ä½ å¥½ï¼Œæˆ'æ˜¯æœ±ç»´å˜šã€‚æ¬¢è¿Žä½ ç»§ç»è·Ÿæˆ'å¦ä¹ ç'¿æ€§ä»£æ•°ï¼Œä»Šå¤©æˆ'è¦è®²çš„å†…å®¹æ˜¯â€œå¦‚ä½•é€šè¿‡çŸ©é˜µè½¬æ¢è®©3Då›¾å½¢æ˜¾ç¤ºåˆ°äºŒç»´å±å¹•ä¸Šâ€ã€‚

åœ¨ç¬¬å…«ç¯‡çš„[ç'¿æ€§æ˜ å°„](#)ä¸ï¼Œæˆ'ä»¬äºŒç»´ç›´è§'æ ‡ç³»çš„è§'åº¦ï¼Œè®²è§£äº†ç'¿æ€§æ˜ å°„ï¼Œå'Œå˜æ¢çŸ©é˜µã€‚å…¶ä¸ï¼Œæˆ'ç‰¹å«è®²åˆ°äº†ï¼ŒäºŒç»´å¹³é¢å›¾å½¢å›¾å½¢å¤„ç†ä¸çš„ç'¿æ€§å˜æ¢ï¼Œæ¯"å¦‚ç‰©ä½"çš„æ‹‰ä¼¸ã€å'Œæ—‹è½¬ã€‚åœ¨ç¬¬ä¹ç¯‡çš„[ä»¿å°„ç©ºé—´](#)ä¸ï¼Œæˆ'æ˜¯æ å°„äº†3Dçš„å¹³ç§»çŸ©é˜µã€ç¼©æ"¾çŸ©é˜µå'Œæ—‹è½¬çŸ©é˜µã€‚

è€Œè¿™ä¸€ç¯‡å°±æ˜¯æœ‰ä¸ä¸€æ ·ï¼Œæˆ'ä¼šä»Žæ›´å®žè·µçš„è§'åº¦ï¼Œè®©ä½ ä»†è§£åˆ°äºŒç»´å¹³é¢å'Œä¸‰ç»´ç©ºé—´çš„å˜æ¢ï¼Œä»¥åŠ3Då›¾å½¢æ˜¾ç¤ºåˆ°äºŒç»´å±å¹•ä¸Šçš„ã€‚çŸ©é˜µåœ¨è¿™é‡Œæ‰®æ¼"çš„è§'è‰²å¯ä»¥è¯´æ˜¯å'Ÿä¸å¯æ²¡ï¼ŒæŽ¥ä¸‹æ¥æˆ'ä»¬ä¸€èµ·æ¥çœ‹ä¸‹çŸ©é˜µåˆ°åº•æ˜¯æ€Žä¹ˆåšåˆ°çš„ã€‚

ä¸‰ç»´ç©ºé—´å˜æ¢

æˆ'ä»¬éƒ½çŸ¥é"ï¼Œè®¡ç®—æœºå›¾å½¢å›¾åƒå¤„ç†çš„æ˜¯å›¾ç‰‡ï¼Œ"è®¡ç®—æœºå±å¹•æ˜¯äºŒç»´çš„ã€‚é‚£ä½ æœ‰æ²¡æœ‰æƒ³è¿‡ï¼Œæˆ'ä»¬åœ¨å±å¹•ä¸Šçœ‹åˆ°çš„ç™½æ€å'ŒåŠ¨æ€ä¸‰ç»´ä¸–ç•Œåˆ°åº•æ˜¯æ€Žä¹ˆåšåˆ°çš„ï¼Ÿè¿™ä¸ªå°±è¦æ¶‰åŠåˆ°ä¸‰ç»´åˆ°äºŒç»´çš„æŠ•å½±æŠ€æœ¯äº†ï¼Œè¿™ç±»æŠ€æœ¯éƒ½ç¦»ä¸å¼€çŸ©é˜µï¼Œè€Œä¸"æ˜¯è¶…å¤§è§„æ¨¡çŸ©é˜µè¿ç®—ã€‚

