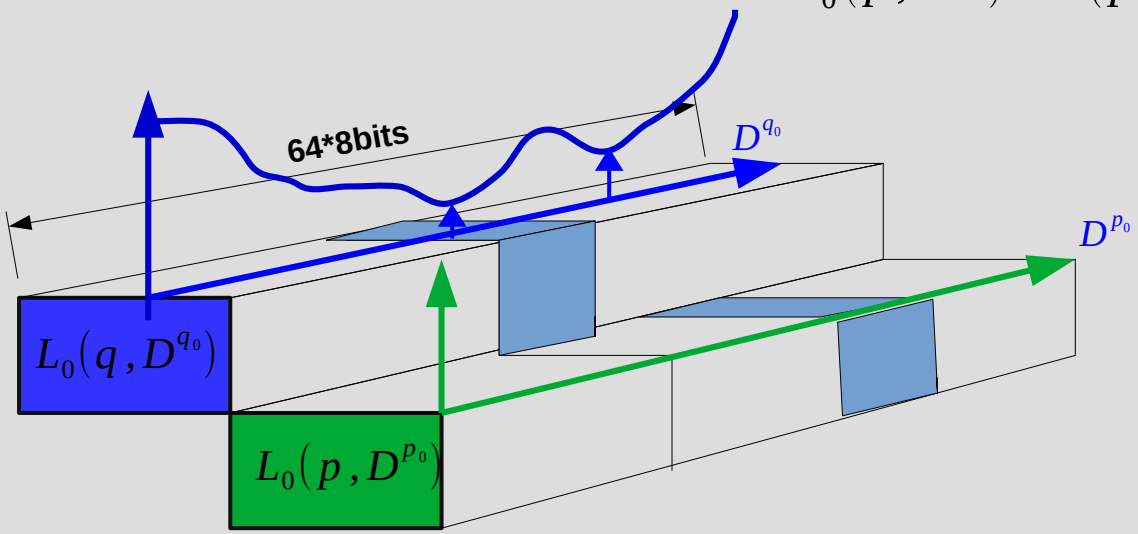

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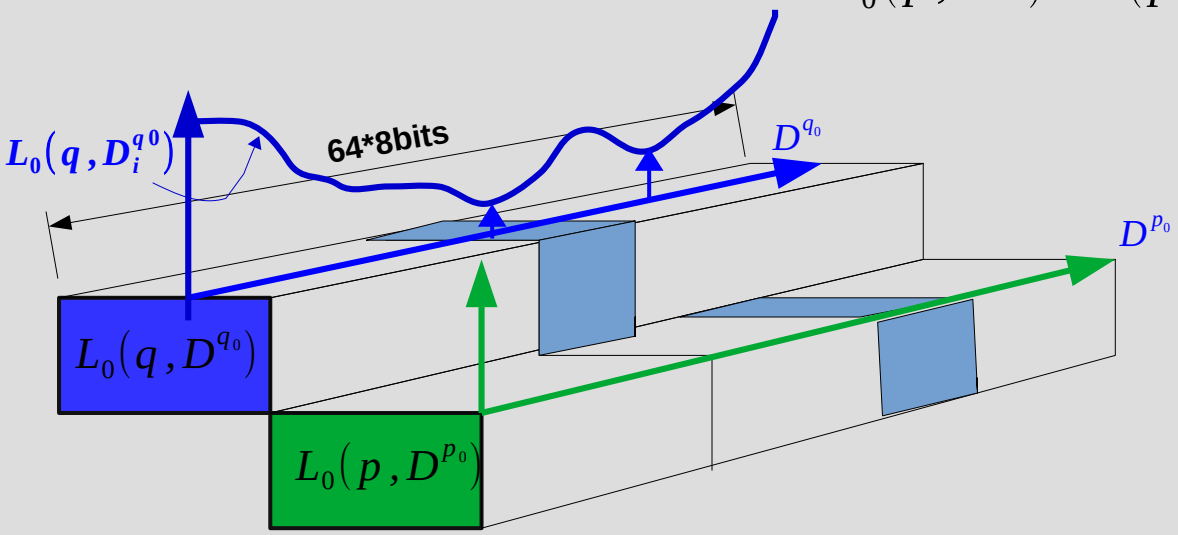

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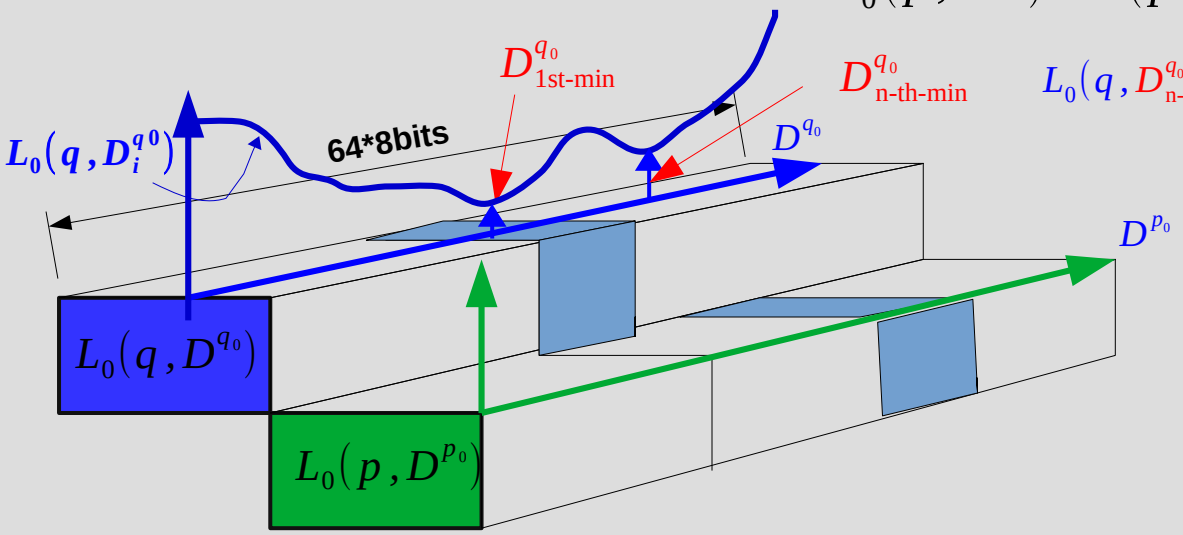

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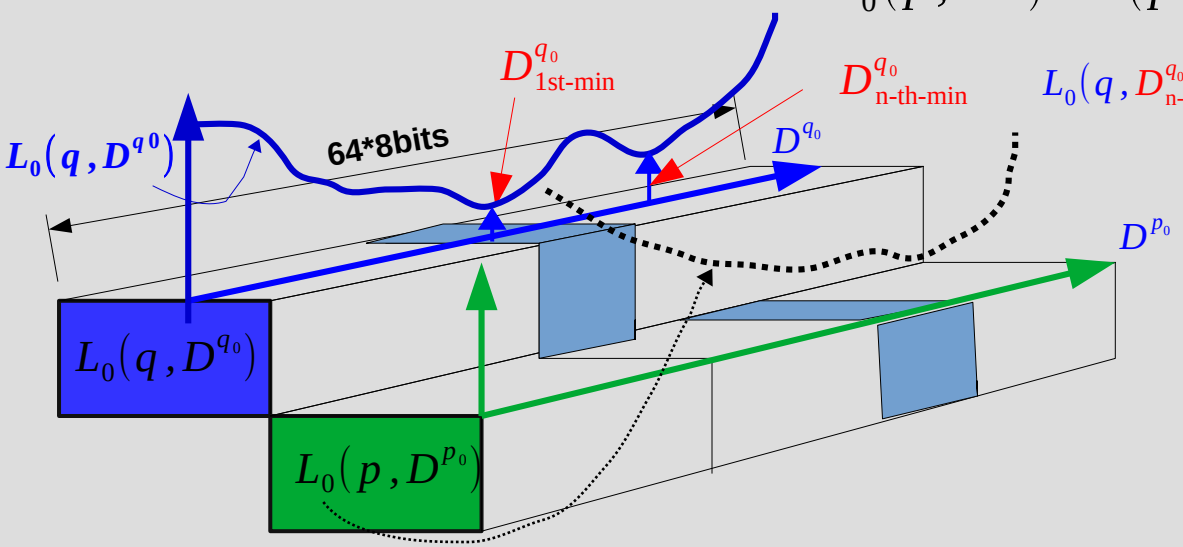

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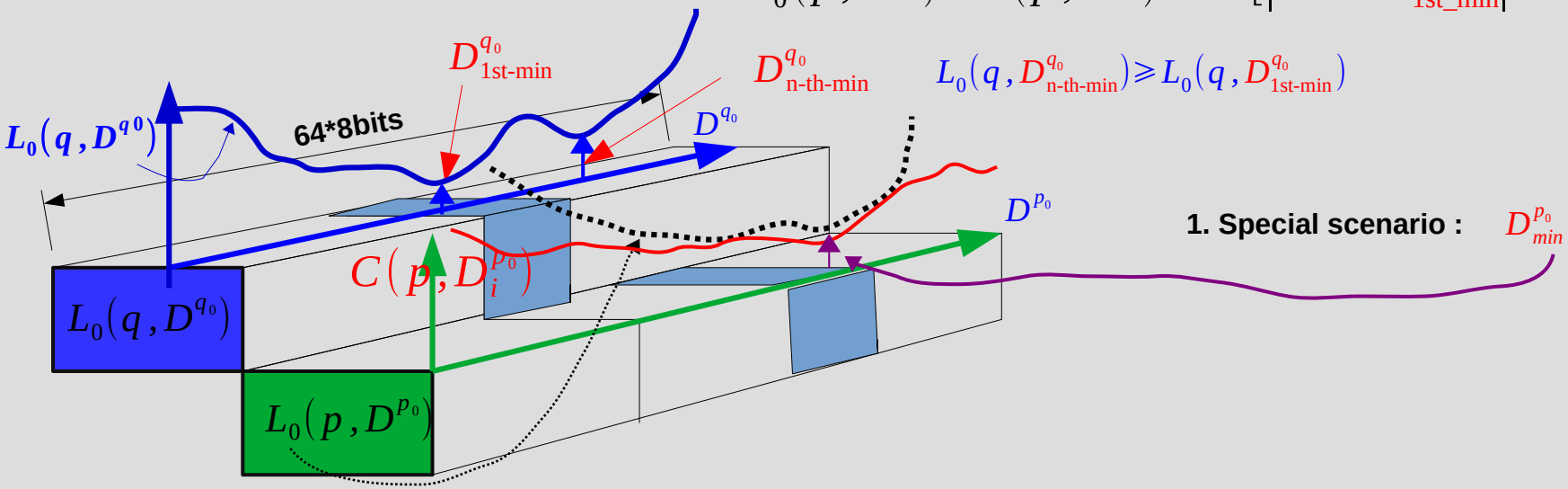

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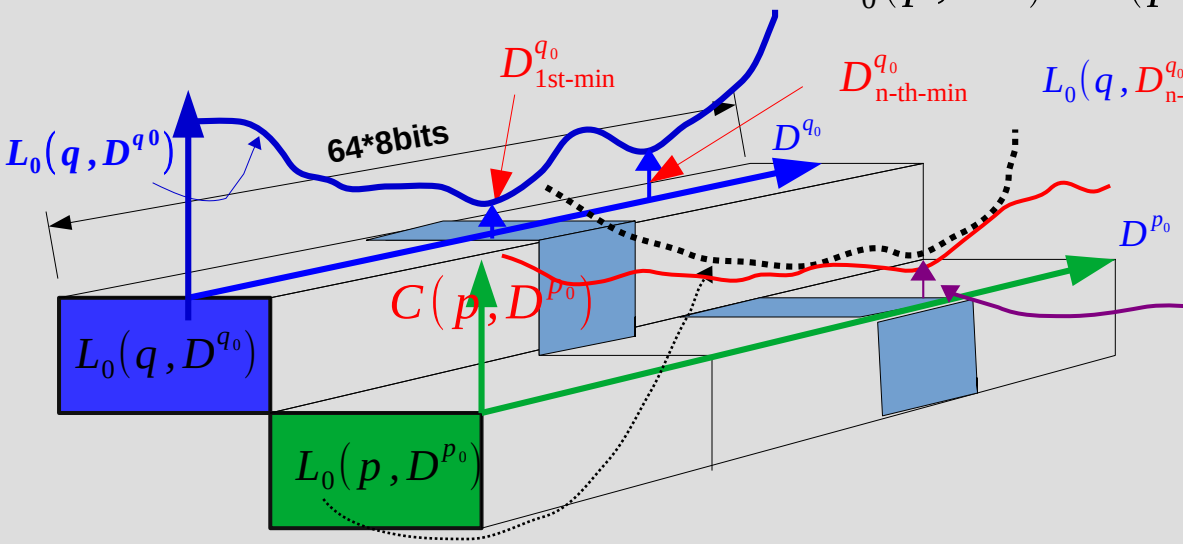

1. Special scenario : $D^{p_0}_{min}$ **for** $\underset{i\in[0,D-1]}{Min}\ C(p,D^{p_0}_i)$ **where**

$$|D^{p_0}_{min}-D^{q_0}_{n\text{-}th\text{-}min}|\leq 1$$

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$D^{q_0}_{n\text{-}th\text{-}min}$ **is the actual disparity value D for pixel q,** $D^{q_0}_{1st\text{-}min}$ **becomes minimum because of noise**

Analyze a special scenario for solution

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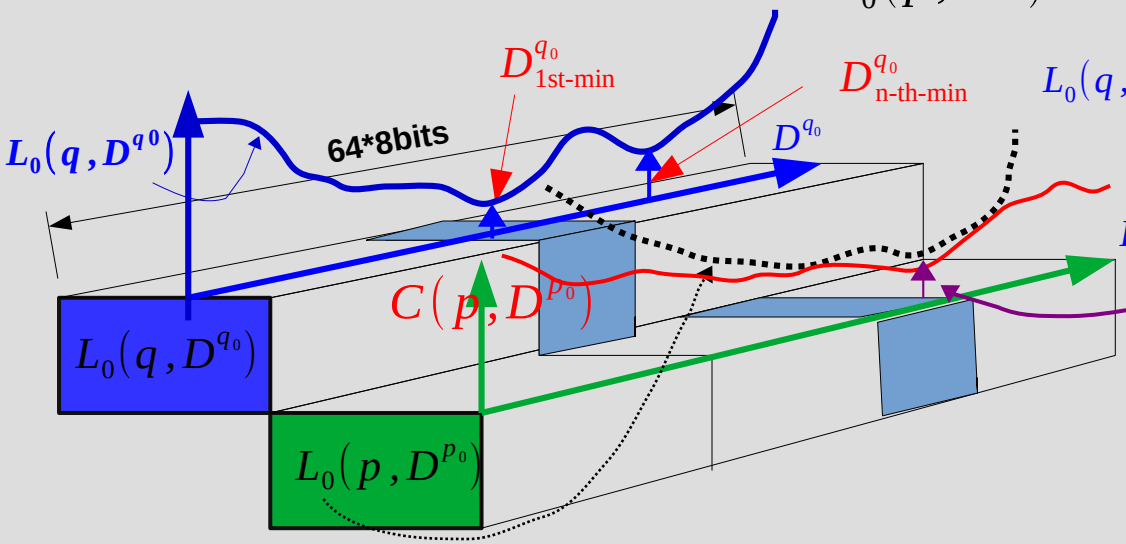

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2. Question ? :
how do we tell the algorithm to choose $D^{q_0}_{\text{n-th-min}}$ over $D^{q_0}_{\text{1st-min}}$ for computing $L_0(p, D^{p_0}_{min})$?

