Mixed precision

16 bit and 32 bit float points during training

to make it run faster and use less memory.

Compute

GPU Compatable to 7.0 (or) higher.

arising for better performance

wi P100 GPU.

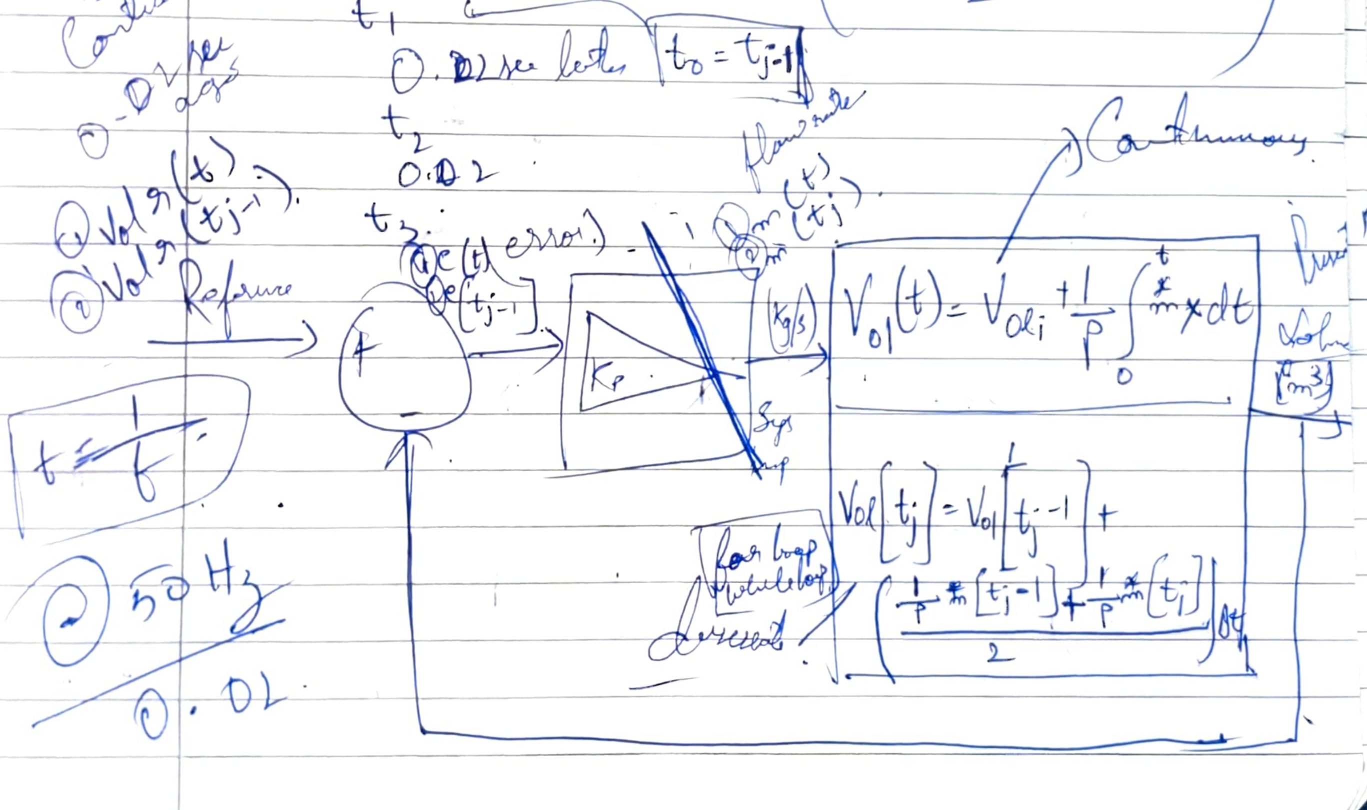
V100 (or) above for 7.0 (or) higher.

T4, A100

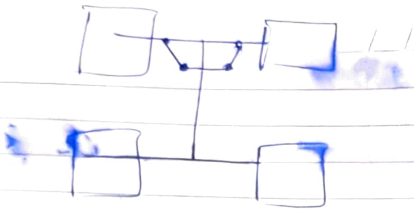
Compare history.