ä¸‰ç»´ç©ºé—´çš„å˜æ¢ä¾èµ–äºŽ4Ã—4çŸ©é˜µï¼Œå¯è ƒä½ ä¼šæƒ³ï¼Œä¸ºä»€ä¹ˆæ˜¯3Ã—3å'¢ï¼Ÿè¿™æ˜¯å› ä¸ºå›ä¸ªå…³é"®è¿ç®——ä¸æœ‰ä¸€ä¸ªæ— æ³•ç"¨3Ã—3çŸ©é˜µæ¥å®Œæˆï¼Œå…¶ä»–ä¸‰ä¸ªè¿ç®——ä¸ºäº†ç»Ÿä¸€èµ·æ¥å°±éƒ½ç"¨äº†4Ã—4çŸ©é˜µäº†ï¼Œè¿™å›ä¸ªå…³é"®è¿ç®——æ˜¯ï¼š

- å¹³ç§»ï¼›
- ç¼©æ"¾ï¼›
- æ—‹è½¬ï¼›
- æŠ•å½±ã€‚

å¹³ç§»å°±æ˜¯é‚£ä¸ªæ— æ³•ç"¨3Ã—3çŸ©é˜µæ¥å®Œæˆçš„ç‰¹æ®Šè¿ç®——ï¼Œä¹Ÿæ˜¯çœ‹èµ·æ¥æœ€ç®€å•çš„è¿ç®——ï¼Œåªæ˜¯æ¯ä¸ªç¹é‚£åŠ ä¸Šå'é‡v_{0}ï¼Œä¹Ÿå°±æ˜¯ç¹(x_{0},y_{0},z_{0})ã€‚

ä½†æ˜¯ï¼Œä½ å^«è¢«è¿™ä¸ªå‡è±¡æ¬ºéª—äº†ï¼Œå¹³ç§»è¿™ä¸ªè¿ç®——æ˜¯éžç'¿æ€§çš„ã€‚è¿™ä¸€ç¹é€šè¿‡çœ‹å¹³ç§»å‰å'Œç¹ä¸ŽåŽŸç¹çš„è¿žç'¿ï¼Œä»¥åŠå¹³ç§»åŽå'Œç¹ä¸ŽåŽŸç¹ä¹‹é—´çš„è¿žç'¿å°±çŸ¥é"äº†ã€‚æˆ–è€……ï¼Œä½ ä¹Ÿå¯ä»¥ä»Žå…¬å¼ä¸Šçœ‹ï¼Œè§'åº¦ç†è§£ï¼Œå°±æ˜¯$f(a+b)$ä¸ç‰ä ŽŽ$f(a)+f(b)$ã€‚è€Œä¸ºäº†è§£å†³å¹³ç§»ï¼Œä»¥åŠçŽ°å®žä¸–ç•Œçš„æ›´è¿ç"¨ï¼Œå°±éœ€è¦ä½¿ç"¨ç¬¬ä¹ç¯‡ä¸è¯´çš„[ä»¿å°„ç©ºé—´](#)ã€‚æ‰€ä»¥ï¼Œ3Ã—3çŸ©é˜µæ˜¯æ— æ³•å¹³ç§»åŽŸç¹çš„ã€‚

