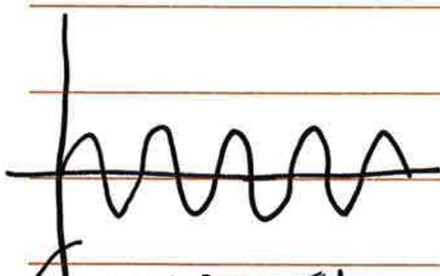
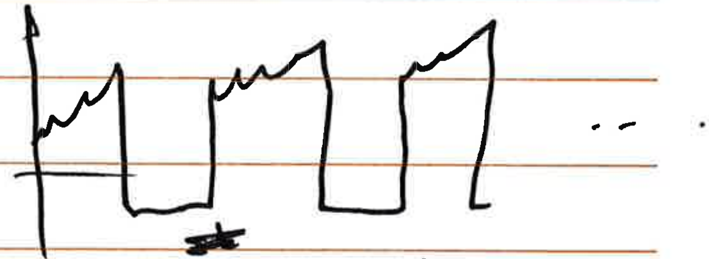
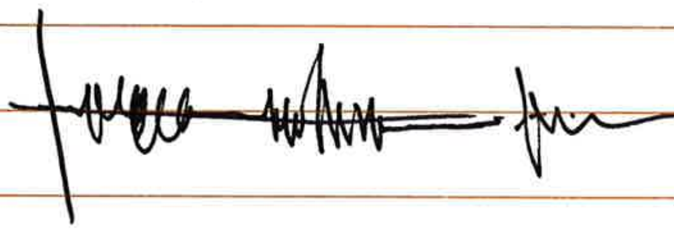
Sound is produced