Analyze a special scenario for solution

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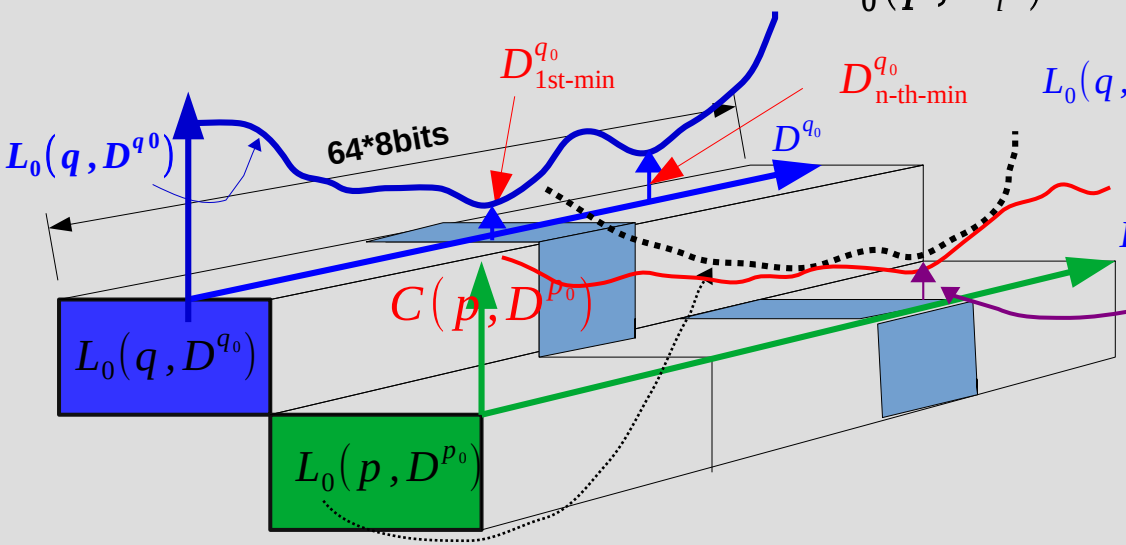
$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + P1[|D_i^{p_0} - D_{1st\_min}^{q_0}| = 1] + P2[|D_i^{p_0} - D_{1st\_min}^{q_0}| \geq 2]$$



$L_0(q, D_{n\text{-}th\text{-}min}^{q_0}) \geq L_0(q, D_{1st\text{-}min}^{q_0})$

1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i \in [0, D-1]}{Min}\ C(p, D^{p_0})$ **where** $|D_{min}^{p_0} - D_{n\text{-}th\text{-}min}^{q_0}| \leq 1$, $|D_{min}^{p_0} - D_{1st\text{-}min}^{q_0}| \geq 2$

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

Analyze a special scenario for solution

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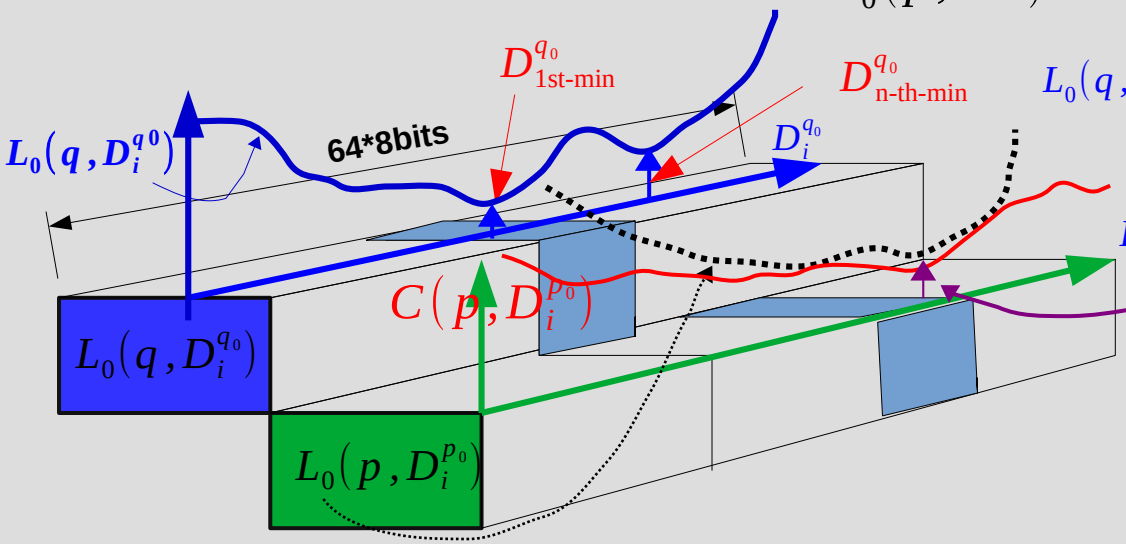

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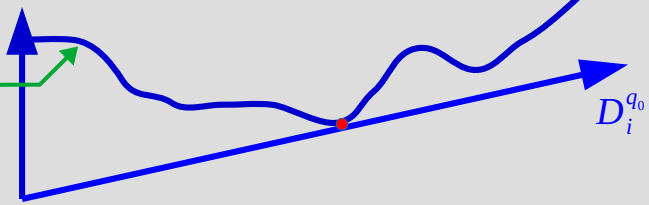

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Analyze a special scenario for solution

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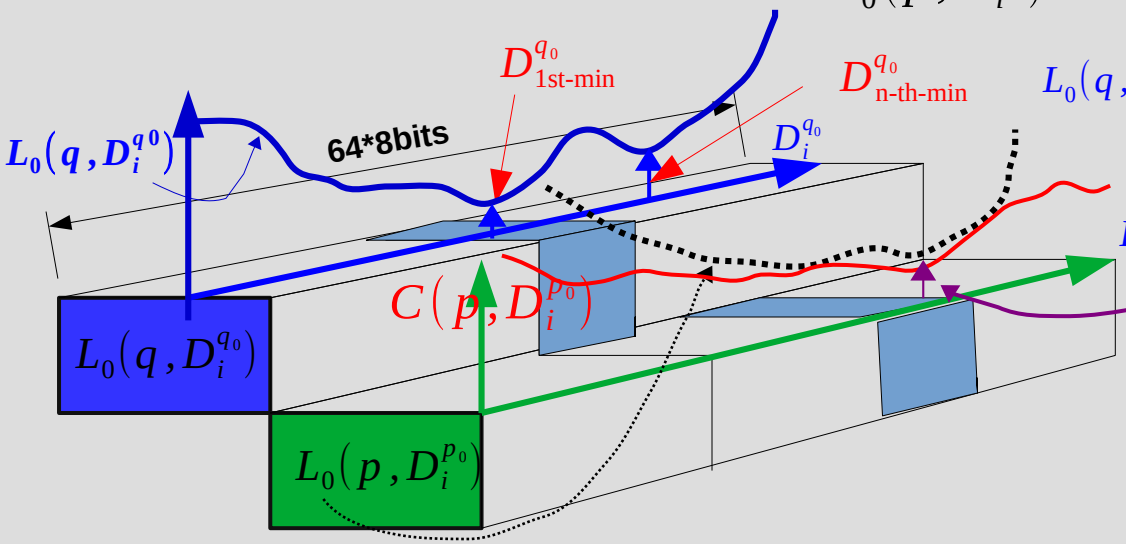

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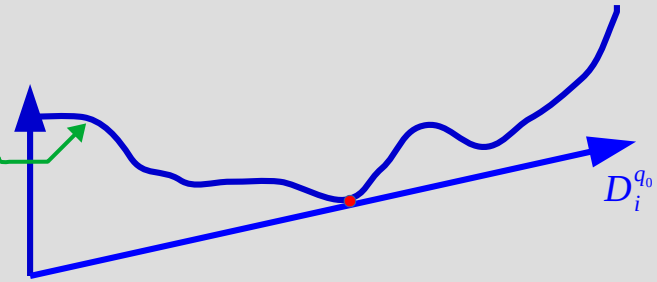

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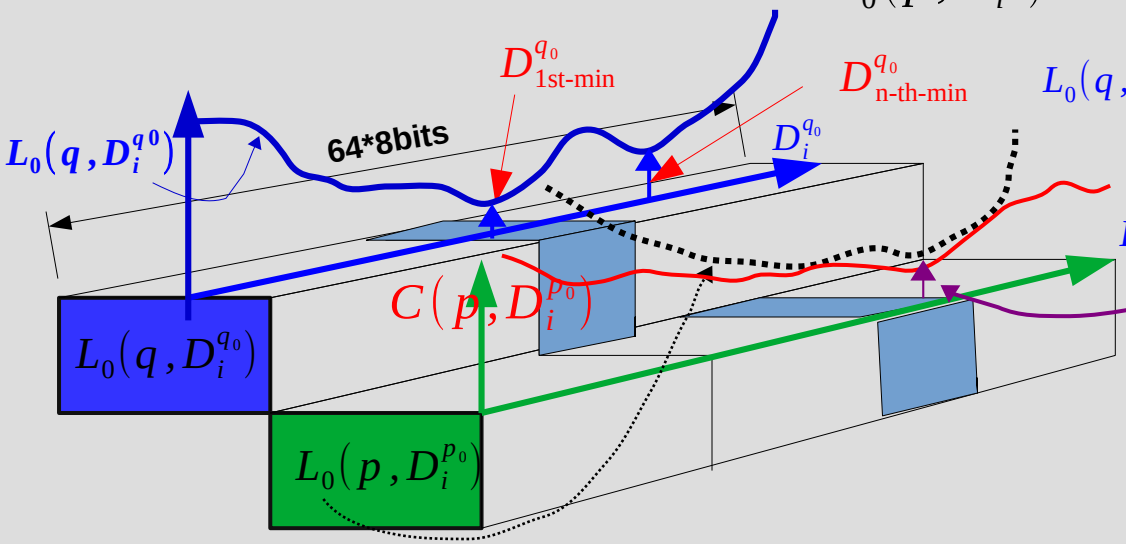

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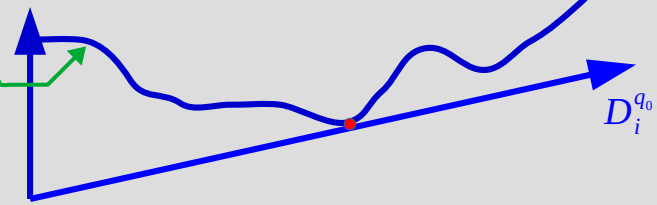

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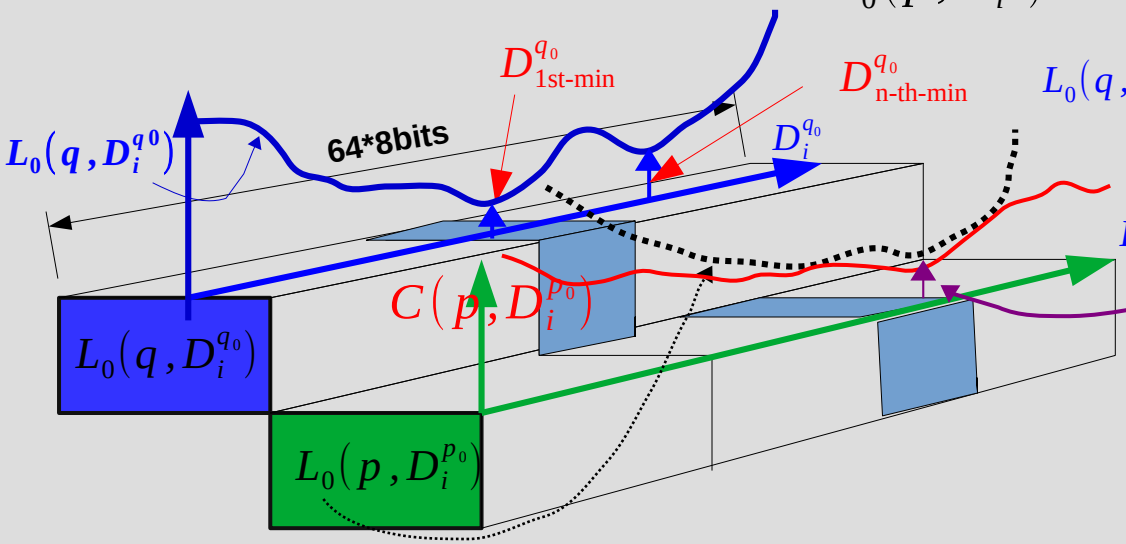