ä½†æ˜¯ï¼Œå¦‚æžœæˆ'ä»¬æŠŠåŽŸç¹å˜æˆ$(0,0,0,1)$ï¼Œé‚£å°±è§£å†³äº†å¹³ç§»çš„é—®é¢˜äº†ã€‚ç¹(x,y,z)çš„é½æ¬¡å'æ ‡å°±æ˜¯$(x,y,z,1)$ï¼Œè¿™å°±å˜æˆäº†4Ã—4çŸ©é˜µã€‚æŽ¥ä¸‹æ¥ï¼Œæˆ'å†å‹ä½ç»è¿™å›ä¸ªå…³é"®è¿ç®——ï¼Œå®ƒä»¬æ˜¯3Då›¾å½¢æ˜¾ç¤ºåœ¨å±å¹•ä¸Šçš„ç¬¬ä¸€æ¥ï¼Œä¹Ÿå°±æ˜¯å½±ç›¸åˆ°å'æ ‡ç³»ï¼Œå'Œæ˜¯ä¸ªæŠ•å½±å'æ ‡…ï¼Œæ¯"å¦‚ï¼šå°†ä¸€ä¸ªç¹ä»ŽåŽŸå'æ ‡ç³»åœ¨è¿ç®—æ ‡ç³»æ˜¯é€šè¿‡å¹³ç§»ã€ç¼©æ"¾åŠæ—‹è½¬çŸ©é˜µè¿›è¡Œçš„ã€‚

å¹³ç§»

æˆ'ä»¬æ²¿ç€å'é‡v_{0}å¹³ç§»æ•´ä¸ªä¸‰ç»´ç©ºé—´ï¼ŒæŠŠåŽŸç¹å¹³ç§»åˆ°äº†(x_{0},y_{0},z_{0})ï¼Œè¿™ä¹Ÿå°±æ„å'³ç€ä¸‰ç»´ç©ºé—´çš„æ¯ä¸ªç¹éƒ½åŠ ä¸Šäº†ç¹(x_{0},y_{0},z_{0})ã€‚ä½¿ç"¨é½æ¬¡å'æ ‡ï¼ŒæŠŠæ•´ä¸ªç©ºé—´å¹³ç§»äº†v_{0}çš„4Ã—4çŸ©é˜µTå¦‚ä¸‹æ‰€ç¤ºã€‚

$$
T=\left[\begin{array}{llll}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
x_{0} & y_{0} & z_{0} & 1
\end{array}\right]
$$

è¿™é‡Œå¾ˆé‡è¦çš„ä¸€ç¹æ˜¯ï¼Œè®¡ç®—æœºå›¾å½¢å›¾åƒæ˜¯åŸºäºŽè¡Œå'é‡è®¡ç®—çš„ã€‚ä¹Ÿå°±æ˜¯è¯´ï¼Œè®¡ç®—æ–¹æ³•æ˜¯è¡Œä¹˜çŸ©é˜µï¼Œè€Œä¸æ˜¯çŸ©é˜µä¹˜åˆ—ï¼Œæ¯"å¦‚ï¼š$\left[\begin{array}{llllllll}0 & 0 & 0 & 1\end{array}\right] T=\left[\begin{array}{llll}x_{0} & y_{0} & z_{0} & 1\end{array}\right]$ã€‚

å¹³ç§»çš„æ•´ä¸ªè¿‡ç¨‹æ˜¯è¿™æ ·çš„ï¼šå‡è®¾è¦æŠŠåŽŸæ¥çš„æŸä¸ªç¹(x,y,z)å¹³ç§»v_{0}ï¼Œæˆ'ä»¬é¦–å…ˆæŠŠå®ƒå˜æˆé½æ¬¡å'æ ‡$(x,y,z,1)$ï¼Œç„¶åŽï¼Œ$(x,y,z,1)$å†ä¹˜Tï¼Œå°±è½¬åŒ–åˆ°æ˜¯ä¸ªåŽŸæ¥çš„å'é‡vå¹³ç§»åˆ°$v+v_{0}$çš„ç»ˆæ€ç»"æžœï¼š$\left[\begin{array}{llll}x & y & z & 1\end{array}\right] T=\left[\begin{array}{lllll}x+x_{0} & y+y_{0} & z+z_{0} & 1\end{array}\right]$ã€‚