stationary



stationary



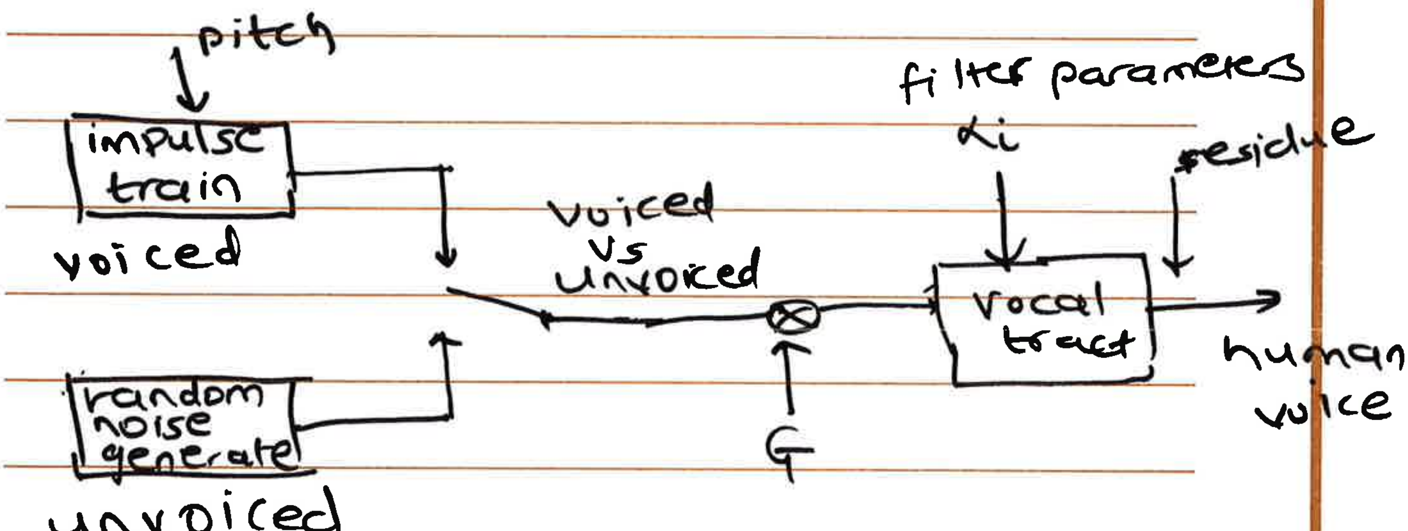
non stationary

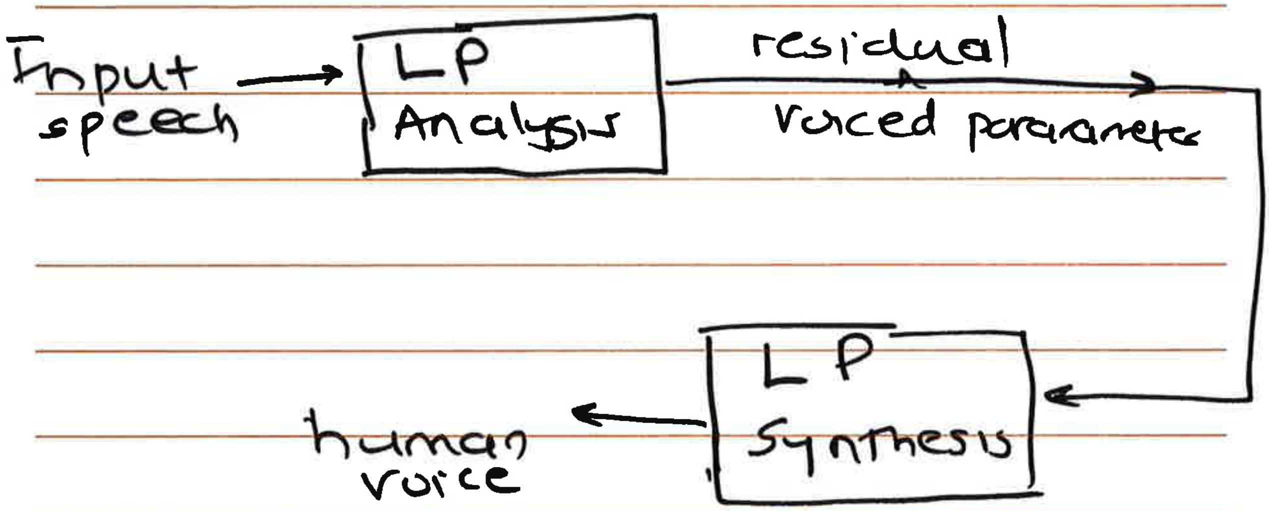
$$x_t = \rho x_{t-1} + \varepsilon$$

$$|\rho| < 1$$

voice 8 KHz → 8000 samples/sec

voiced & unvoiced





first order

$$s(n) = \alpha_1 s(n-1) + e$$

pth order

$$s(n) = \sum_{k=1}^{p} \alpha_k s(n-k) + e$$

$$s(i) = \sum_{k=1}^{p} \alpha_k s(i-k) + e$$

$$e = s(i) - \sum_{k=1}^{p} \alpha_k \, s(|i-k|)$$

$$s(1) = \alpha_1 s(0) + \alpha_2 s(1) + \cdots \alpha_p s(p-1)$$

$$s(2) = \alpha_1 s(1) + \alpha_2 s(0) + \alpha_3 s(1) + \cdots \alpha_p s(p-2)$$

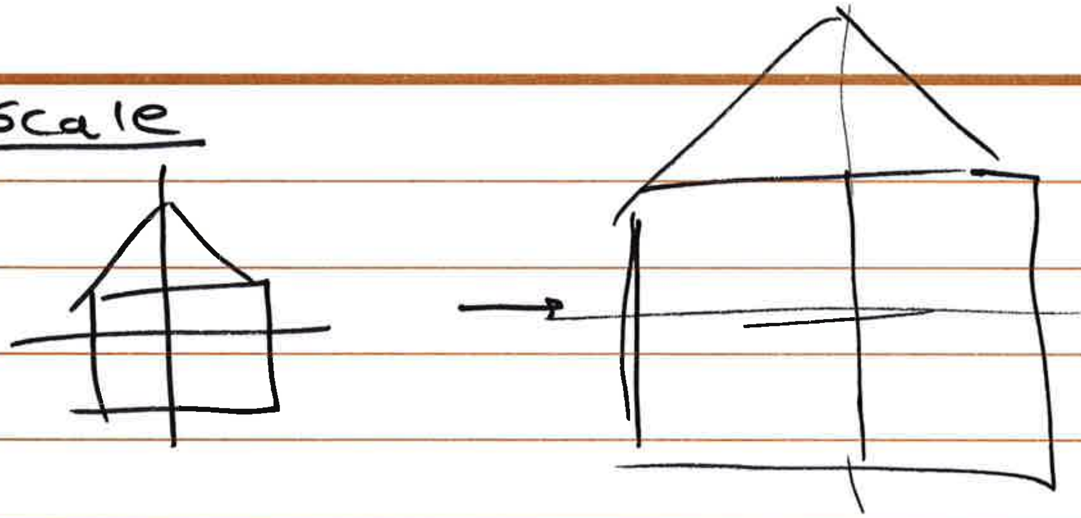
$$s(3) = \alpha_1 s(2) + \alpha_2 s(1) + \alpha_3 s(0) + \cdots \alpha_p s(p-3)$$

$$\vdots$$

$$s(p) = \alpha_1 s(p-1) + \alpha_2 s(p-2) + \alpha_3 s(p-3) + \cdots \alpha_p s(0)$$

$$\begin{bmatrix} s(0) & s(1) & s(2) & \cdots & s(p-1) \\ s(1) & s(0) & s(1) & \cdots & s(p-2) \\ s(2) & s(1) & s(0) & \cdots & s(p-3) \\ \vdots & & & & \\ s(p-1) & s(p-2) & s(p-3) & \cdots & s(0) \end{bmatrix} \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \vdots \\ \alpha_p \end{bmatrix} = \begin{bmatrix} s(1) \\ s(2) \\ \vdots \\ s(p) \end{bmatrix}$$