Automotive water sup system controller.

$$V_0\left[t_j\right] = V_0\left[t_j - 1\right] + \left(\frac{\frac{1}{P}\dot{m}\left[t_j - 1\right] + \frac{1}{P}\dot{m}\left[t_j\right]}{2}\right)\Delta t$$

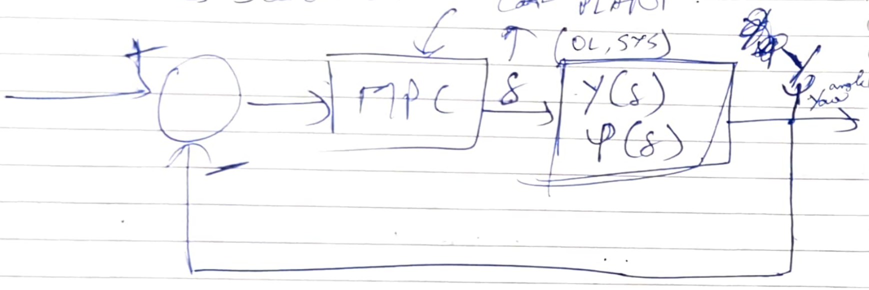


PID ~~[illegible]~~
[illegible]

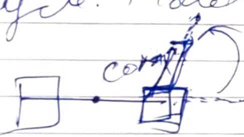


MPC (Model Predictive Control)

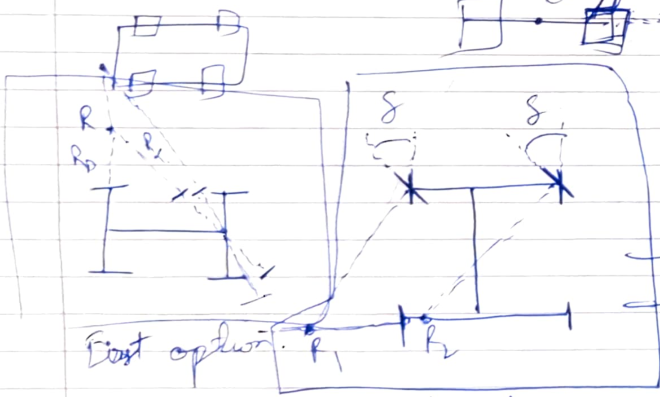
→ MIMO suitable
→ Scalable



Car model vs Bicycle. Model



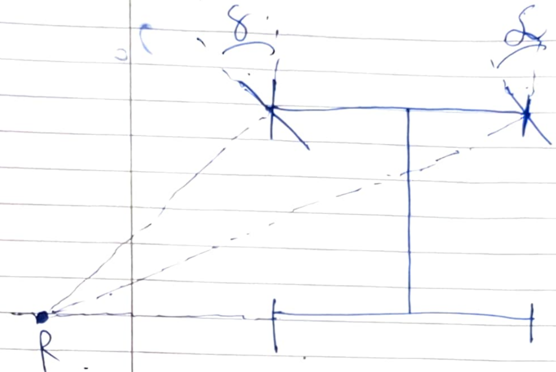
δ Steering wheel angle



→ Tyre slipps
→ 2 Centers of Rotations.

First option.

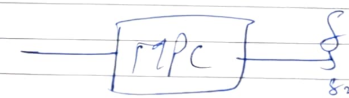
Second option.

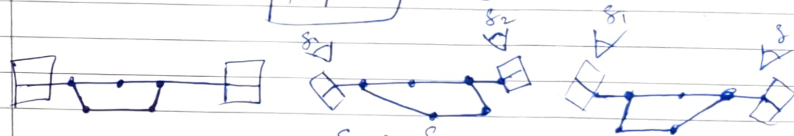


for bicycle

Third option.

AckerMan Steering.

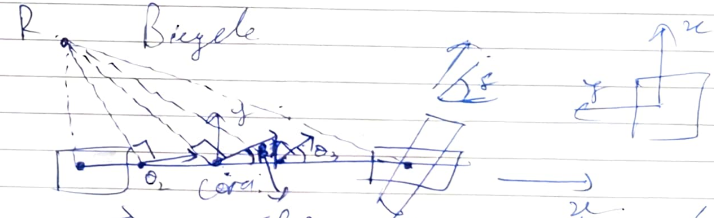




$\delta_1 > \delta_2$

$\delta_1 < \delta_2$

Bicycle



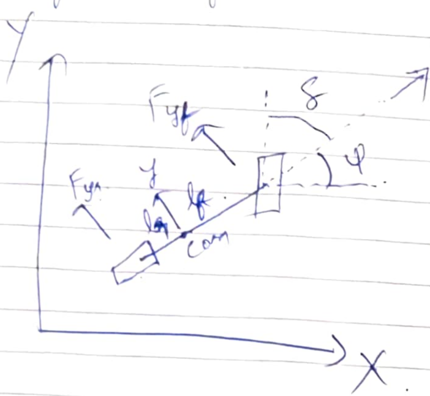
$\theta_1 = 0$

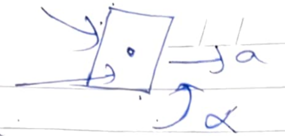
slip
$\angle^{le}$ of Vehicle.