è¿™é‡Œä½ éœ€è¦æ³¨æ„ï¼šä¸€ä¸ªè¡Œå'é‡ä¹˜Tçš„ç»"æžœè¿˜æ˜¯ä¸€ä¸ªè¡Œå'é‡ã€‚

ç¼©æ"¾

åœ¨å‰ç«¯å¼€å'ä¸ï¼Œæˆ'ä»¬ç»å¸¸ä¼šè°ƒæ•´å›¾ç‰‡å¤§å°ä»¥é€‚åº"å¹³å°ï¼Œæ¯"å¦‚ï¼šå®½åº¦å'Œé«˜åº¦å'Œæˆ'ä»¬æƒ³è¦æŠŠå›¾ç‰‡ç¼©æ"¾åˆ°90%ï¼Œé‚£ä¹ˆåœ¨çº¿æ€§ä»£æ•°ä¸å°±æ˜¯0.9ä¹˜å•ä½çŸ©é˜µã€‚åœ¨äºŒç»´å¹³é¢ä¸ï¼Œæˆ'ä»¬é€šå¸¸ç"¨2Ã—2çŸ©é˜µæ¥è¡¨è¾¾ç¼©æ"¾ï¼Œåœ¨ä¸‰ç»´ç©ºé—´ä¸åˆ™æ˜¯3Ã—3çŸ©é˜µã€‚è€Œåœ¨è®¡ç®—æœºå›¾å½¢å›¾åƒçš„é½æ¬¡å'æ ‡ä¸ï¼Œå°±ä¸ä¸€æ ·äº†ï¼Œéœ€è¦å¤šä¸€ä¸ªç»´åº¦ï¼Œä¹Ÿå°±æ˜¯è ´ï¼Œ3Ã—3çŸ©é˜µå˜æˆäº†4Ã—4çŸ©é˜µã€‚

æ¯"å¦‚ï¼Œä¸ºäºŒç»´å¹³é¢å›¾ç‰‡æ"¾å¤§90%å°±æ˜¯ï¼š

$$
S=\left[\begin{array}{ccc}
0.9 & 0 & 0 \\
0 & 0.9 & 0 \\
0 & 0 & 1
\end{array}\right]
$$

ä¸‰ç»´ç«‹ä½"å›¾ç‰‡æ"¾å¤§90%å°±æ˜¯ï¼š

$$
S=\left[\begin{array}{cccc}
0.9 & 0 & 0 & 0 \\
0 & 0.9 & 0 & 0 \\
0 & 0 & 0.9 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]
$$

ç¼©æ"¾è¿˜å¯ä»¥åœ¨ä¸åŒçš„æ–¹å'ä¸Šè¿›è¡Œï¼Œæ¯"å¦‚ï¼šä¸€ä¸ªäºŒç»´å¹³é¢å›¾ç‰‡ä»Žæ•´é¡µé€‚é…è°ƒæ•´åˆ°åŠé¡µé€‚é…ï¼Œyæ–¹å'å°±è¦ä¹˜$\frac{1}{2}$ï¼Œå½¢æˆä¸€ä¸ª$\frac{1}{4}$çš„é¡µè¾¹ç•™ç™½ï¼Œxæ–¹å'å°±è¦ä¹˜$\frac{3}{4}$ï¼Œè¿™æ ·å¾—åˆ°çš„ç¼©æ"¾çŸ©é˜µå°±æ˜¯ï¼š

$$
S=\left[\begin{array}{lll}
\frac{3}{4} & 0 & 0 \\
0 & \frac{1}{2} & 0 \\
0 & 0 & 1
\end{array}\right]
$$