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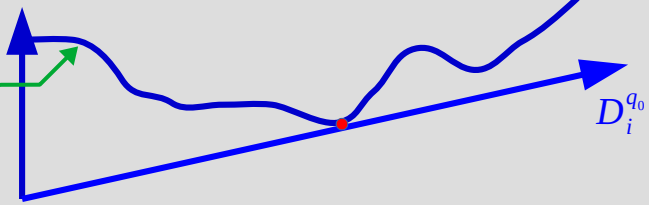

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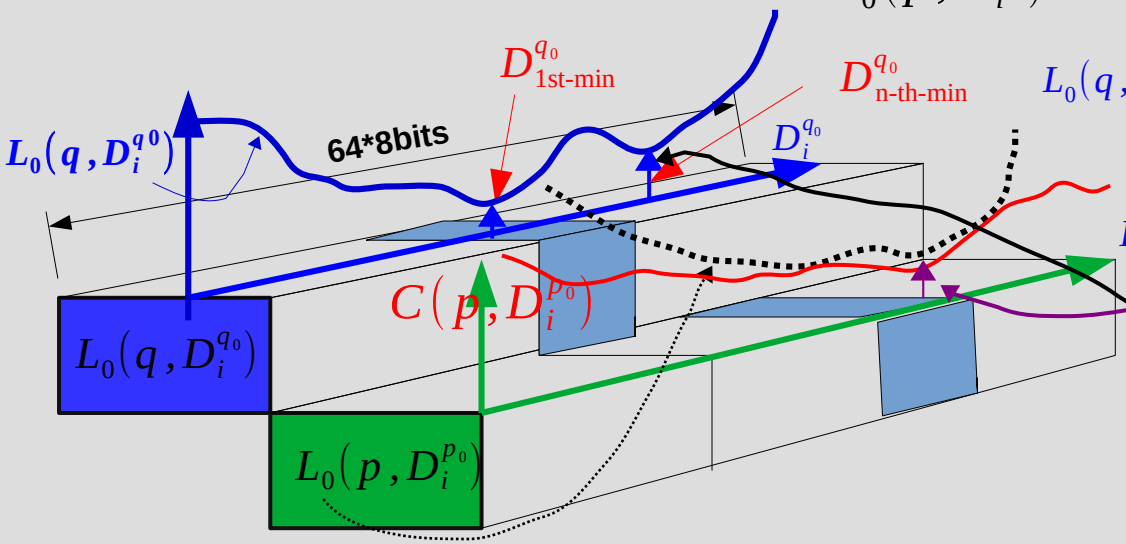

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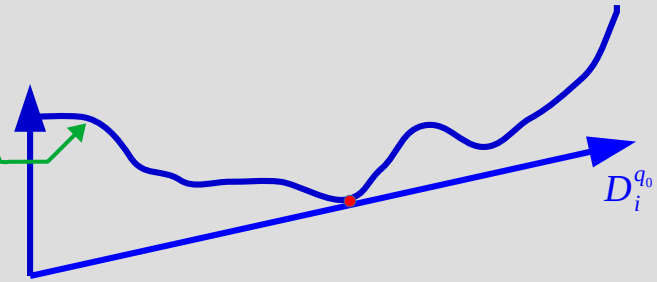

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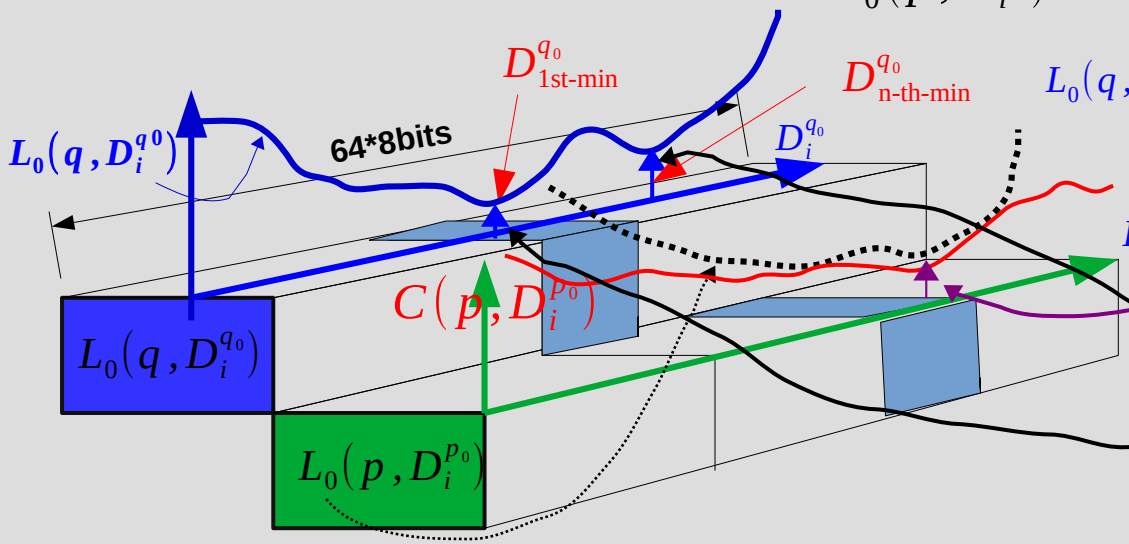

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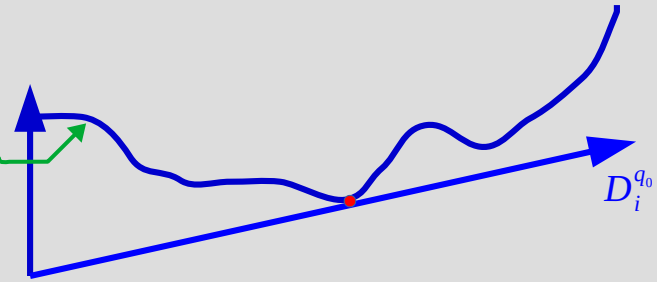
$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+Min(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY\ \text{from}\ D_i^{p_0}\text{'s neighbor}\ D_i^{q_0}, i.e.\ D_{n\text{-}th\text{-}min}^{q_0}\},\ TOTAL\_PENALTY\ \text{from}\ D_{1st\text{-}min}^{q_0})$$

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

2. Question ? :
how do we tell the algorithm to choose $D_{n\text{-}th\text{-}min}^{q_0}$ over $D_{1st\text{-}min}^{q_0}$ for computing $L_0(p,D_{min}^{p_0})$?



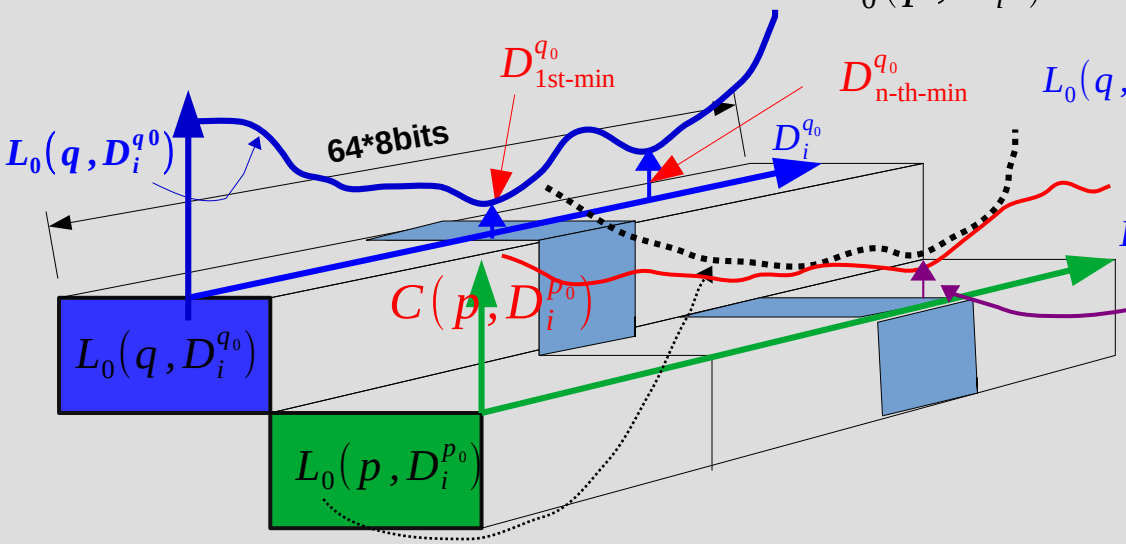
3.Solution :
Introducing possibility propagation, using $L_0(q,D_i^{q_0})-\underset{i\in[0,D-1]}{Min}\ L_0(q,D_i^{q_0})$ to represent the inverse-possibility of each $D_i^{q_0}$ being the right disparity for pixel **q** . and also used as penalty information as well, which is kind of a information from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

This term is to avoid overflow in propagation,can set maximum value to cliff off,so as to further make sure no overflow happens

Analyze a special scenario for solution

#hohy #metoo #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+P1[|D_i^{p_0}-D_{1st\_min}^{q_0}|=1]+P2[|D_i^{p_0}-D_{1st\_min}^{q_0}|\geq 2]$$



1. Special scenario : $D_{min}^{p_0}$ for $\underset{i\in[0,D-1]}{Min}\ C(p,D_i^{p_0})$ where $|D_{min}^{p_0}-D_{n\text{-}th\text{-}min}^{q_0}|\leq 1$, $|D_{min}^{p_0}-D_{1st\text{-}min}^{q_0}|\geq 2$

$D_{n\text{-}th\text{-}min}^{q_0}$ is the actual disparity value D for pixel q, $D_{1st\text{-}min}^{q_0}$ becomes minimum because of noise

$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+Min(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_i^{q_0}, i.e.\ D_{n\text{-}th\text{-}min}^{q_0}\},\ TOTAL\_PENALTY \text{ from } D_{1st\text{-}min}^{q_0})$$

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

Question : how to compute $TOTAL\_PENALTY = PENALTY\_PROPAGATE(q,D_i^{q_0}) + spacial\ smooth\ constrain\ term$?

Analyze a special scenario for solution

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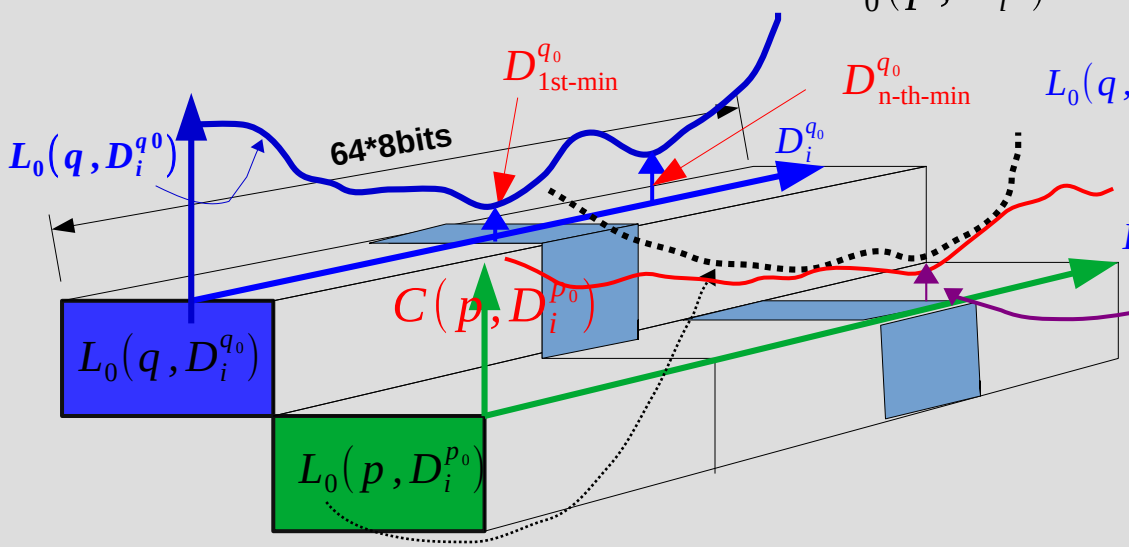
$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + P1\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| = 1\right] + P2\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| \geq 2\right]$$



1. Special scenario : $D_{min}^{p_0}$ for $\underset{i \in [0, D-1]}{Min}\ C(p, D_i^{p_0})$ where $\left|D_{min}^{p_0} - D_{\text{n-th-min}}^{q_0}\right| \leq 1$ $\left|D_{min}^{p_0} - D_{\text{1st-min}}^{q_0}\right| \geq 2$

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Take computing as an example.