Scale



$$\begin{bmatrix} x_i' \\ y_i' \end{bmatrix} = \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix} \begin{bmatrix} x_i \\ y_i \end{bmatrix}$$

$$x_i' = s_x \cdot x_i$$

$$y_i' = s_y \cdot y_i$$

homogeneous

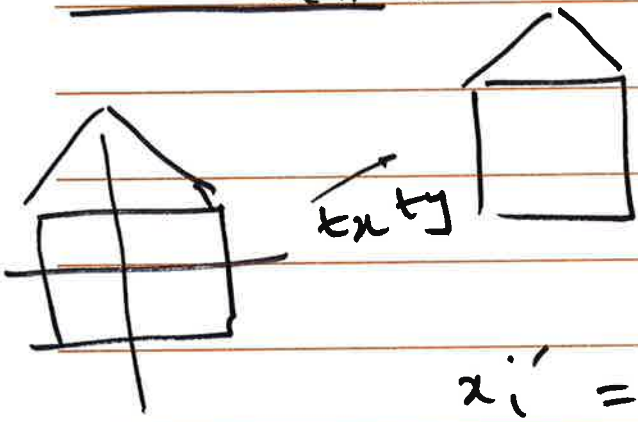
$$\begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} s_x & 0 & 1 \\ 0 & s_y & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_i \\ y_i \\ 1 \end{bmatrix}$$

$$\ldots T R S T \cdot P$$

Translation

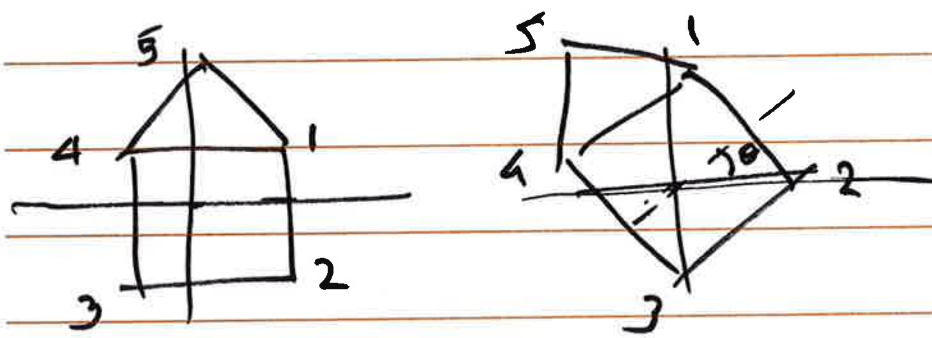


$$\begin{bmatrix} x_i' \\ y_i' \end{bmatrix} = \begin{bmatrix} x_i \\ y_i \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}$$

$$x_i' = x_i + t_x$$

$$y_i' = y_i + t_y$$

Rotation



$$\begin{bmatrix} x_i' \\ y_i' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x_i \\ y_i \end{bmatrix}$$

$$x_i' = x_i \cos\theta - y_i \sin\theta$$

$$y_i' = x_i \sin\theta + y_i \cos\theta$$

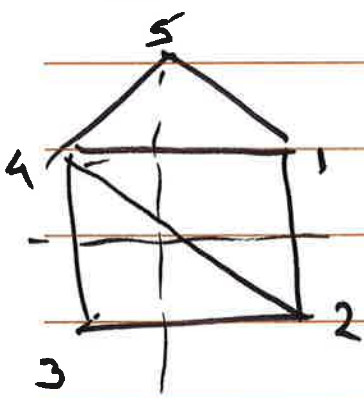
3D compression

vertices — faces

x y

0	$x_1\ y_1\ z_1$	$f_1 \langle 0\ 1\ 2 \rangle$
1	$x_2\ y_2\ z_2$	$f_2 \langle 1\ 6\ 7 \rangle$
⋮		
n	$x_n\ y_n\ z_n$	