$V_c^x = 20\,m/s$.

$\theta_1 < \theta_2 < \beta < \theta_3 < \delta$

Equations of Motions.





$\Sigma F = ma$

$\Sigma M = I\alpha$

angular acceleration

$\Sigma F = m a_y$

$F_{yr} + F_{yf} = m a_y$

$F_{fy} \cdot l_f - F_{fr} \cdot l_r = I\ddot{\psi}$

$a_y = \ddot{y} + \dot{x}\dot{\psi}$

Centripetal acceleration

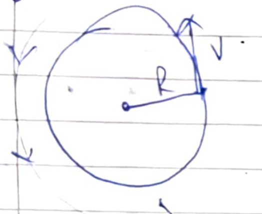
$\dot{\theta} = V/R$

$V = \dot{\theta} \cdot R$

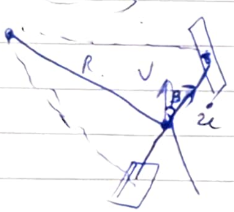
$\dot{\psi} = \frac{\dot{x}}{R}$

$\dot{x} = \dot{\psi} R$

$\frac{V^2}{R}$



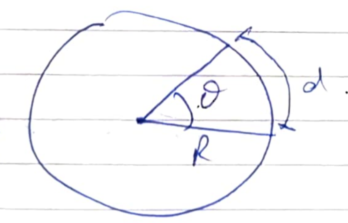
→ If Buggle is turning then we should have Centripetal acceleration.



$d = R\theta$

$\dot{d} = \dot{R}\theta + R\dot{\theta}$

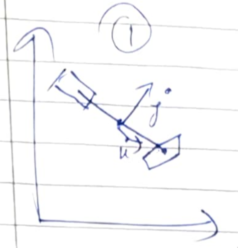
$\dot{d} = R\dot{\theta}$

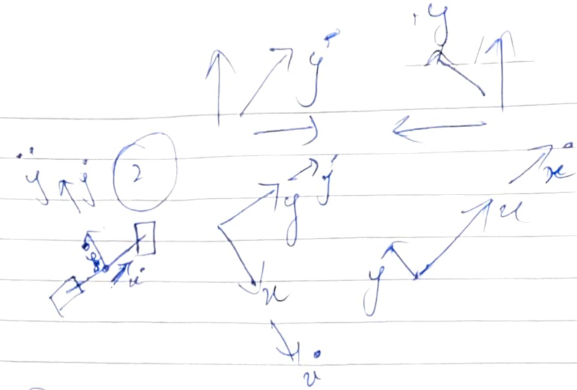


$F_{yf} + F_{yr} = m(\ddot{y} + \dot{x}\dot{\psi})$

$a_y = \ddot{y} + \dot{x}\dot{\psi}$

① ②

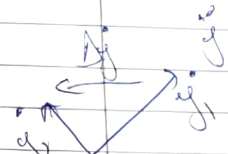




Presence of $\dot{y}$ m/s indicates there might be slipping in the tyre which would be very less.