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Analyze a special scenario for solution

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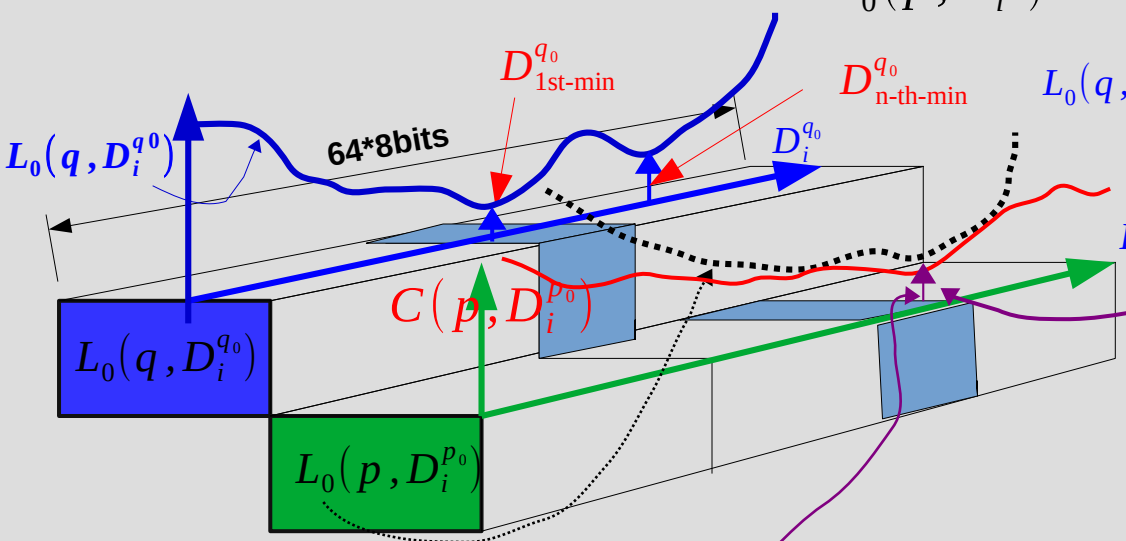

1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i\in[0,D-1]}{Min}\ C(p,D_i^{p_0})$ **where** $|D_{min}^{p_0}-D_{n\text{-}th\text{-}min}^{q_0}|\leq 1$, $|D_{min}^{p_0}-D_{1st\text{-}min}^{q_0}|\geq 2$

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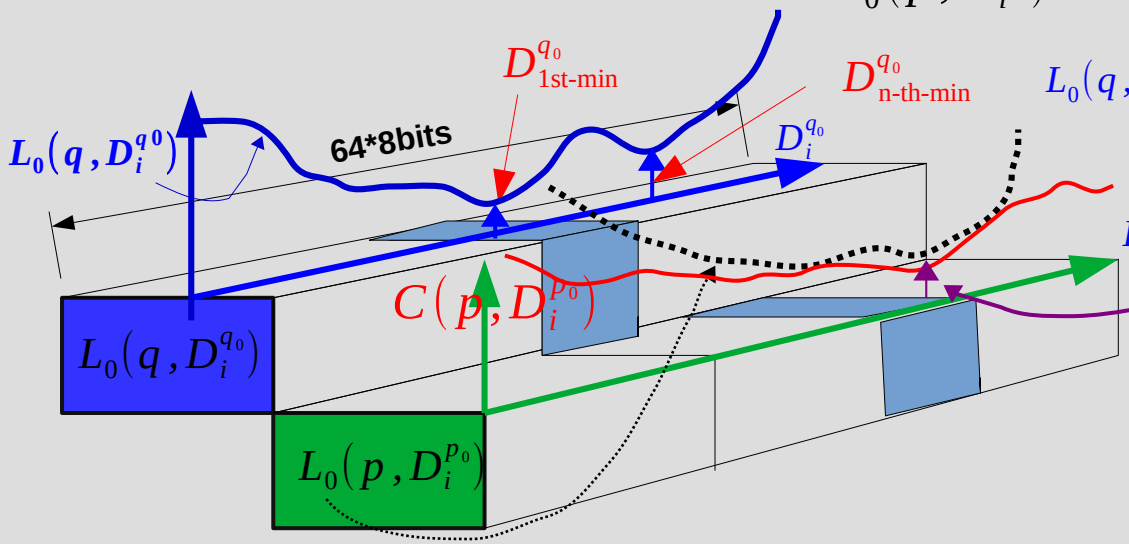

1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i \in [0, D-1]}{Min}\ C(p, D_i^{p_0})$ **where**

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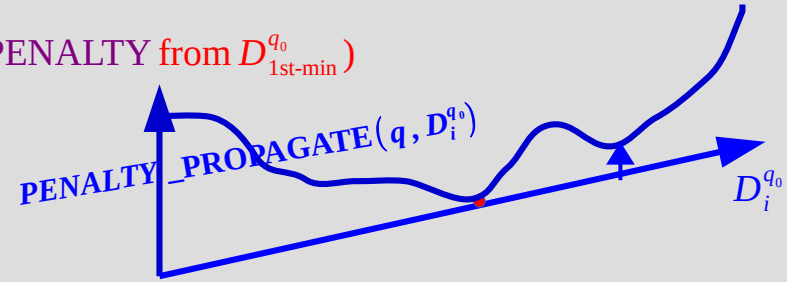

Since $\left|D_{min}^{p_0} - D_{\text{n-th-min}}^{q_0}\right| \leq 1$

$$L_0(p, D_{min}^{p_0}) = C(p, D_{min}^{p_0}) + Min\left(\underset{n \in [0, D_{max}-2]}{Min}\ \{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_{min}^{q_0}, i.e.\ D_{\text{n-th-min}}^{q_0}\},\ TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0}\right)$$

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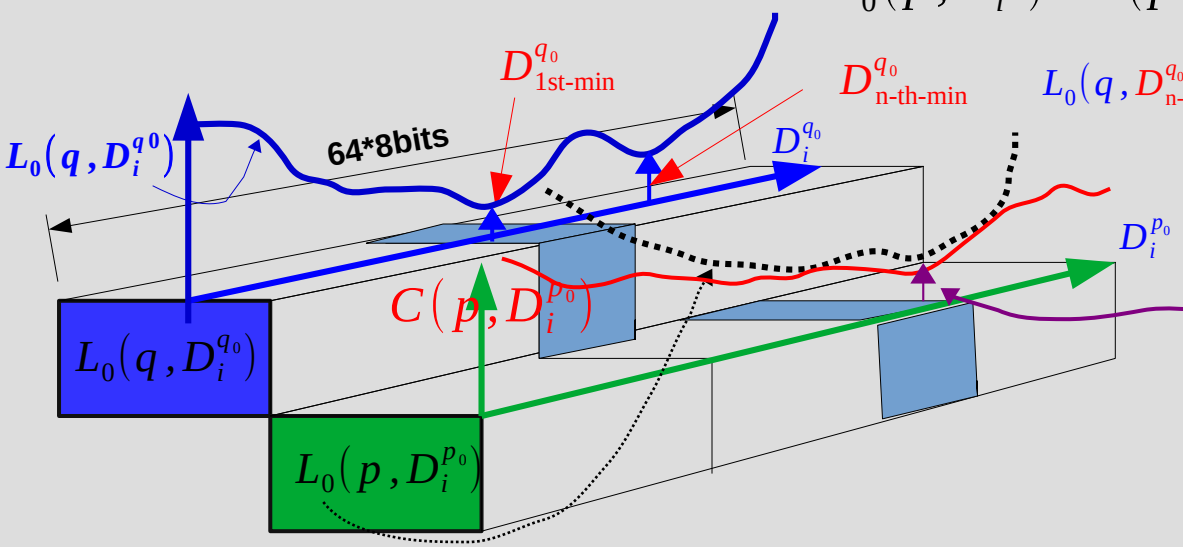
Analyze a special scenario for solution

#hohy #metoo #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+P1[|D_i^{p_0}-D_{1st\_min}^{q_0}|=1]+P2[|D_i^{p_0}-D_{1st\_min}^{q_0}|\geq 2]$$



1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i\in[0,D-1]}{Min}\ C(p,D_i^{p_0})$ **where** $|D_{min}^{p_0}-D_{n\text{-}th\text{-}min}^{q_0}|\leq 1$, $|D_{min}^{p_0}-D_{1st\text{-}min}^{q_0}|\geq 2$

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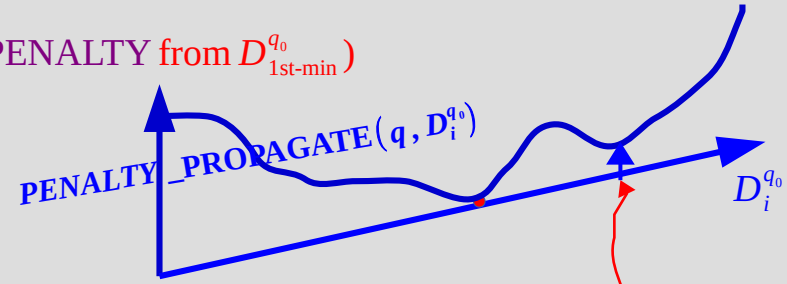

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$D_{n\text{-}th\text{-}min}^{q_0}$

Analyze a special scenario for solution

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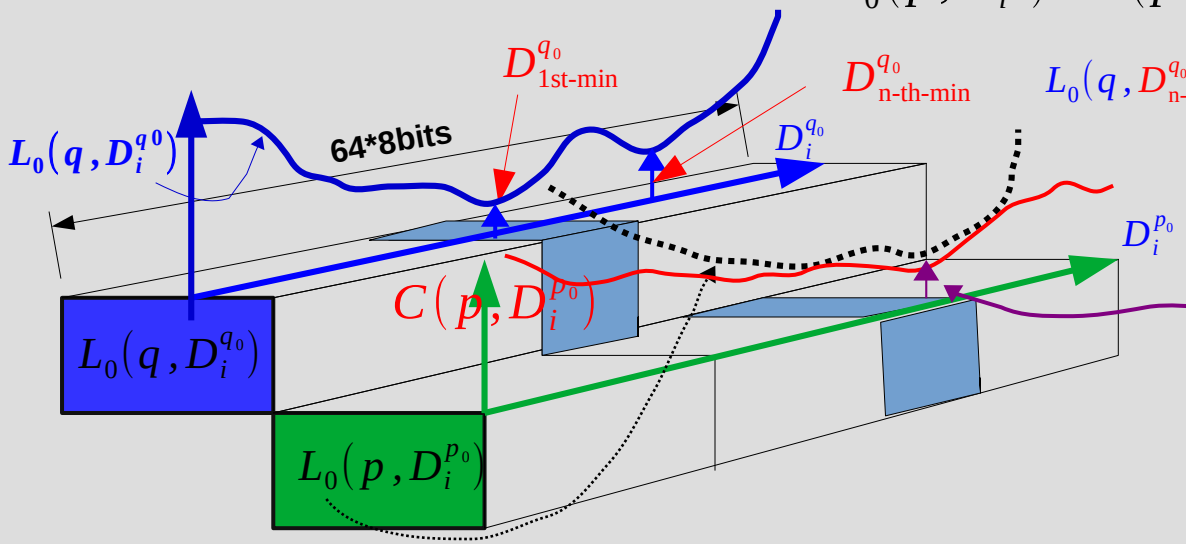
$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + P1\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| = 1\right] + P2\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| \geq 2\right]$$



$L_0(q, D^{q_0}_{\text{n-th-min}}) \geq L_0(q, D^{q_0}_{\text{1st-min}})$

1. Special scenario : $D^{p_0}_{min}$ **for** $\underset{i\in[0,D-1]}{Min}\ C(p, D_i^{p_0})$ **where** $\left|D^{p_0}_{min} - D^{q_0}_{\text{n-th-min}}\right| \leq 1$, $\left|D^{p_0}_{min} - D^{q_0}_{\text{1st-min}}\right| \geq 2$

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$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + Min\Big(\underset{n\in[0, D_{max}-2]}{Min}\{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_i^{q_0}, i.e.\ D^{q_0}_{\text{n-th-min}}\},\ TOTAL\_PENALTY \text{ from } D^{q_0}_{\text{1st-min}}\Big)$$

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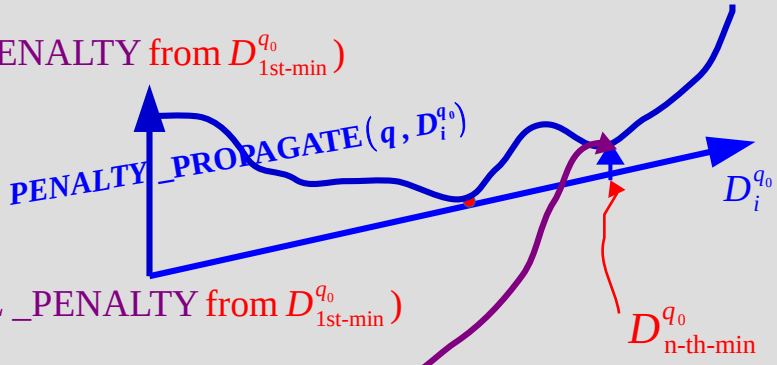

Since $\left|D^{p_0}_{min} - D^{q_0}_{\text{n-th-min}}\right| \leq 1$

$$L_0(p, D^{p_0}_{min}) = C(p, D^{p_0}_{min}) + Min\Big(\underset{n\in[0, D_{max}-2]}{Min}\{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D^{q_0}_{min}, i.e.\ D^{q_0}_{\text{n-th-min}}\},\ TOTAL\_PENALTY \text{ from } D^{q_0}_{\text{1st-min}}\Big)$$

$$TOTAL\_PENALTY \text{ from } D^{q_0}_{\text{n-th-min}} = L_0(q, D^{q_0}_{\text{n-th-min}}) - \underset{i\in[0, D_{max}-1]}{Min} L_0(q, D_i^{q_0}) + P1$$

Analyze a special scenario for solution

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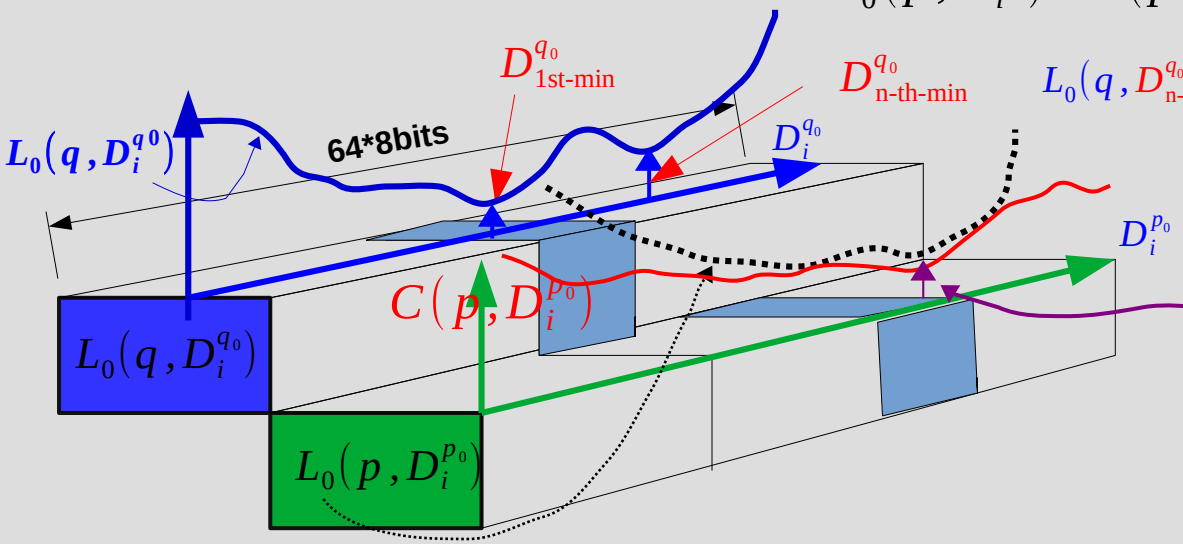
$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+P1[|D_i^{p_0}-D_{1st\_min}^{q_0}|=1]+P2[|D_i^{p_0}-D_{1st\_min}^{q_0}|\geq 2]$$



