Appendix

A   Derivation of Eq. (3)

To calculate the visibility according to Eq. (2), we need to calculate the total light intensity in the plane of the camera ($z = 0$):

$$I(x, y, t) = \int |E_1(x, y, 0, t) + E_2(x, y, 0, t)e^{i\phi_{\mathrm{piezo}}(t)}|^2 \mathrm{d}x\mathrm{d}y$$

$$= \int \left[E_1 E_1^* + E_2 E_2^* + E_1 E_2^* e^{i\phi_{\mathrm{piezo}}(t)} + E_1^* E_2 e^{i\phi_{\mathrm{piezo}}(t)} \right] \mathrm{d}x\mathrm{d}y, \qquad (5)$$

where the wave amplitudes are given by Eq. (1):

$$E_1(x, y, 0, t) = \exp\left[-\frac{(x - x_0)^2}{r^2} \right] \exp(ik_x(x - x_0)) \cdot \exp\left[-\frac{(y - y_0)^2}{r^2} \right] \exp(ik_y(y - y_0));$$

$$E_2(x, y, 0, t) = \exp\left[-\frac{x^2}{r^2} \right] \cdot \exp\left[-\frac{y^2}{r^2} \right].$$

Using the Gaussian integral $\int_{-\infty}^{+\infty} \exp(-\frac{ax^2}{2} + iJx)\mathrm{d}x = \left(\frac{2\pi}{a}\right)^{1/2} \cdot \exp(-\frac{J^2}{2a})$, we can calculate for the first two terms in Eq. (5),

$$\int_{-\infty}^{+\infty} (E_1 E_1^* + E_2 E_2^*) \, \mathrm{d}x\mathrm{d}y = 2 \int_{-\infty}^{+\infty} \exp\left(-\frac{2x^2}{r^2} \right) \mathrm{d}x \cdot \int_{-\infty}^{+\infty} \exp\left(-\frac{2y^2}{r^2} \right) \mathrm{d}y = \pi r^2, \quad (6)$$

and for the last two components,

$$\int_{-\infty}^{+\infty} (E_1 E_2^* + E_1^* E_2) \, \mathrm{d}x\mathrm{d}y =$$

$$\pi r^2 \exp\left[-\frac{(k_x^2 + k_y^2)r^2}{8} \right] \exp\left(-\frac{x_0^2 + y_0^2}{2r^2} \right) \cos\left(\frac{k_x x_0 + k_y y_0}{2} - \phi_{\mathrm{piezo}}(t) \right). \quad (7)$$

Now summing up Eqs. (6) and (7), we find

$$I_{\mathrm{tot}}(t) = \pi r^2 \left[1 + \exp\left(-\frac{(k_x^2 + k_y^2)r^2}{8} \right) \exp\left(-\frac{x_0^2 + y_0^2}{2r^2} \right) \cos\left(\frac{k_x x_0 + k_y y_0}{2} - \phi_{\mathrm{piezo}}(t) \right) \right].$$

$$(8)$$

Applying Eq. (2), and taking into account that the maximum and minimum of $I_{\mathrm{tot}}(t)$ corresponds to $\cos(\cdot) = \pm 1$, respectively, we obtain Eq. (3).

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B Additional figures

Fig. 6 shows the average action size (in units of α_{max}) during the episode as a function of step number. It is seen that in the beginning, when the setup is completely misaligned, Interferobot implements large actions. In the end, the agent performs the smallest actions to fine-tune the interferometer.
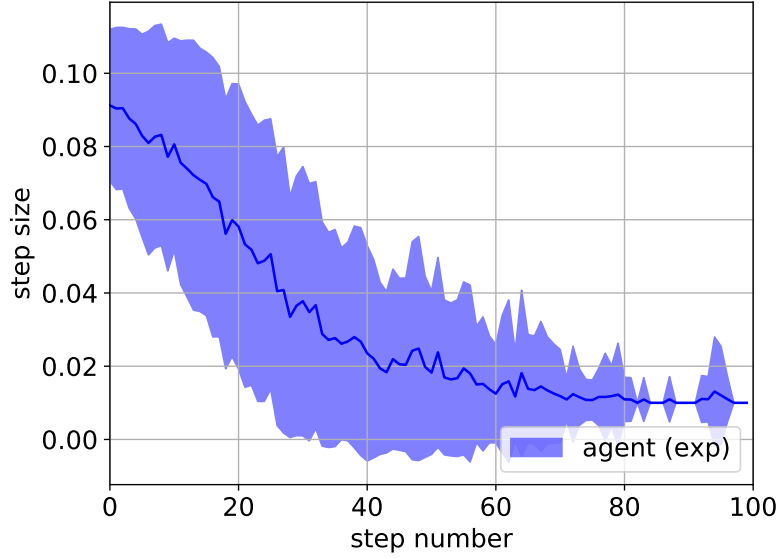
Figure 6: Agent step length averaged over 100 evaluations.

