Let

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix}, \quad M = \begin{bmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{bmatrix}$$

The convolution of A by M is given by

$$A' = \begin{bmatrix} a'_{11} & a'_{12} & a'_{13} & a'_{14} \\ a'_{21} & a'_{22} & a'_{23} & a'_{24} \\ a'_{31} & a'_{32} & a'_{33} & a'_{34} \\ a'_{41} & a'_{42} & a'_{43} & a'_{44} \end{bmatrix}$$

where

$$\begin{aligned} a'_{11} &= \cdots \\ &\vdots \\ a'_{33} &= \frac{m_{11}a_{22} + m_{12}a_{23} + m_{13}a_{24} + m_{21}a_{32} + m_{22}a_{33} + m_{23}a_{34} + m_{31}a_{42} + m_{32}a_{43} + m_{33}a_{44}}{m_{11} + m_{12} + m_{13} + m_{21} + m_{22} + m_{23} + m_{31} + m_{32} + m_{33}} \\ a'_{34} &= \frac{m_{11}a_{23} + m_{12}a_{24} + m_{21}a_{33} + m_{22}a_{34} + m_{31}a_{43} + m_{32}a_{44}}{m_{11} + m_{12} + m_{21} + m_{22} + m_{31} + m_{32}} \\ &\vdots \\ a'_{44} &= \frac{m_{11}a_{33} + m_{12}a_{34} + m_{21}a_{43} + m_{22}a_{44}}{m_{11} + m_{12} + m_{21} + m_{22}} \end{aligned}$$