$\ddot{y}$ m/s presence states there is more slipp

$\ddot{y} = 0 m/s^2$



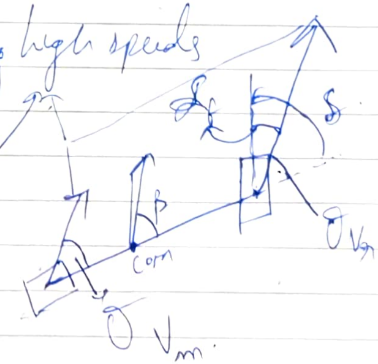
2 things

$F_{yf} + F_{yr} = m(\ddot{y} + \dot{x}\dot{\psi})$

$F_{yf} \cdot l_f - F_{yr} \cdot l_r = I\ddot{\psi}$

during high speeds

due to tyre deformation



$\delta_f = \delta - \theta_{Vf}$

$\delta_r = 0 - \theta_{Vr}$

$= -\theta_{Vr}$

$F_{yf} \propto \delta_f$

$F_{yr} \propto \delta_r$

Cornering Stiffness

$F_{yf} = 2 C_{\delta f} \cdot \delta_f$ $\qquad C_{\delta f} \to$ slope

$F_{yr} = 2 C_{\delta r} \cdot \delta_r$ $\qquad N/rad$

only for small slip angles

$$F_{yf} = 2 C_{\delta f} \left(\delta - \boxed{\theta_{Vf}}\right)$$

$$F_{yr} = 2 C_{\delta r} \left(-\boxed{\theta_{Vr}}\right)$$

in terms of $\dot{x}\ \dot{y}\ l_f\ l_r\ \dot{\psi}$

θ_{Vf}

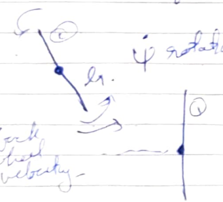
θ_{Vr}

$\dot{x} = 20\,m/s$

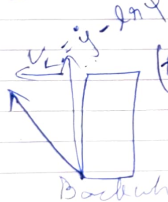
$$\tan(\theta_{Vf}) = \frac{V_L}{\dot{x}}$$

$$V_L = \dot{y} + l_f \cdot \dot{\psi}$$

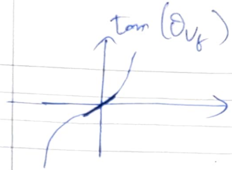
$$\tan(\theta_{Vf}) = \frac{\dot{y} + l_f \cdot \dot{\psi}}{\dot{x}}$$



ψ rotation angle.



$$\tan(\theta_{Vr}) = \frac{\dot{y} - l_r \dot{\psi}}{\dot{x}}$$



$$\tan(\theta_{Vf}) \approx \theta_{Vf}$$

$$\tan(\theta_{Vr}) \approx \theta_{Vr}$$

$$\theta_{Vf} = \frac{\dot{y} + l_f \dot{\psi}}{\dot{x}}$$ only when they are small

$$\theta_{Vr} = \frac{\dot{y} - l_r \dot{\psi}}{\dot{x}}$$

$$m(\ddot{y} + \dot{\psi}\dot{x}) = 2 C_{\delta f}(\delta - \theta_{Vf}) + 2 C_{\delta r}(-\theta_{Vr})$$

$$m\ddot{y} + m\dot{\psi}\dot{x} = 2 C_{\delta f} \cdot \delta - 2 C_{\delta f}\theta_{Vf} - 2 C_{\delta r}\theta_{Vr}$$

$$\ddot{y} = \underbrace{\left[\frac{-2C_{\delta f}}{m\dot{x}} - \frac{2C_{\delta r}}{m\dot{x}}\right]}_{a}\dot{y} + \underbrace{\left[-\dot{x} - \frac{2C_{\delta f} \cdot l_f}{m\dot{x}} + \frac{2C_{\delta r} \cdot l_r}{m\dot{x}}\right]}_{b}\dot{\psi} + \underbrace{\frac{2C_{\delta f}}{m}\delta}_{e}$$

$$\begin{bmatrix} \ddot{y} \\ \ddot{\psi} \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} \dot{y} \\ \dot{\psi} \end{bmatrix} + \begin{bmatrix} e \\ f \end{bmatrix} \delta$$

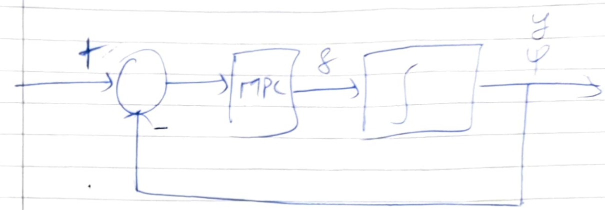
$$I\ddot{\psi} = l + 2C_{\delta f}(\delta - \theta_{v_f}) + l_r\, 2C_{\delta r}(\theta_{v_r})$$

$$\ddot{\psi} = \underbrace{\left[\frac{-l_f + 2C_{\delta f} + l_r 2C_{\delta r}}{I\dot{x}}\right]}_{c}\dot{y} + \underbrace{\left[\frac{-l_f^2 2C_{\delta f} - l_r^2 2C_{\delta r}}{I\dot{x}}\right]}_{d}\dot{\psi} + \underbrace{\left[\frac{l_f 2C_{\delta f}}{I}\right]}_{f}\cdot\delta$$

longitudinal Velocity is Const
∴ a b c d e f are Const.