å¹³ç§»å'Œç¼©æ"¾ç»„åˆæƒ…å†µä¸‹ï¼šæ€Žæ ·å'¢ï¼Ÿå¦‚æžœæˆ'ä»¬è¦å…ˆå¹³ç§»å†ç¼©æ"¾ï¼Œé‚£å°±è¦è¿™æ ·ä¹˜ï¼švTSï¼Œå¦‚æžœæˆ'ä»¬è¦å…ˆç¼©æ"¾å†å¹³ç§»ï¼Œé‚£å°±è¦è¿™æ ·ä¹˜ï¼švSTã€‚æ³¨æ„ï¼šå®ƒä»¬ä¹˜çš„é¡ºåºæ˜¯ä¸ä¸€æ ·çš„ï¼Œå'ªä¸ªè¿ç®——å…ˆåšå°±å…ˆä¹˜ï¼Œå› ä¸ºçŸ©é˜µçš„å·¦ä¹˜å'Œå³ä¹˜çš„ç»"æžœæ˜¯ä¸ä¸€æ ·çš„ã€‚

åœ¨ç¬¬ä¹ç¯‡çš„[ä»¿å°„ç©ºé—´](#)ä¸æåˆ°äº†å¹³ç§»å'Œç¼©æ"¾çŸ©é˜µï¼Œä½ ä¹Ÿå¯ä»¥å›žè¿‡å¤´åŽ»å›žé¡¾ç»ƒç»ƒã€‚

æ—‹è½¬

äºŒç»´å'Œä¸‰ç»´ç©ºé—´çš„æ—‹è½¬ç"±æ£äº¤çŸ©é˜µQæ¥å®Œæˆï¼Œå®ƒçš„è¡Œå—å¼æ˜¯+1ã€‚åŒæ ·æˆ'ä»¬ä½¿ç"¨é½æ¬¡å'æ ‡ï¼Œä¸€ä¸ªå¹³é¢æ—‹è½¬çš„æ£äº¤çŸ©é˜µQå°±ä»Ž2Ã—2å°±å˜æˆäº†3Ã—3çŸ©é˜µRã€‚

$$
Q=\left[\begin{array}{cc}
\cos \theta & -\sin \theta \\
\sin \theta & \cos \theta
\end{array}\right]
$$

$$
R=\left[\begin{array} {ccc}
\cos \theta & -\sin \theta & 0 \\
\sin \theta & \cos \theta & 0 \\
0 & 0 & 1
\end{array}\right]
$$

è¿™ä¸ªçŸ©é˜µæ˜¯å›´ç»•åŽŸç‚¹æ—‹è½¬äº†å¹³é¢ï¼Œé‚£å¦‚æžœçŸ©é˜µæ—‹è½¬æ—¶å›´ç»•çš„ä¸æ˜¯åŽŸç‚¹ï¼Œè€Œæ˜¯å…¶ä»–ç‚¹å‘¢ï¼Ÿè¿™ä¸ªå°±ç¨å¾®å¤æ‚ä¸€äº›ï¼Œä¸æ˜¯ç›´æŽ¥æ—‹è½¬ï¼Œè€Œæ˜¯å…ˆå¹³ç§»å†æ—‹è½¬ï¼Œæ¯”å¦‚æˆ‘ä»¬è¦å›´ç»•ç‚¹$(4,5)$ï¼Œè®©å¹³é¢æ—‹è½¬θè§’åº¦çš„è¯ï¼š

1. é¦–å…ˆï¼Œè¦æŠŠ$(4,5)$å¹³ç§»åˆ°$(0,0)$ï¼›
2. æŽ¥ç€ï¼Œæ—‹è½¬θè§’åº¦ï¼›
3. æœ€åŽï¼Œå†æŠŠ$(0,0)$å¹³ç§»å›ž$(4,5)$ã€‚