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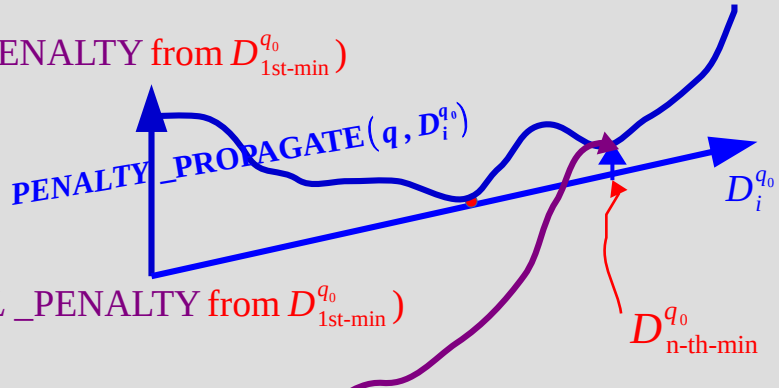

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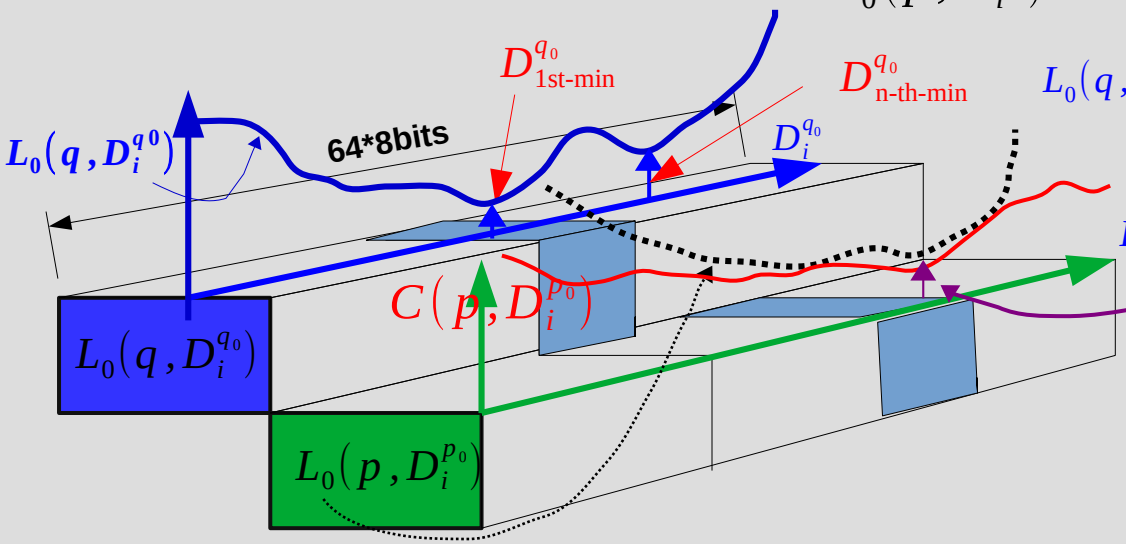

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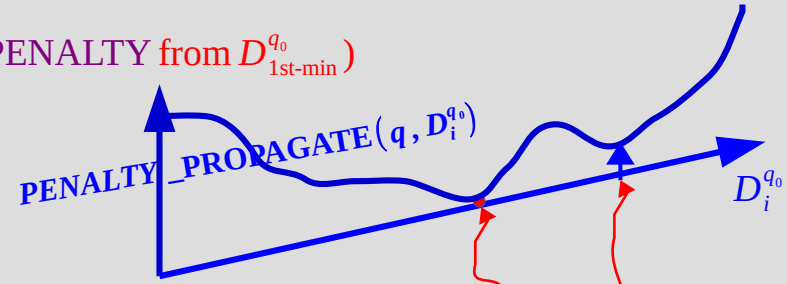

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$$TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0} = L_0(q, D_{\text{1st-min}}^{q_0}) - \underset{i \in [0, D_{max}-1]}{Min} L_0(q, D_i^{q_0}) + P2$$

Since $\left|D_{min}^{p_0} - D_{\text{1st-min}}^{q_0}\right| \geq 2$

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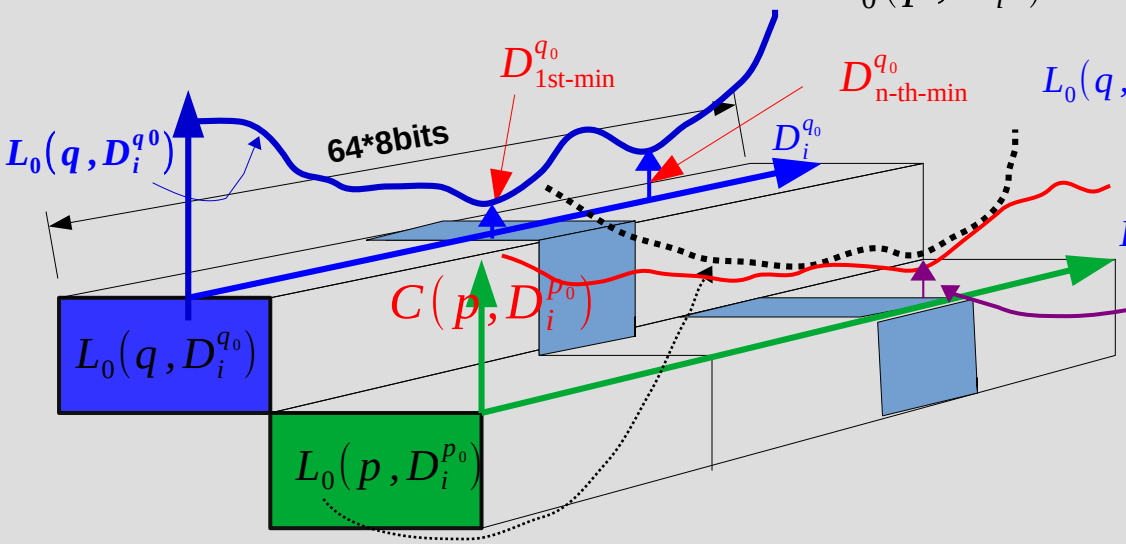
#hohy #metoo #MeToMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+P1[|D_i^{p_0}-D_{\text{1st\_min}}^{q_0}|=1]+P2[|D_i^{p_0}-D_{\text{1st\_min}}^{q_0}|\geq 2]$$

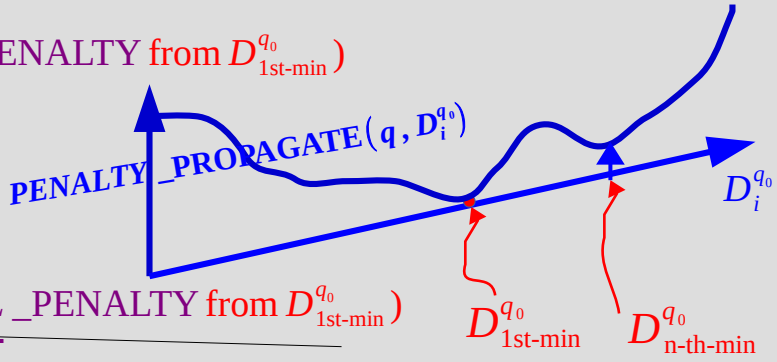


1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i\in[0,D-1]}{Min}\ C(p,D_i^{p_0})$ **where** $|D_{min}^{p_0}-D_{\text{n-th-min}}^{q_0}|\leq 1$, $|D_{min}^{p_0}-D_{\text{1st-min}}^{q_0}|\geq 2$

$D_{\text{n-th-min}}^{q_0}$ **is the actual disparity value D for pixel q,** $D_{\text{1st-min}}^{q_0}$ **becomes minimum because of noise**

$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+Min(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY\ \text{from}\ D_i^{p_0}\text{'s neighbor}\ D_i^{q_0}, i.e.\ D_{\text{n-th-min}}^{q_0}\},\ TOTAL\_PENALTY\ \text{from}\ D_{\text{1st-min}}^{q_0})$$

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



Since $|D_{min}^{p_0}-D_{\text{n-th-min}}^{q_0}|\leq 1$

$$L_0(p,D_{min}^{p_0})=C(p,D_{min}^{p_0})+Min(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY\ \text{from}\ D_i^{p_0}\text{'s neighbor}\ D_{min}^{q_0}, i.e.\ D_{\text{n-th-min}}^{q_0}\},\ TOTAL\_PENALTY\ \text{from}\ D_{\text{1st-min}}^{q_0})$$

$$TOTAL\_PENALTY\ \text{from}\ D_{\text{n-th-min}}^{q_0}=L_0(q,D_{\text{n-th-min}}^{q_0})-\underset{i\in[0,D_{max}-1]}{Min}L_0(q,D_i^{q_0})+P1$$

$$TOTAL\_PENALTY\ \text{from}\ D_{\text{1st-min}}^{q_0}=L_0(q,D_{\text{1st-min}}^{q_0})-\underset{i\in[0,D_{max}-1]}{Min}L_0(q,D_i^{q_0})+P2$$

Analyze a special scenario for solution

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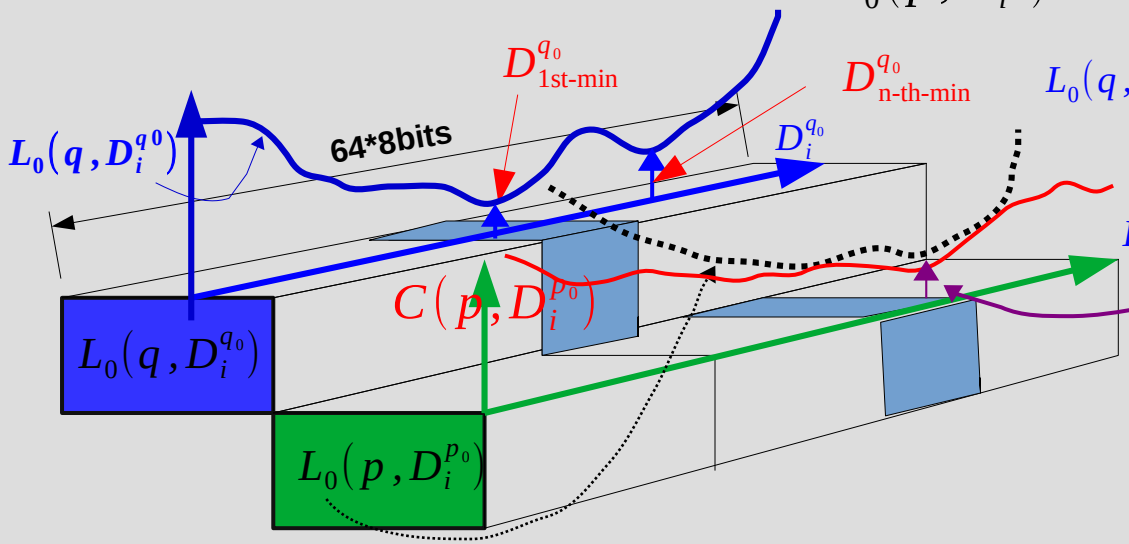
$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + P1\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| = 1\right] + P2\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| \geq 2\right]$$



1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i\in[0,D-1]}{Min}\ C(p, D_i^{p_0})$ **where**

$$\left|D_{min}^{p_0} - D_{\text{n-th-min}}^{q_0}\right| \leq 1$$

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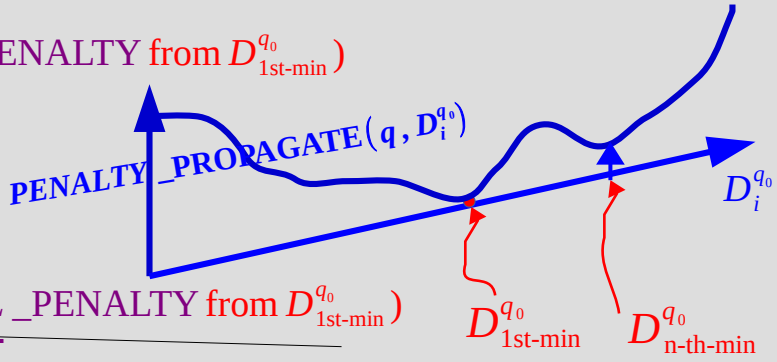
$D_{\text{n-th-min}}^{q_0}$ **is the actual disparity value D for pixel q,** $D_{\text{1st-min}}^{q_0}$ **becomes minimum because of noise**

$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + Min\left(\underset{n\in[0, D_{max}-2]}{Min}\{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_i^{q_0}, i.e.\ D_{\text{n-th-min}}^{q_0}\},\ TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0}\right)$$

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



Since $\left|D_{min}^{p_0} - D_{\text{n-th-min}}^{q_0}\right| \leq 1$

$$L_0(p, D_{min}^{p_0}) = C(p, D_{min}^{p_0}) + Min\left(\underset{n\in[0, D_{max}-2]}{Min}\{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_{min}^{q_0}, i.e.\ D_{\text{n-th-min}}^{q_0}\},\ TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0}\right)$$

$$TOTAL\_PENALTY \text{ from } D_{\text{n-th-min}}^{q_0} = L_0(q, D_{\text{n-th-min}}^{q_0}) - \underset{i\in[0, D_{max}-1]}{Min} L_0(q, D_i^{q_0}) + P1$$

$$TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0} = L_0(q, D_{\text{1st-min}}^{q_0}) - L_0(q, D_{\text{1st-min}}^{q_0}) + P2$$

