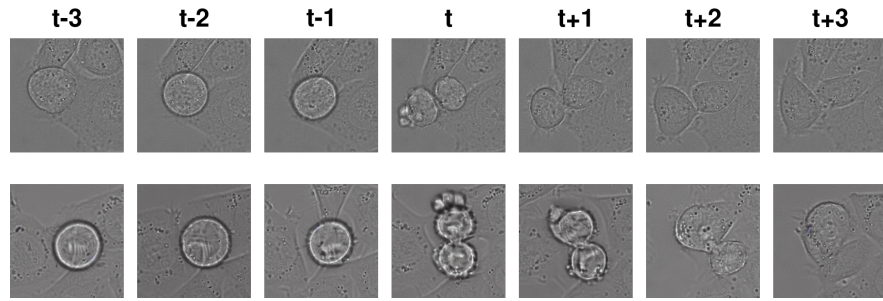


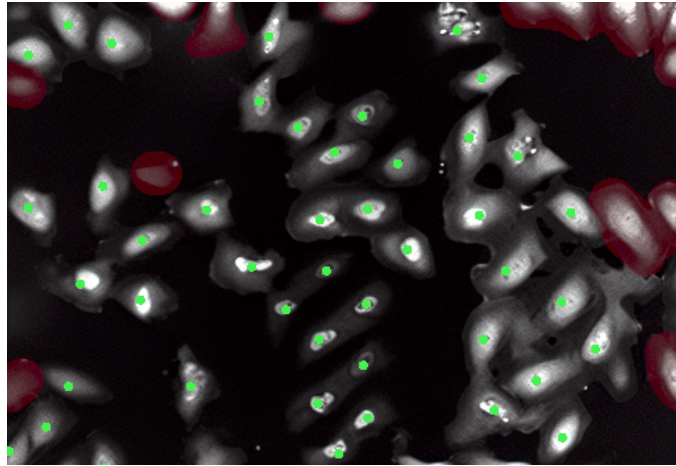
## Supplementary Material SynCellFactory

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**Fig. 1.** Comparison of real (top) and simulated mitosis (bottom). Shown here are the cell division at time  $t$ , plus three frames before and after. Key differences include the simulated cell being brighter and lacking the gradual brightness change seen in the real cell before the split. However, the model accurately simulates cell contraction at  $t - 1$  and realistic artifacts at the split. Post-split, the simulated daughter cells transition realistically from  $t + 1$  to  $t + 3$ .



**Fig. 2.** Example of cell hallucinations close to the image boundary. The network inpaints cells marked in red which do not match the conditioning shown in green.

**Table 1.** Difference in numbers of tracking mistakes with and without *SynCellFactory*.  $\Delta$ Split is the difference in splitting detection errors, the  $\Delta$ FP E represents the difference in false positive edge predictions, and  $\Delta$ FN E represents the difference in false negative edge predictions. Any value lower than zero signifies an improvement by means of *SynCellFactory*. The most notable improvements from our data augmentation are observed in resolving splitting errors and in reducing missing tracking assignments ( $\Delta$ FN E).

data set	$\Delta$ Splits	$\Delta$ FP E	$\Delta$ FN E
Fluo-C2DL-Huh7	0	-1	-1
Fluo-C2DL-MSK	0	-3	-126
DIC-C2DH-HeLa	-3	-2	-10
Fluo-N2DH-GOWT1	-13	-3	-35
Fluo-N2DL-HeLa	-10	0	-17
PhC-C2DL-PSC	-780	-14	-230
PhC-C2DH-U373	0	0	+3

**Table 2.** Parameters used for ControlNet training and sampling.  $n_{\text{cell}}$  denotes the number of cells expected in a single timeframe and determines the number of optimization steps. For example, if  $n_{\text{cell}}$  is in the order of  $10^1 - 10^2$ , we start our training procedure by training the CN-pos base model (BM) for 30000 optimizer steps. If  $n_{\text{cell}}$  is in the order of  $10^2 - 10^3$ , we train the CN-pos base model for 60000 optimizer steps. The optimizer steps for consecutive ControlNet training are denoted in the same way in this table.

Total Trainable Parameters	1.2 B
Latent Representation	shape(z) = (1,4,64,64)
Diffusion Steps	50
Optimizer	AdamW
Learning Rate	5e-6
Batch Size	4
Training BM CN-pos $n_{\text{cell}} : 10^2; 10^3$	30000; 60000 Steps
Training BM CN-mov $n_{\text{cell}} : 10^2; 10^3$	10000; 20000 Steps
Finetuning FM CN-pos $n_{\text{cell}} : 10^2; 10^3$	3000; 7000 Steps
Finetuning FM CN-mov $n_{\text{cell}} : 10^2; 10^3$	3000; 7000 Steps
Sampling Time (12 Timeframes)	$\sim 3$ min