æ•´ä¸ªè¿‡ç¨‹é€šè¿‡æ•°å¦å…¬å¼æ¥è¡¨è¾¾å°±æ˜¯ï¼š

$$
v T_{00} R T_{45}=\left[\begin{array} {lll}
x & y & 1
\end{array}\right]\left[\begin{array} {ccc}
1 & 0 & 0 \\
0 & 1 & 0 \\
-4 & -5 & 1
\end{array}\right]\left[\begin{array} {ccc}
\cos \theta & -\sin \theta & 0 \\
\sin \theta & \cos \theta & 0 \\
0 & 0 & 1
\end{array}\right]\left[\begin{array} {ccc}
1 & 0 & 0 \\
0 & 1 & 0 \\
4 & 5 & 1
\end{array}\right]
$$

è¯´å®Œäº†ç»´æˆ‘ä»¬å†æ¥è¯´ä¸‰ç»´ã€‚ä¸è¿‡åœ¨ä¸‰ç»´ç©ºé—´ä¸ï¼Œæ—‹è½¬å°±æœ‰äº›ä¸ä¸€æ ·äº†ï¼Œå› ä¸ºå®ƒæ˜¯å›´ç»•ä¸€ä¸ªè½´â€œç»•è½¬â€çš„ã€‚æ›´â€œæ•°å¦â€çš„è¯´æ³•å°±æ˜¯ï¼Œå›´ç»•$Î»=1$çš„ç‰¹å¾å‘é‡çš„ä¸€æ¡ç›´çº¿è½¬ã€‚

çŽ°åœ¨ï¼Œæˆ‘ä»¬æ¥çœ‹çœ‹åˆ†åˆ«å›´ç»•xã€yå’Œzè½´æ—‹è½¬çš„çŸ©é˜µRæœ‰ä»€ä¹ˆåŒºåˆ«ï¼Ÿ

1.å›´ç»•xè½´æ—‹è½¬ï¼š

$$
R_{x}=\left[\begin{array} {cccc}
1 & 0 & 0 & 0 \\
0 & \cos \theta & -\sin \theta & 0 \\
0 & \sin \theta & \cos \theta & 0 \\
0 & 0 & 0 & 1
\end{array}\right]
$$

2.å›´ç»•yè½´æ—‹è½¬ï¼š

$$
R_{y}=\left[\begin{array} {cccc}
\cos \theta & 0 & \sin \theta & 0 \\
0 & 1 & 0 & 0 \\
-\sin \theta & 0 & \cos \theta & 0 \\
0 & 0 & 0 & 1
\end{array}\right]
$$

3.å›´ç»•zè½´æ—‹è½¬ï¼š

$$
R_{z}=\left[\begin{array} {cccc}
\cos \theta & -\sin \theta & 0 & 0 \\
\sin \theta & \cos \theta & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{array}\right]
$$

ä½ çœ‹å‡ºæ¥å“ªé‡Œä¸åŒäº†å—ï¼Ÿå…¶å®žä¸»è¦å°±æ˜¯1çš„ä½ç½®ä¸åŒï¼Œä»¥åŠyè½´æ—‹è½¬çš„sinäº’æ¢äº†ã€‚

æŠ•å½±

çŽ°åœ¨ï¼Œæˆ‘ä»¬æƒ³æŠŠ3Då›¾åƒæŠ•å½±åˆ°äºŒç»´å±å¹•ä¸Šï¼Œè¯¥æ€Žä¹ˆåšå‘¢ï¼Ÿ

ä»Žæ•°å¦è§’åº¦çœ‹è§£å†³æ˜¯æŠŠä¸‰ç»´å‘é‡æŠ•å½±åˆ°å¹³é¢ä¸Šã€‚åœ¨ç º¿æ€§ä»£æ•°ä¸ï¼Œæˆ‘ä»¬çœ‹åˆ°çš„å¤§éƒ¨åˆ†å¹³é¢éƒ½æ˜¯é€šè¿‡åŽŸç‚¹çš„ï¼Œä½†åœ¨çŽ°å®žç”Ÿæ´»ä¸ï¼Œå¾ˆå¤šå¹³é¢æ˜¯ä¸ä¸€æ ·çš„ã€‚ä¸ä¸ªå‡ºçŽ°çš„é—®é¢˜ï¼Œè€Œå…¶ä»–çš„å¹³é¢åˆ™æ˜¯ä»¿å°„ç©ºé—´ï¼Œå……ä½“ä»¿å°„ç©ºé—´çš„å®šä¹‰ä½ å¯ä»¥åŽ»é˜…ä¸€ä¸‹ç¬¬ä¹ç¯‡çš„å†…å®¹ã€‚