2D representation



		faces
1	$x_1\ y_1$	$f_1 \langle 1\ 4\ 5 \rangle$
2	$x_2\ y_2$	$f_2 \langle 1\ 4\ 2 \rangle$
3	$x_3\ y_3$	$f_3 \langle 4\ 3\ 2 \rangle$
4	$x_4\ y_4$	

space requirements

1 $x_1\ y_1\ z_1$ $f_1 \langle i_1\ i_2\ i_3 \rangle$

2 $x_2\ y_2\ z_2$ $f_2 \langle i_3\ i_4\ i_5 \rangle$

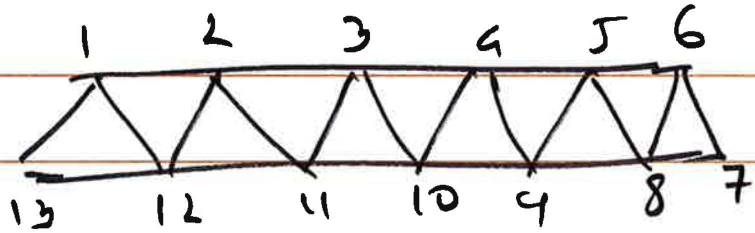
⋮ ⋮

n $x_n\ y_n\ z_n$ f

each coordinate as a "float"

$96n + 6n \log n$

tri strips



$f \langle 1\ 12\ 13 \rangle$ 13 1 12 2 11 3

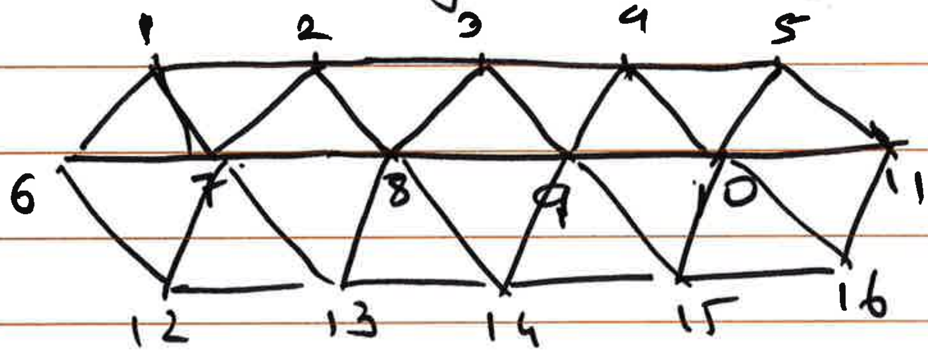
$f \langle 1\ 2\ 12 \rangle$ 10 4 9 5 8

$f \langle 2\ 12\ 11 \rangle$ 6 7

$f \langle 2\ 11\ 3 \rangle$

⋮

connectivity encoding

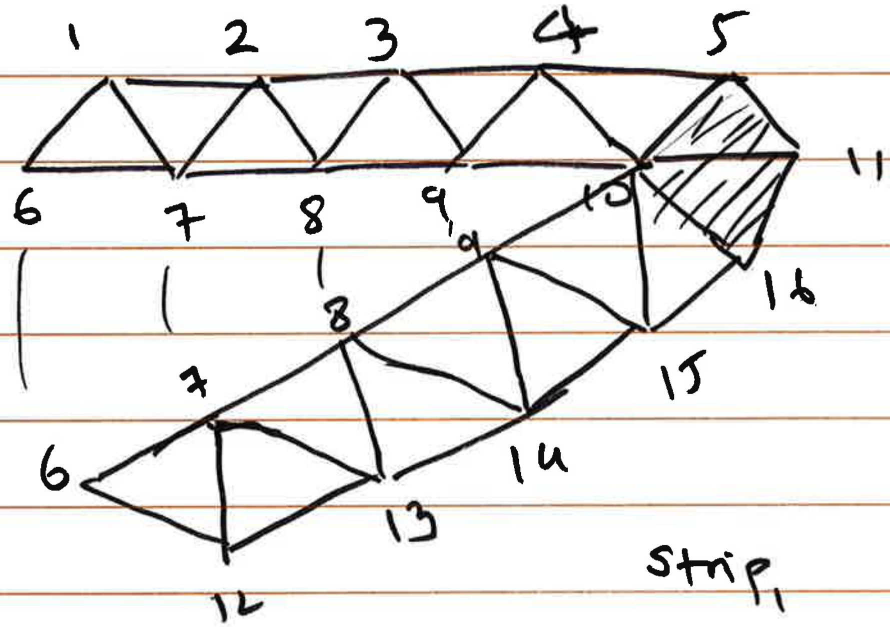


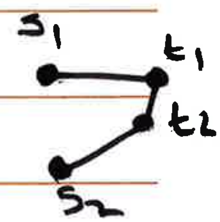
v_1 f_1 <1 6 7>

v_2 f_2 <1 2 7>

⋮ ⋮

v_{16} f_{18} <6 7 12> 56 bits





$strip_1$ 10

$strip_2$ 10

t_1 3

t_2 3