Analyze a special scenario for solution

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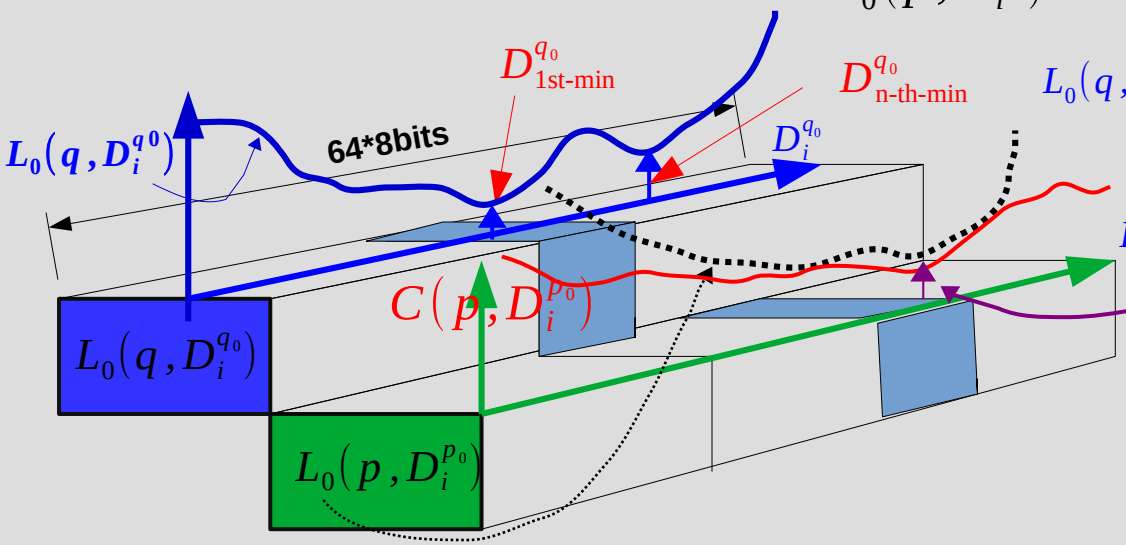
$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+P1[|D_i^{p_0}-D_{1st\_min}^{q_0}|=1]+P2[|D_i^{p_0}-D_{1st\_min}^{q_0}|\geq 2]$$

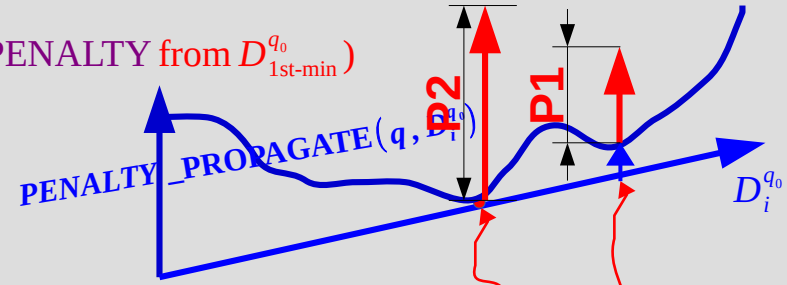


1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i\in[0,D-1]}{Min}\ C(p,D_i^{p_0})$ **where** $|D_{min}^{p_0}-D_{n\text{-}th\text{-}min}^{q_0}|\leq 1$, $|D_{min}^{p_0}-D_{1st\text{-}min}^{q_0}|\geq 2$

$D_{n\text{-}th\text{-}min}^{q_0}$ **is the actual disparity value D for pixel q,** $D_{1st\text{-}min}^{q_0}$ **becomes minimum because of noise**

$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+Min(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY\ \text{from}\ D_i^{p_0}\text{'s neighbor}\ D_i^{q_0}, i.e.\ D_{n\text{-}th\text{-}min}^{q_0}\},\ TOTAL\_PENALTY\ \text{from}\ D_{1st\text{-}min}^{q_0})$$

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



Since $|D_{min}^{p_0}-D_{n\text{-}th\text{-}min}^{q_0}|\leq 1$

$$L_0(p,D_{min}^{p_0})=C(p,D_{min}^{p_0})+Min(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY\ \text{from}\ D_i^{p_0}\text{'s neighbor}\ D_{min}^{q_0}, i.e.\ D_{n\text{-}th\text{-}min}^{q_0}\},\ TOTAL\_PENALTY\ \text{from}\ D_{1st\text{-}min}^{q_0})$$

if $TOTAL\_PENALTY\ \text{from}\ D_{n\text{-}th\text{-}min}^{q_0} = L_0(q,D_{n\text{-}th\text{-}min}^{q_0}) - \underset{i\in[0,D_{max}-1]}{Min} L_0(q,D_i^{q_0}) + P1$ **<** $TOTAL\_PENALTY\ \text{from}\ D_{1st\text{-}min}^{q_0} = L_0(q,D_{1st\text{-}min}^{q_0}) - L_0(q,D_{1st\text{-}min}^{q_0}) + P2 = \mathbf{P2}$

Analyze a special scenario for solution

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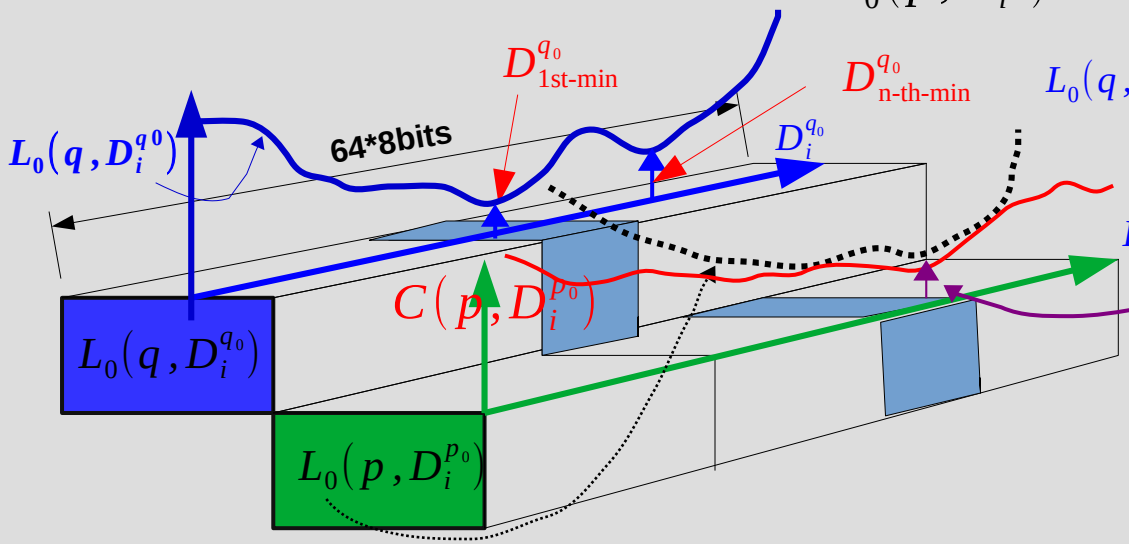
$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + P1\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| = 1\right] + P2\left[\left|D_i^{p_0} - D_{\text{1st\_min}}^{q_0}\right| \geq 2\right]$$

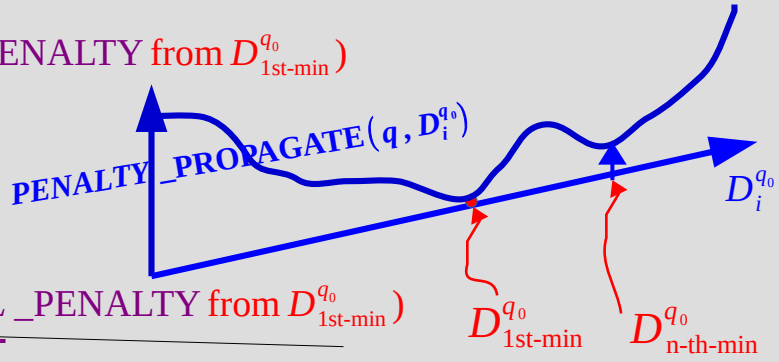


1. Special scenario : $D_{min}^{p_0}$ **for** $\underset{i \in [0, D-1]}{Min}\ C(p, D_i^{p_0})$ **where** $\left|D_{min}^{p_0} - D_{\text{n-th-min}}^{q_0}\right| \leq 1$, $\left|D_{min}^{p_0} - D_{\text{1st-min}}^{q_0}\right| \geq 2$

$D_{\text{n-th-min}}^{q_0}$ **is the actual disparity value D for pixel q,** $D_{\text{1st-min}}^{q_0}$ **becomes minimum because of noise**

$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + Min\left(\underset{n \in [0, D_{max}-2]}{Min}\ \{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_i^{q_0}, i.e.\ D_{\text{n-th-min}}^{q_0}\},\ TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0}\right)$$

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



Since $\left|D_{min}^{p_0} - D_{\text{n-th-min}}^{q_0}\right| \leq 1$

$$L_0(p, D_{min}^{p_0}) = C(p, D_{min}^{p_0}) + Min\left(\underset{n \in [0, D_{max}-2]}{Min}\ \{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_{min}^{q_0}, i.e.\ D_{\text{n-th-min}}^{q_0}\},\ TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0}\right)$$

if

$TOTAL\_PENALTY \text{ from } D_{\text{n-th-min}}^{q_0} = L_0(q, D_{\text{n-th-min}}^{q_0}) - \underset{i \in [0, D_{max}-1]}{Min} L_0(q, D_i^{q_0}) + P1$ $<$ $TOTAL\_PENALTY \text{ from } D_{\text{1st-min}}^{q_0} = L_0(q, D_{\text{1st-min}}^{q_0}) - L_0(q, D_{\text{1st-min}}^{q_0}) + P2 = \mathbf{P2}$

then

$$L_0(p, D_{min}^{p_0}) = C(p, D_{min}^{p_0}) + PENALTY\_PROPAGATE(q, D_{\text{n-th-min}}^{q_0}) + P1$$

Analyze a special scenario for solution

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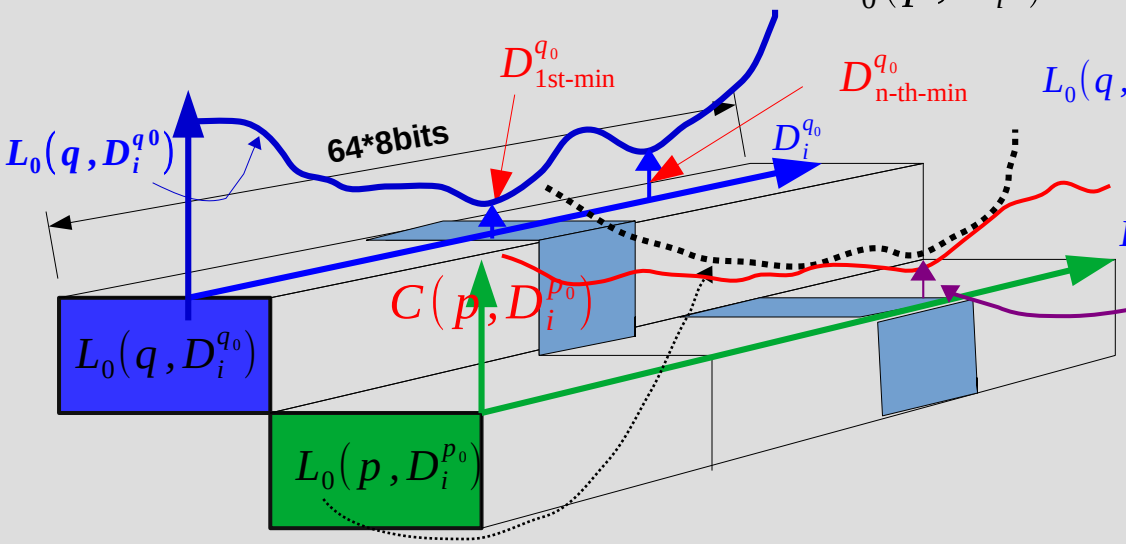
$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + P1[|D_i^{p_0} - D_{1st\_min}^{q_0}| = 1] + P2[|D_i^{p_0} - D_{1st\_min}^{q_0}| \geq 2]$$



$L_0(q, D_{n\text{-}th\text{-}min}^{q_0}) \geq L_0(q, D_{1st\text{-}min}^{q_0})$

1. Special scenario : $D_{min}^{p_0}$ for $\underset{i \in [0, D-1]}{Min}\ C(p, D_i^{p_0})$ where $|D_{min}^{p_0} - D_{n\text{-}th\text{-}min}^{q_0}| \leq 1$ $|D_{min}^{p_0} - D_{1st\text{-}min}^{q_0}| \geq 2$

$D_{n\text{-}th\text{-}min}^{q_0}$ is the actual disparity value D for pixel q, $D_{1st\text{-}min}^{q_0}$ becomes minimum because of noise

$$L_0(p, D_i^{p_0}) = C(p, D_i^{p_0}) + Min(\underset{n \in [0, D_{max}-2]}{Min}\{TOTAL\_PENALTY \text{ from } D_i^{p_0}\text{'s neighbor } D_i^{q_0}, i.e.\ D_{n\text{-}th\text{-}min}^{q_0}\},\ TOTAL\_PENALTY \text{ from } D_{1st\text{-}min}^{q_0})$$

