illustrations projected on the two walls of the room that are actually video screens. The current scenario is an adventurous trip to Monsterland. A snapshot is shown in Fig. 9.

In the last scene the monsters appear and teach the children to dance—basically to perform certain movements. Using the background-subtracted modified version of the MEFs and MHIs, the room can compliment the children on well-performed moves (e.g., spinning) and then turn the control of the situation over to them: the monsters follow the children if the children perform the moves they were taught. The interactive narration coerces the children to room locations where occlusion is not a problem. Of all the vision processes required, the modified temporal template is one of the more robust. We take the ease of use of the method to be an indication of its potential.

**APPENDIX**

**IMAGE MOMENTS**

The two-dimensional \((p+q)\)th order moments of a density distribution function \(\rho(x,y)\) (e.g., image intensity) are defined in terms of Riemann integrals as:

\[
m_{pq} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} x^p y^q \rho(x,y) \, dx \, dy,
\]

for \(p, q = 0, 1, 2, \ldots \).

The central moments \(\mu_{pq}\) are defined as:

\[
\mu_{pq} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} (x - \bar{x})^p (y - \bar{y})^q \rho(x,y) \, dx \, dy,
\]

where

\[
\bar{x} = m_{10}/m_{00},
\bar{y} = m_{01}/m_{00}.
\]

It is well-known that under the translation of coordinates, the central moments do not change, and are therefore invariants under translation. It is quite easy to express the central moments \(\mu_{pq}\) in terms of the ordinary moments \(m_{pq}\). For the first four orders, we have

\[
\begin{align*}
\mu_{00} &= m_{00} = 1 \\
\mu_{10} &= m_{10} \\
\mu_{01} &= m_{01} \\
\mu_{20} &= m_{20} - \mu x^2 \\
\mu_{11} &= m_{11} - \mu \bar{y} \\
\mu_{02} &= m_{02} - \mu y^2 \\
\mu_{30} &= m_{30} - 3m_{20}\bar{x} + 2\mu x^3 \\
\mu_{21} &= m_{21} - m_{10}\bar{y} - 2m_{11}x + 2\mu x^2 y \\
\mu_{12} &= m_{12} - m_{01}\bar{x} + 2m_{11}y + 2\mu y^2 \\
\mu_{03} &= m_{03} - 3m_{02}\bar{x} + 2\mu y^3.
\end{align*}
\]

To achieve invariance with respect to orientation and scale, we first normalize for scale defining \(\eta_{pq}\):

\[
\eta_{pq} = \frac{\mu_{pq}}{(\mu_{00})^{p+q+1}},
\]

where \(\gamma = (p+q)/2 + 1\) and \(p + q \geq 2\). The first seven orientation invariant Hu moments are defined as:

\[
\begin{align*}
\nu_1 &= \eta_{20} + \eta_{02} \\
\nu_2 &= (\eta_{20} - \eta_{02})^2 + 4\eta_{11} \\
\nu_3 &= (\eta_{20} - 3\eta_{12})^2 + (3\eta_{21} - \eta_{03})^2 \\
\nu_4 &= (\eta_{20} + \eta_{02})^2 + (\eta_{21} + \eta_{10})^2 \\
\nu_5 &= (\eta_{20} - 3\eta_{12})((\eta_{20} + \eta_{12})^2 - 3(\eta_{21} + \eta_{12})) \\
&+ (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{10}) \\
&- [8\eta_{20}(\eta_{20} + \eta_{12})^2 - (\eta_{21} + \eta_{10})^2] \\
\nu_6 &= (\eta_{20} - \eta_{02})((\eta_{20} + \eta_{12})^2 - (\eta_{21} + \eta_{10})^2) \\
&+ 4\eta_{21}(\eta_{20} + \eta_{12})(\eta_{21} + \eta_{10}) \\
\nu_7 &= (3\eta_{20} - \eta_{02})(\eta_{20} + \eta_{12})((\eta_{20} + \eta_{12})^2 - 3(\eta_{21} + \eta_{12})) \\
&- (\eta_{20} - 3\eta_{12})(\eta_{20} + \eta_{12})(3(\eta_{20} + \eta_{12})^2 - (\eta_{21} + \eta_{12})^2).
\end{align*}
\]

These moments can be used for pattern identification independent of position, size, and orientation.

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**REFERENCES**

### Euclidean distance:

\[
\begin{array}{cccccc}
3 & \sqrt{8} & \sqrt{5} & 2 & \sqrt{5} & \sqrt{8} \\
\sqrt{5} & \sqrt{2} & 1 & \sqrt{2} & \sqrt{5} \\
3 & 2 & 1 & 0 & 1 & 2 & 3 \\
\sqrt{5} & \sqrt{2} & 1 & \sqrt{2} & \sqrt{5} \\
\sqrt{8} & \sqrt{5} & 2 & \sqrt{5} & \sqrt{8} \\
3 &
\end{array}
\]

### City-block distance:

\[
\begin{array}{cccccc}
3 & 3 & 3 & 3 & 3 & 3 \\
3 & 2 & 2 & 2 & 2 & 2 & 2 \\
3 & 2 & 1 & 1 & 1 & 1 & 1 \\
3 & 2 & 1 & 1 & 1 & 1 & 1 \\
3 & 2 & 1 & 1 & 1 & 1 & 1 \\
3 &
\end{array}
\]