Figure 7 shows examples of interference patterns observed at the starting point of the episode before the alignment begins.

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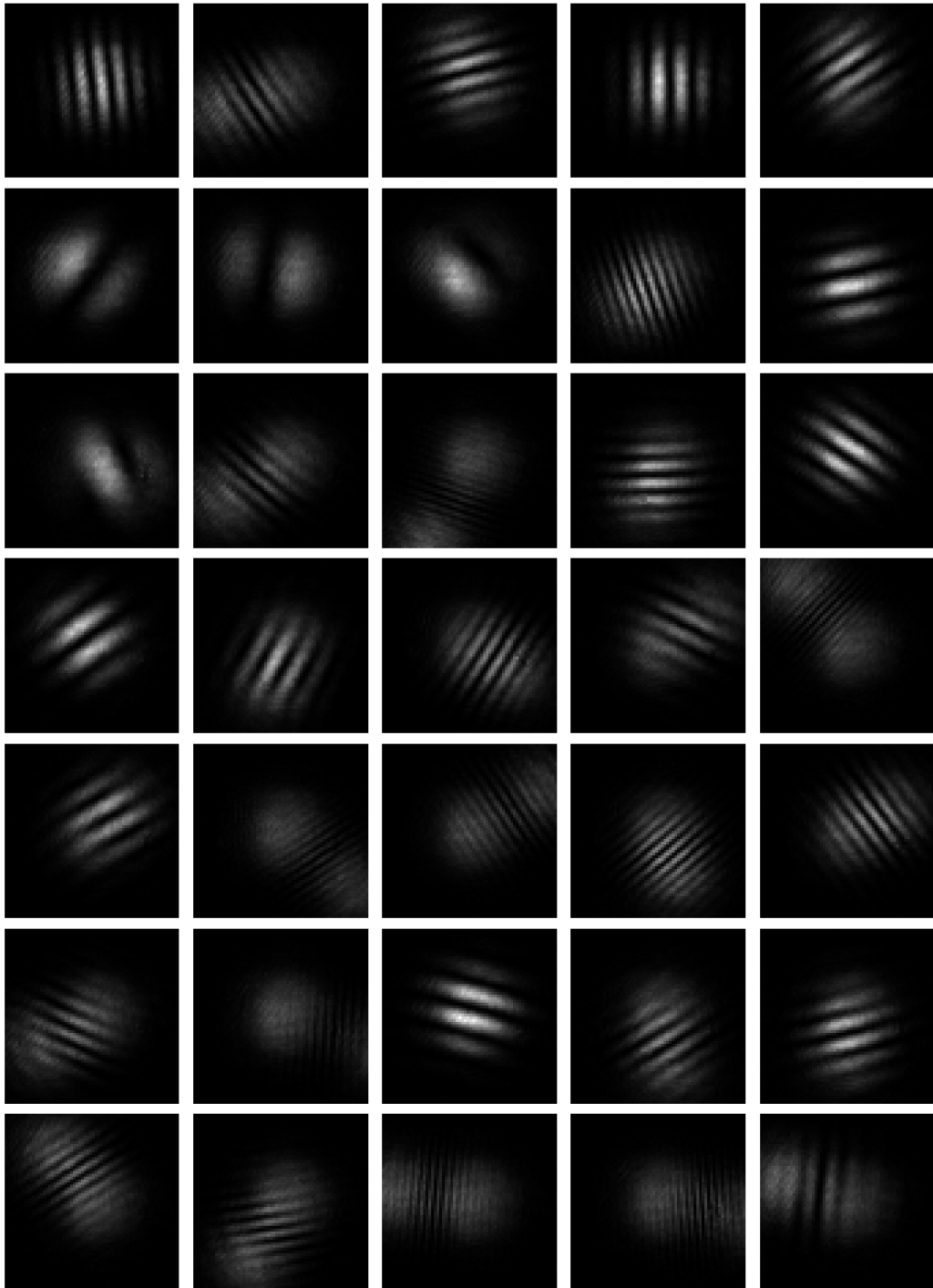
Figure 7: Examples of interference patterns experimentally observed after resets.

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