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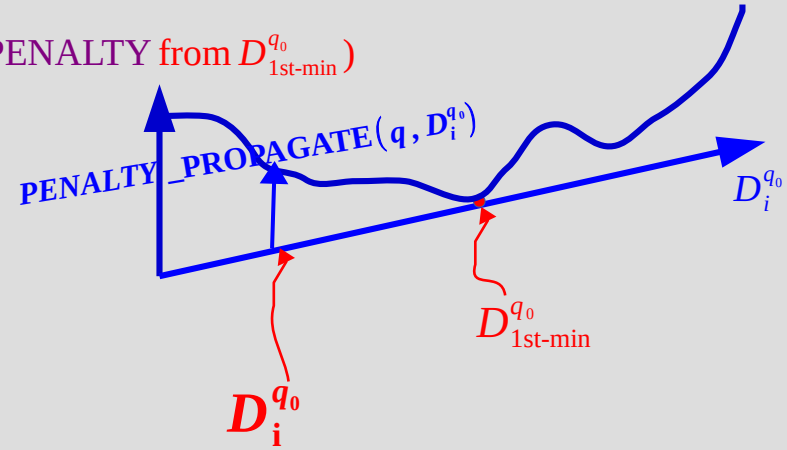

It follows same procedure to compute $L_0(p, D_i^{p_0})$ for arbitrary $D_i^{p_0}$

Analyze a special scenario for solution

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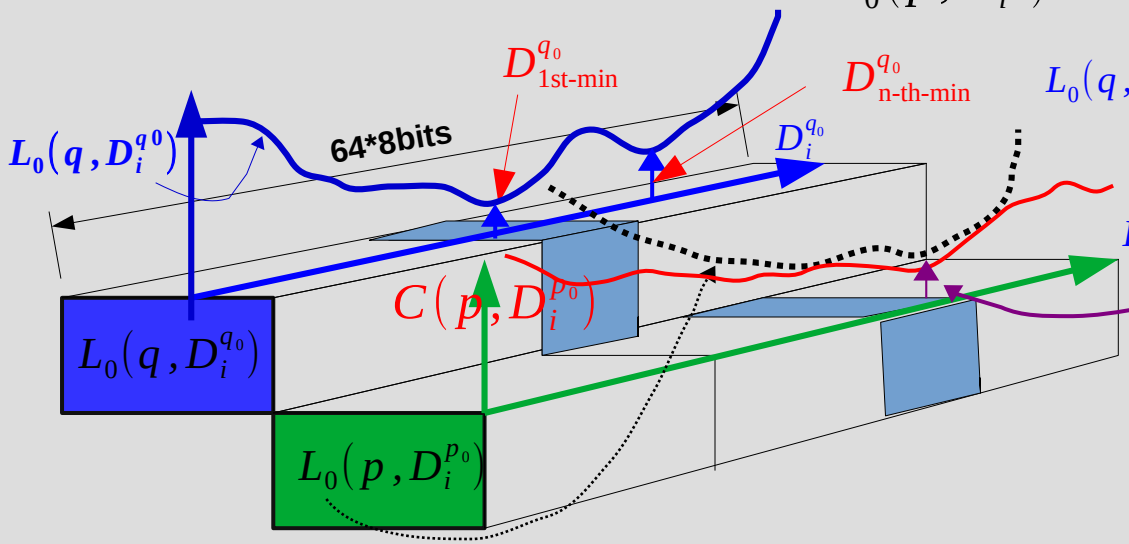
$$L_0(p,D_i^{p_0})=C(p,D_i^{p_0})+P1[|D_i^{p_0}-D_{1st\_min}^{q_0}|=1]+P2[|D_i^{p_0}-D_{1st\_min}^{q_0}|\geq 2]$$



1. Special scenario : $D_{min}^{p_0}$ for $\underset{i\in[0,D-1]}{Min}\ C(p,D_i^{p_0})$ where $|D_{min}^{p_0}-D_{n\text{-}th\text{-}min}^{q_0}|\leq 1$, $|D_{min}^{p_0}-D_{1st\text{-}min}^{q_0}|\geq 2$

$D_{n\text{-}th\text{-}min}^{q_0}$ is the actual disparity value D for pixel q, $D_{1st\text{-}min}^{q_0}$ becomes minimum because of noise

$$L_0(p,D^{p_0})=C(p,D^{p_0})+Min(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY\ \text{from}\ D^{p_0}\text{'s neighbor}\ D^{q_0}, i.e.\ D_{n\text{-}th\text{-}min}^{q_0}\},\ TOTAL\_PENALTY\ \text{from}\ D_{1st\text{-}min}^{q_0})$$

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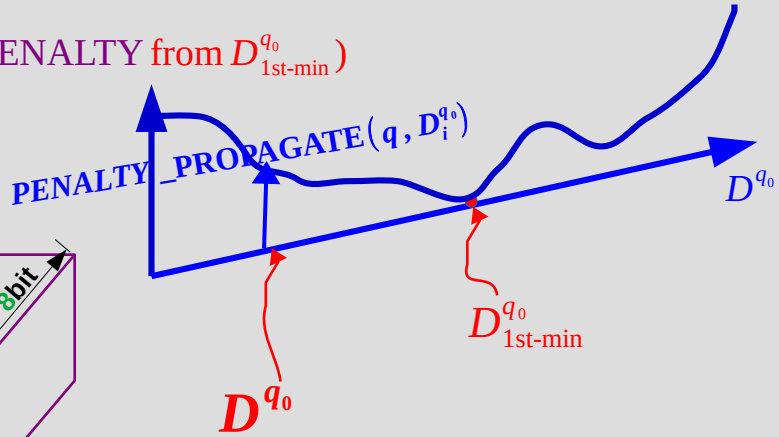
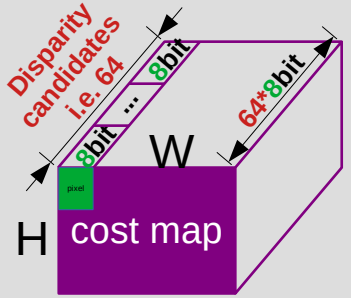




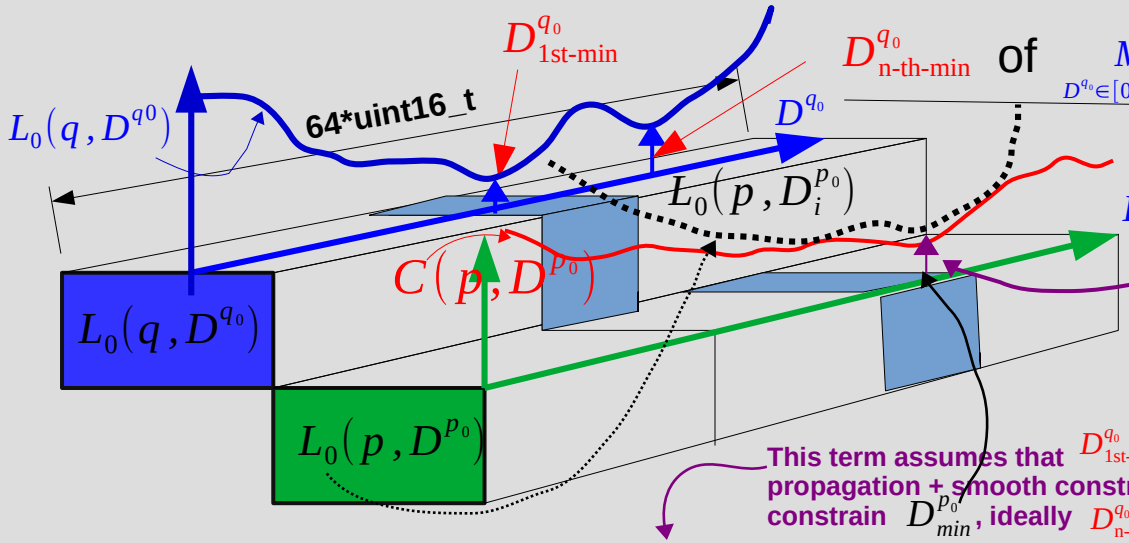
It follows same procedure to compute $L_0(p,D^{p_0})$ for arbitrary D^{p_0}

Then you will have 64 disparity cost candidates for any pixel P, to be precise, pixel P's r=0 directional component, after summing all direction, i.e. r=0,1,…,7, then you will have 64 disparity cost candidates, i.e. cost map . The minimum value of the 64 candidates is the disparity for that pixel

Analyze a special scenario for solution

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

$$L_0(p,D^{p_0}) = C(p,D^{p_0}) + P1\left[\left|D^{p_0} - D^{q_0}_{\text{1st\_min}}\right| = 1\right] + P2\left[\left|D^{p_0} - D^{q_0}_{\text{1st\_min}}\right| \geq 2\right]$$



$D^{q_0}_{\text{n-th-min}}$ of $\underset{D^{q_0}\in[0,D_{max}-1]}{Min} L_0(q,D^{q_0})$ where $L_0(q,D^{q_0}_{\text{n-th-min}}) \geqslant L_0(q,D^{q_0}_{\text{1-st-min}})$

1. Special scenario : $D^{p_0}_{min}$ of $\underset{D^{p_0}\in[0,D_{max}-1]}{Min} C(p,D^{p_0})$ where $\left|D^{p_0}_{min} - D^{q_0}_{\text{n-th-min}}\right| \leq 1$, $\left|D^{p_0}_{min} - D^{q_0}_{\text{1st-min}}\right| \geq 2$

$D^{q_0}_{\text{n-th-min}}$ **is the actual disparity value D for pixel q,** $D^{q_0}_{\text{1st-min}}$ **becomes minimum because of noise**

This term assumes that $D^{q_0}_{\text{1st-min}}$ **is contaminated, see if we can recover it from penalty / probability propagation + smooth constrain from the rest 63 candidates, which best match current pixel's color constrain** $D^{p_0}_{min}$**, ideally** $D^{q_0}_{\text{n-th-min}}$ **will yield minimum** $\underset{D^{p_0}\in[0,63]}{min} L_0(p,D^{p_0})$ **at disparity value** $D^{p_0}_{min}$ **as shown in the left image**

$$L_0(p,D^{p_0}) = C(p,D^{p_0}) + Min\left(\underset{n\in[0,D_{max}-2]}{Min}\{TOTAL\_PENALTY \text{ from } D^{p_0}\text{'s neighbor } D^{q_0}, i.e.\ D^{q_0}_{\text{n-th-min}}\},\ TOTAL\_PENALTY \text{ from } D^{q_0}_{\text{1st-min}}\right)$$

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

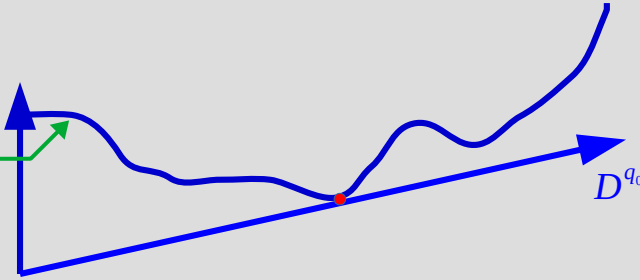
Previously we only compare this term, now P2 will make this term larger, so will no longer be considered as smooth constrain item

4. The result :

Then $D^{q_0}_{\text{n-th-min}}$ is chosen when total penalty from $D^{q_0}_{\text{1st-min}}$ is bigger than that from $D^{q_0}_{\text{n-th-min}}$

2. Question ? :

how do we tell the algorithm to choose $D^{q_0}_{\text{n-th-min}}$ over $D^{q_0}_{\text{1st-min}}$ for computing $L_0(p,D^{p_0}_{min})$?



3.Solution :

Introducing possibility propagation, using $L_0(q,D^{q_0}) - \underset{D^{q_0}\in[0,D_{max}-1]}{Min} L_0(q,D^{q_0})$ to represent the inverse-possibility of each D^{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 $PENALTY\_PROPAGATE(q,D^{q_0}) = L_0(q,D^{q_0}) - \underset{D^{q_0}\in[0,D_{max}-1]}{Min} L_0(q,D^{q_0})$

This term is to avoid overflow in propagation,can set maximum value to cliff off,so as to further make sure no overflow happens

Cost function from SGM paper

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

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

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

$$- min\big(L_r(q_r,D\pm k)\big) \qquad n \geq 2\ ,k \geq 0$$

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.

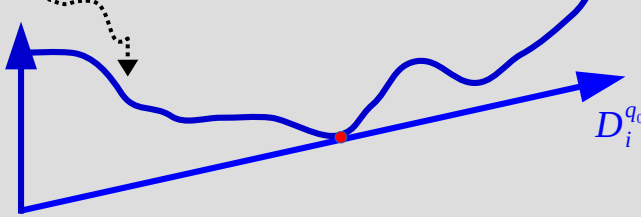
The price we have to pay is the exhaustive searching in all candidates, i.e. the rest 63 disparity positions.

