The growth of pollen tubes is of significant interest in plant cell biology, as it provides an understanding of internal cell dynamics that affect observable structural characteristics such as cell diameter, length, and growth rate. However, these parameters can only be measured in experimental videos if the complete shape of the cell is known. The challenge is to accurately obtain the cell boundary in noisy video images. Usually, these measurements are performed by a scientist who manually draws regions-of-interest on the images displayed on a computer screen. In this paper, a new automated technique is presented for boundary detection by fusing fluorescence and brightfield images, and a new efficient method of obtaining the final cell boundary through the process of Seam Carving is proposed. This approach takes advantage of the nature of the fusion process and also the shape of the pollen tube to efficiently search for the optimal cell boundary. In video segmentation, the first two frames are used to initialize the segmentation process by creating a search space based on a parametric model of the cell shape. Updates to the search space are performed based on the location of past segmentations and a prediction of the next segmentation. Experimental results show comparable accuracy to a previous method, but significant decrease in processing time. This has the potential for real time applications in pollen tube microscopy.