æˆ‘ä»¬å…ˆæ¥çœ‹çœ‹å¹³é¢é€šè¿‡åŽŸç‚¹çš„æƒ…况。å‡è®¾ä¸€ä¸ªé€šè¿‡åŽŸç‚¹çš„å¹³é¢ï¼Œå®ƒçš„å•ä½æ³•å‘é‡æ˜¯nï¼Œé£Žäº†å¹³é¢ä¸Šçš„å‘é‡vï¼Œæ»¡è¶³è¿™ä¸ªç‰å¼ï¼š$n^{T} v=0$ã€‚

è€ŒæŠ•å½±åˆ°å¹³é¢çš„æŠ•å½±çŸ©é˜µæ˜¯ï¼š$I-nn^{T}$ã€‚

å¦‚æžœæŠŠåŽŸæ¥çš„å‘é‡å'Œè¿™ä¸ªæŠ•å½±çŸ©é˜µç›¸ä¹˜ï¼Œå°±èƒ½æŠ•å½±è¿™ä¸ªå‘é‡ã€‚æˆ‘ä»¬å¯ä»¥ç"¨è¿™ä¸ªæŠ•å½±çŸ©é˜µæ¥éªŒè¯ä¸€ä¸‹ï¼šå•ä½æ³•å‘é‡næŠ•å½±åŽæˆä¸ºäº†0å‘é‡ï¼Œè€Œå¹³é¢å‘é‡væŠ•å½±åŽ¶è‡ªèº«ã€‚

$$
(I-n n^{T}) n=n-n(n^{T} n)=0
$$

$$
(I-n n^{T}) v=v-n(n^{T} v)=v
$$

æŽ¥ä¸‹æ¥ï¼Œæˆ‘ä»¬åœ¨é½æ¬¡åæ ‡ä¸æ¥çœ‹ä¸€ä¸‹4Ã—4çš„æŠ•å½±çŸ©é˜µï¼š

$$
P=\left[\begin{array} {lll}
& & & 0 \\
& I-n n^{T} & & 0 \\
& & & 0 \\
0 & 0 & 0 & 1
\end{array}\right]
$$

å‡è®¾çŽ°åœ¨æœ‰ä¸€ä¸ªä¸è¿‡åŽŸç‚¹çš„å¹³é¢ï¼Œv_{0}æ˜¯è¿™ä¸ªå¹³é¢ä¸Šçš„ä¸€ä¸ªç‚¹ï¼ŒçŽ°åœ¨è¦æŠŠv_{0}æŠ•å½±åˆ°è¿™ä¸ªå¹³é¢ï¼Œå°±éœ€è¦ç»åŽ†ä¸‰ä¸ªæ¥éª¤ï¼Œå’Œåˆšæ‰ä»‹ç»çš„å›´ç»•ç‚¹$(4,5)$ï¼Œè®©å¹³é¢æ—‹è½¬θè§’åº¦ç»åŽ†çš„ä¸‰ä¸ªæ¥éª¤ç±»ä¼¼ï¼š

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> ã€ŠComputer Graphics: Principles and Practice (3rd Edition)ã€‹ï¼ˆä½œè€…ï¼šHughes, Van Dam, McGuire, Skylar, Foley, Feiner, Akeleyï¼‰è¿™æœ¬ä¹¦è¢«ç§°ä¸ºæœ€æƒå¨çš„è®¡ç®—æœºå›¾å½¢å¦è®ºè‘—ä¹‹ä¸€ã€‚

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