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

$$PENALTY\_PROPAGATE(q, D^{q_0}) = L_0(q, D^{q_0}) - \underset{D^{q_0} \in [0, D_{max}-1]}{Min} L_0(q, D^{q_0})$$



Show me the code for below process

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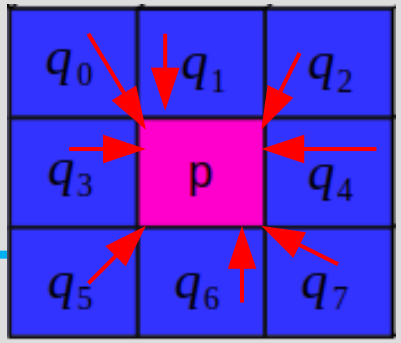


$$L_0(q, D^{q_0}) \quad L_1(q, D_i^{q_1}) \quad L_3(q, D_i^{q_3}) \quad L_2(q, D_i^{q_2})$$

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

$L_0(p, D^{p_0})$	$L_1(p, D^{p_1})$	$L_3(p, D^{p_3})$	$L_2(p, D^{p_2})$	$S(p, D^p)$
$D^{p_0}=0$	$D^{p_1}=0$	$D^{p_3}=0$	$D^{p_2}=0$	$D^p=0$
$D^{p_0}=1$	$D^{p_1}=1$	$D_{min}^{p_3}$	$D^{p_2}=1$	$D^p=1$
$D_{min}^{p_0}$	$D_{min}^{p_1}$	$D^{p_3}=2$	$D_{min}^{p_2}$	D_{min}^p
$D^{p_0}=3$	$D^{p_1}=3$	$D^{p_3}=3$	$D^{p_2}=3$	$D^p=3$
$D^{p_0}=4$	$D^{p_1}=4$	$D^{p_3}=4$	$D^{p_2}=4$	$D^p=4$

$$L_r(p, D^{p_r}) = C(p, D^{p_r}) + min(L_r(q, D^{p_r}) + 0, L_r(q, D^{p_r} \pm 1) + P1, min(L_r(q, D^{p_r} \pm n) + P2))$$

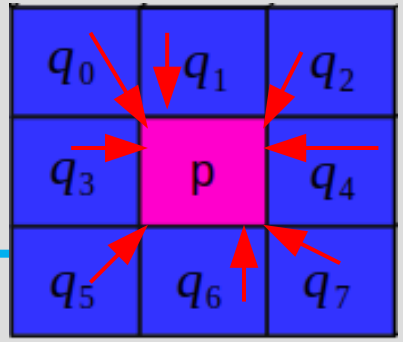
$$- min(L_r(q, D^{p_r} \pm k)) \qquad n \geq 2 \ , k \geq 0$$

confusing notation in original paper

$$\min_{D^{q_r} \in [0,63]} (L_r(q, D^{q_r}))$$

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

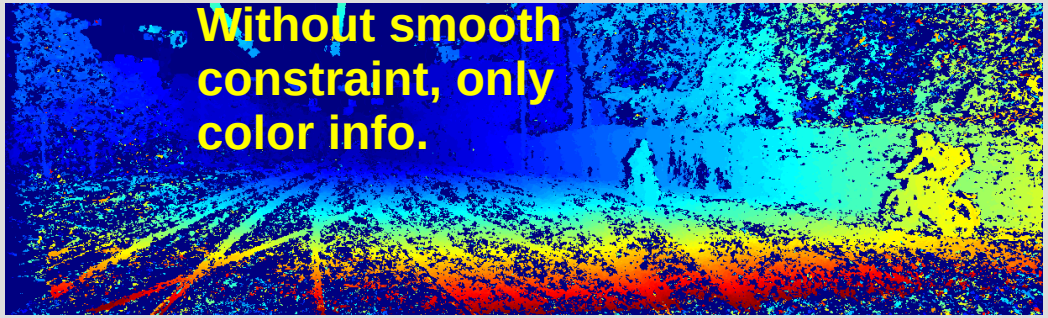
Show me the code for below process 2

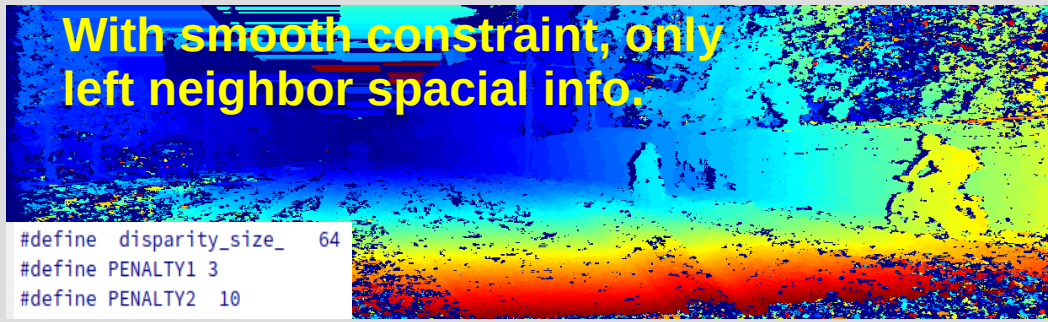


#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

```
    scan_scost_cpu(H_matching_cost,H_scan_cost,left.cols,left.rows) ;   // according to original paper
//    spacial_smooth_constrain_cpu(H_matching_cost,H_scan_cost,left.cols,left.rows) ;
//    bypass_spacial_smooth_constrain_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 minumum
{
    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 ;
```






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


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


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

Next: get Right_cost from Left_cost

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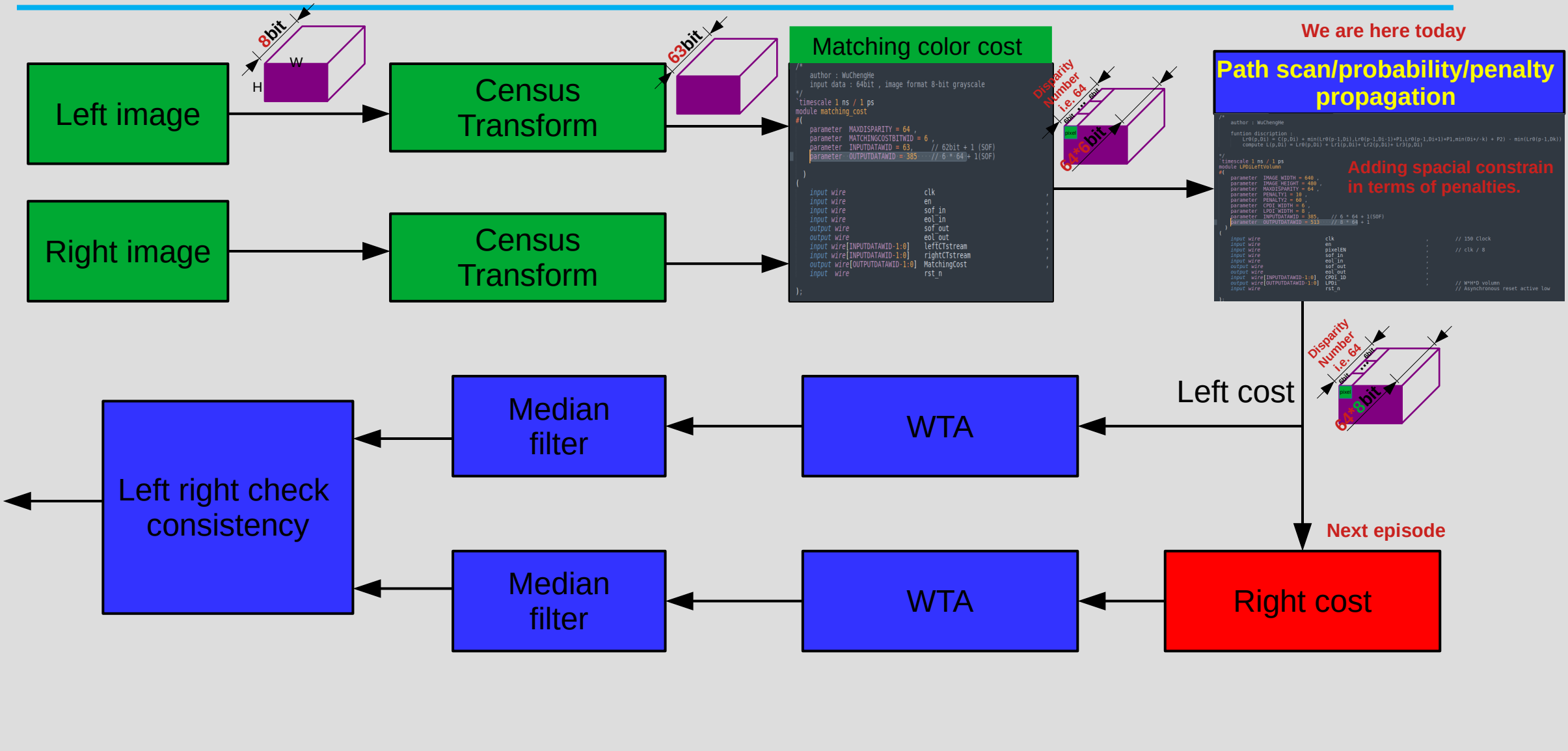


Brief intro. about me

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset

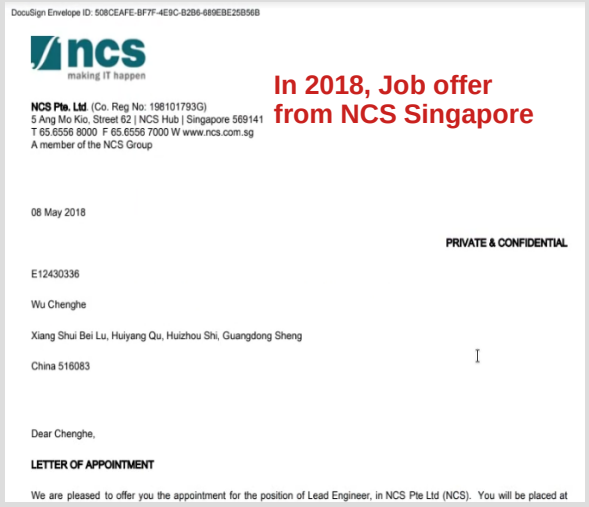
- Over 11+ years of R&D work experience,capable of designing and deploying computer vision and deep learning algorithms on embedded device like FPGA and ARM.
- Full stack web development with Django,React/Vue/Nextjs,MySQL,Nodejs,Golang,etc....
- skilled at FPGA / ZYNQ SOC design (Verilog HDL)
- good 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 (Streo vision), object detection, motor control

More on Linkedin : https://www.linkedin.com/in/brianwchh/

G.E.M.【幫你實現新年願望】鄧紫棋

52K views • 5 years ago

In 2018, GEM help you to fulfill the new year dreams



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A member of the NCS Group

In 2018, Job offer from NCS Singapore

08 May 2018

PRIVATE & CONFIDENTIAL

E12430336

Wu Chenghe

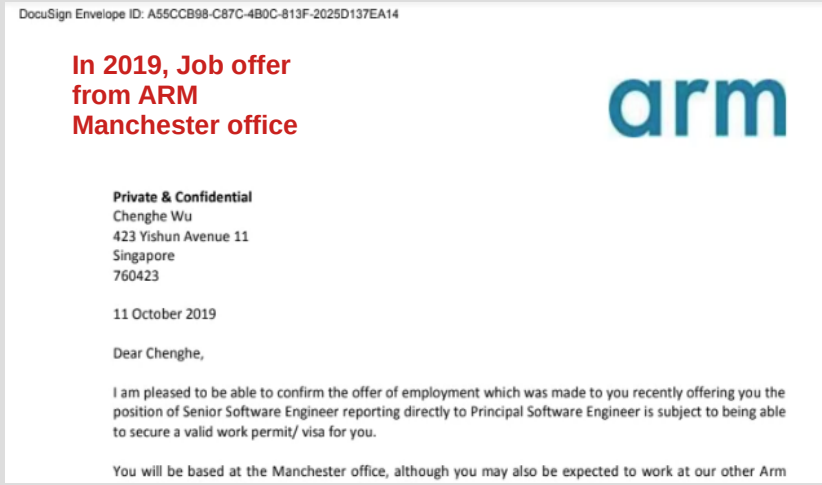
Xiang Shui Bei Lu, Huiyang Qu, Huizhou Shi, Guangdong Sheng

China 516083

Dear Chenghe,

LETTER OF APPOINTMENT

We are pleased to offer you the appointment for the position of Lead Engineer, in NCS Pte Ltd (NCS). You will be placed at



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In 2019, Job offer from ARM Manchester office

arm

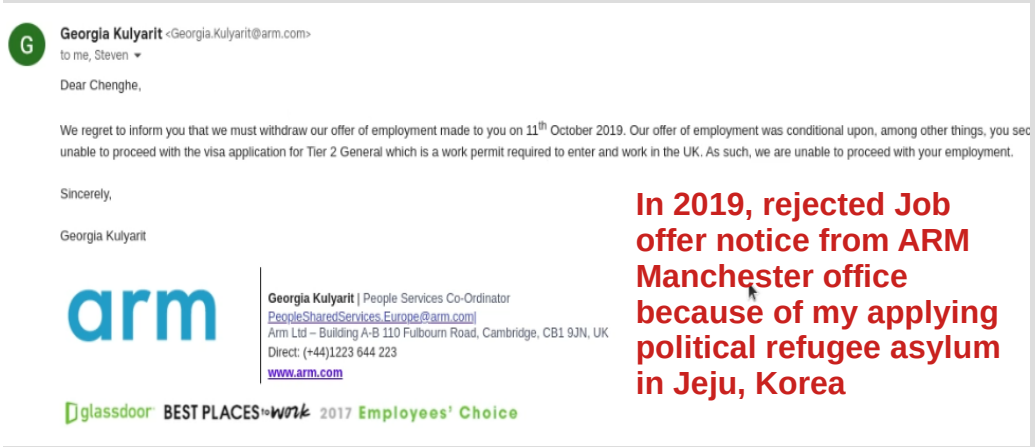
Private & Confidential
Chenghe Wu
423 Yishun Avenue 11
Singapore
760423

11 October 2019

Dear Chenghe,

I am pleased to be able to confirm the offer of employment which was made to you recently offering you the position of Senior Software Engineer reporting directly to Principal Software Engineer is subject to being able to secure a valid work permit/ visa for you.

You will be based at the Manchester office, although you may also be expected to work at our other Arm



Georgia Kulyarit <Georgia.Kulyarit@arm.com>
to me, Steven

Dear Chenghe,

We regret to inform you that we must withdraw our offer of employment made to you on 11th October 2019. Our offer of employment was conditional upon, among other things, you sec unable to proceed with the visa application for Tier 2 General which is a work permit required to enter and work in the UK. As such, we are unable to proceed with your employment.

Sincerely,

Georgia Kulyarit

arm

Georgia Kulyarit | People Services Co-Ordinator
PeopleSharedServices.Europe@arm.com
Arm Ltd – Building A-B 110 Fulbourn Road, Cambridge, CB1 9JN, UK
Direct: (+44)1223 644 223
www.arm.com

glassdoor BEST PLACES to work 2017 Employees' Choice

In 2019, rejected Job offer notice from ARM Manchester office because of my applying political refugee asylum in Jeju, Korea

Thank you

#hohy #metoo #MeTooMovement https://github.com/brianwchh/ChatGPT_mindControl_dataset