$$\begin{bmatrix}\ddot{y}\\ \ddot{\psi}\end{bmatrix} = \begin{bmatrix} a & b \\ c & d\end{bmatrix}\begin{bmatrix}\dot{y}\\ \dot{\psi}\end{bmatrix} + \begin{bmatrix} e \\ f\end{bmatrix}\delta$$

$$\left.\begin{aligned}\ddot{y} &= a\cdot\dot{y} + b\dot{\psi} + e\delta\\ \ddot{\psi} &= c\cdot\dot{y} + d\dot{\psi} + f\delta\end{aligned}\right\}$$ State space equation
First order diff equation



$\dot{\psi}, \dot{y} \rightarrow$ States

Variables to describe how sys behaves.

Non linear State space equation (Dummy example)

$$\left\{\begin{aligned}\dot{x}_1 &= a\cdot x_1 + c x_2^2 + d x_3^3 + u_1.\\ \dot{x}_2 &= c^2\cdot x_1 + \sin(x_2) + u_1 + u_2\\ x_3 &= f\cdot x_1^3\end{aligned}\right.$$

Dummy example

$\dot{y} = x_1$	$\dot{x}_1 = \ddot{y}$	$\dot{x}_1 = a x_1 + b x_3 + f\cdot u$
$\psi = x_2$	$\dot{x}_2 = \dot{\psi}$	$\dot{x}_2 = x_3$
$\dot{\psi} = x_3$	$\dot{x}_3 = \ddot{\psi}$	$\dot{x}_3 = c x_1 + d x_3 + f\cdot u$
$Y = x_4$	$\dot{x}_4 = \dot{Y}$	$\dot{x}_4 = x_1\cdot\cos(x_2) + \dot{x}\sin(x_2)$
	$\delta = u$	

State space equation

$$\begin{aligned}\ddot{y} &= a\dot{y} + b\dot{\psi} + f\delta\\ \dot{\psi} &= \dot{\psi}\\ \ddot{\psi} &= c\dot{y} + d\dot{\psi} + f\delta\\ \dot{Y} &= \dot{y}\cos(\psi) + \dot{x}\cdot\sin(\psi)\end{aligned}$$

3 max

Future state prediction

$$\vec{x}_{k+1} = A_d x_k + B_d \delta_k$$
$$\vec{y}_k = C_d \vec{x}_k + D_d \delta_k$$

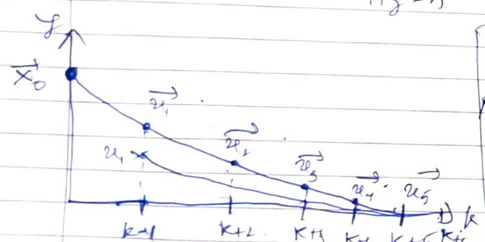
→ Discrete LTI

$$\vec{x}_1 = A\vec{x}_0 + B\delta_0$$
$$\vec{x}_2 = A\vec{x}_1 + B\delta_1$$
$$\vec{x}_3 = A\vec{x}_2 + B\delta_2$$
$$\vec{x}_4 = A\vec{x}_3 + B\delta_3$$
$$\vec{x}_5 = A\vec{x}_4$$

$$\vec{x}_5 = A^5\vec{x}_0 + A^4B\delta_0 + A^3B\delta_1 + A^2B\delta_2 + AB\delta_3 + B\delta_4$$

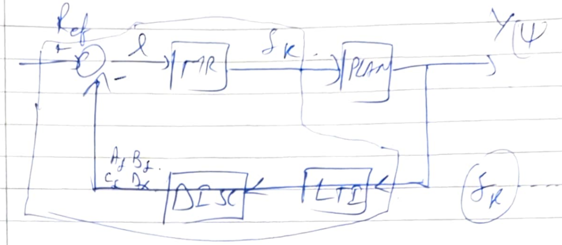
$$\vec{X}_k = A^k\vec{X}_0 + \begin{bmatrix} A^{k-1}B & A^{k-2}B & \cdots & AB & B \end{bmatrix} \begin{bmatrix} \delta_0 \\ \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix}$$

