With usual notations, the control input plan is determined by optmising the objective function:

$$J = \sum_{i=1}^{p} \left(Y_{k+i}^{ref} - \hat{Y}_{k+i/k}\right)^T Q^y \left(Y_{k+i}^{ref} - \hat{Y}_{k+i/k}\right) + \sum_{j=0}^{m-1} u_{m+j}^T Q^u u_{m+j}$$

The prediction at k+i time step can be written as:

$$\begin{aligned}
\hat{Y}_{k+i/k} &= CA^i \hat{X}_{k/k} + CA^{i-1}Bu_k + CA^{i-2}Bu_{k+1} + \ldots + CA^0 Bu_{k+i-1} \\
&= CA^i \hat{X}_{k/k} + \begin{bmatrix} CA^{i-1}B & CA^{i-2}B & \ldots & CA^0 B \end{bmatrix} \begin{bmatrix} u_k \\ u_{k+1} \\ \vdots \\ u_{k+i-1} \end{bmatrix} \\
&= CA^i \hat{X}_{k/k} + CAB_i \begin{bmatrix} u_k \\ u_{k+1} \\ \vdots \\ u_{k+m-1} \end{bmatrix} \\
&= CA^i \hat{X}_{k/k} + CAB_i U
\end{aligned}$$

where,

$$CAB_i = \begin{cases} \begin{bmatrix} CA^{i-1}B & CA^{i-2}B & \ldots & CA^0 B & 0 & 0 & \ldots & 0 \end{bmatrix}_{1\times m} & i \leq m \\ \begin{bmatrix} CA^{i-1}B & CA^{i-2}B & \ldots & CA^{i-m+1}B & C\left(A^0 + A^1 + \ldots + A^{(i-m)}\right)B \end{bmatrix}_{1\times m} & i > m \end{cases}$$

Using this, the objective function can be written in the form below

$$J = \frac{1}{2} U^T H U + f^T U + K$$

where,

$$\begin{aligned}
H &= CAB_i^T Q^y CAB_i + \begin{bmatrix} Q^u & 0 & \cdots & 0 \\ 0 & Q^u & \cdots & 0 \\ \vdots & \vdots & \ddots & 0 \\ 0 & 0 & \cdots & Q^u \end{bmatrix}_{m\times m} \\
f^T &= \hat{X}_{k/k}^T \left(A^i\right)^T C^T Q^y CAB_i - \left(Y_{k+i}^{ref}\right)^T Q^y CAB_i
\end{aligned}$$

U is then solved for using the matlab function quadprog.