Hz = 5

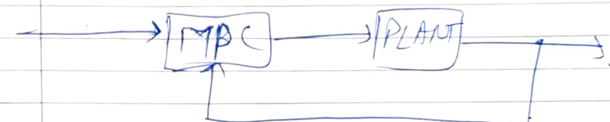


$$\begin{bmatrix} \vec{x}_1 \\ \vec{x}_2 \\ \vec{x}_3 \\ \vec{x}_4 \\ \vec{x}_5 \end{bmatrix} = \begin{bmatrix} B & & & \\ AB & B & & \\ A^2B & AB & B & \\ \vdots & & \ddots & \\ A^{N-1}B & A^{N-2}B & \cdots & B \end{bmatrix} \begin{bmatrix} \delta_0 \\ \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \end{bmatrix} + \begin{bmatrix} A \\ A^2 \\ \vdots \\ A^N \end{bmatrix} \vec{x}_0$$

$$\begin{matrix} LTI \\ ABCD \end{matrix} \xrightarrow{Dis} \begin{matrix} A_d & B_d \\ C_d & D_d \end{matrix}$$



δ_k ...... δ_{k+4}



Reformulating the Cost fn

$$J = \frac{1}{2}\vec{e}^{\,T}_{k+N} S \vec{e}_{k+N} + \frac{1}{2}\sum_{i=0}^{N-1}\left[\vec{e}^{\,T}_{k+i} Q \vec{e}_{k+i} + \vec{\delta}^{\,T}_{k+i} R\, \delta_{k+i}\right]$$

N = 5

$$J = \frac{1}{2}\vec{e}^{\,T}_{k+5} S \vec{e}_{k+5} + \frac{1}{2}\Big[\vec{e}^{\,T}_k Q \vec{e}_k + \vec{\delta}^{\,T}_k R \vec{\delta}_k + \vec{e}^{\,T}_{k+1} Q \vec{e}_{k+1} + \vec{\delta}^{\,T}_{k+1} R \vec{\delta}_{k+1} + \dots + \vec{e}^{\,T}_{k+4} Q \vec{e}_{k+4} + \vec{\delta}^{\,T}_{k+4} \cdot R \cdot \vec{\delta}_{k+4}\Big]$$

$$J = \frac{1}{2}\underbrace{\vec{e}_{k+N}}_{\vec{r}_{k+5} - C\tilde{\vec{x}}_{k+5}} S \vec{e}_{k+N} + \frac{1}{2}\sum_{i=0}^{N-1}\left[\vec{e}^{\,T}_{k+i} Q \vec{e}_{k+i} + \Delta\vec{\delta}^{\,T}_{k+i} \Delta R \Delta\delta_{k+i}\right]$$

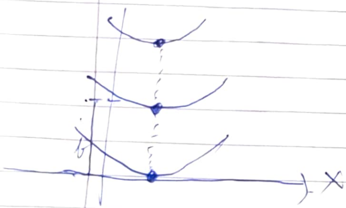
1 Img (Car lane) Img

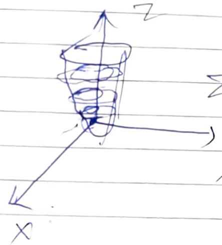
$$J = \frac{1}{2}\left[\vec{x}_{k+N} - \tilde{C}\vec{\tilde{x}}_{k+N}\right]^T S\left(\vec{x}_{k+N} - \tilde{C}\tilde{x}_{k+N}\right)$$

$$+ \frac{1}{2}\sum_{i=0}^{N-1}\left[\left(\vec{x}_{k+i} - \tilde{C}\tilde{x}_{k+i}\right)^T Q\left(\vec{x}_{k+i} - \tilde{C}\tilde{x}_{k+i}\right) + \Delta\vec{u}_{k+i}^T R \Delta\vec{u}_{k+i}\right]$$

$y = ax + b$

$y = a(x - x_1)^2 + b$





$Z = (x - x_1)^2 + (y - y_1)^2 + b_0$

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Data Science file

LipNet ✓
CNN Image Classifier ✓
Edge detection (Open CV) → Proo file
IRIS Tracker
Face recognition app
Deep audio classifier
GAN ✓
ESRGAN (SuperRes)

RTCV with Tensorflow Js and React + 7 projects ✓
~~LipNet~~

Pdf available
Book

Water tank ✓
PID ✓
MPC Car ~~automation~~ lane assist (Lateral) ✓

Skimlit (NLP)
Bit predict

Landmark detection.

Installing Facemesh (Pretrained deep learning library)
Building the facemesh app. (react up model)
Detecting yo face in Real time (detection)

How it works.
1. Create a webcam stream inside of front end React app.
2. Tensorflow.Js (load facemesh.)(make detection from stream)
3. Draw keypoints and triangle on javascript Canvas.