

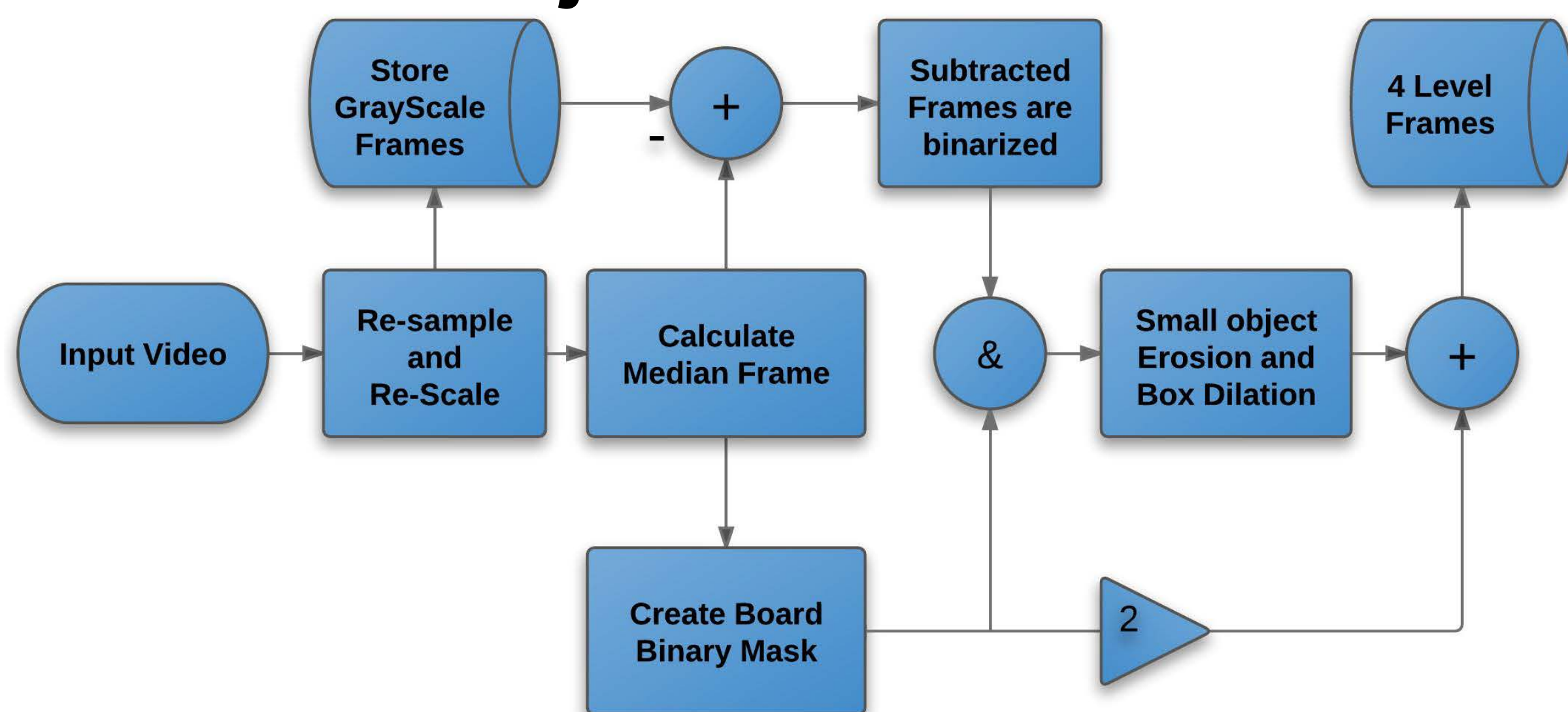
Whiteboard Disclosure using Background Subtraction and Object Tracking

Bongsoo Suh, Alex Gonzalez, Eun Soo Choi
Department of Electrical Engineering, Stanford University

Motivation and Goal

- Online video lectures are very common.
- The lecturer frequently blocks our view to the whiteboard information.
- Our goal is to reconstruct the whiteboard to provide the full information to viewers.

Object Detection



- A reliable background is obtained through the median frame. Other methods of background subtraction like frame by frame subtraction, mixture of Gaussians, and high pass filtering were not as effective.
- The object is then detected by subtracting each frame with the median. Since for this application an exact shape is not needed and because the result is a noisy estimate, we perform a box dilation.
- For each frame a four-level-image is constructed : background, object, board, board plus object

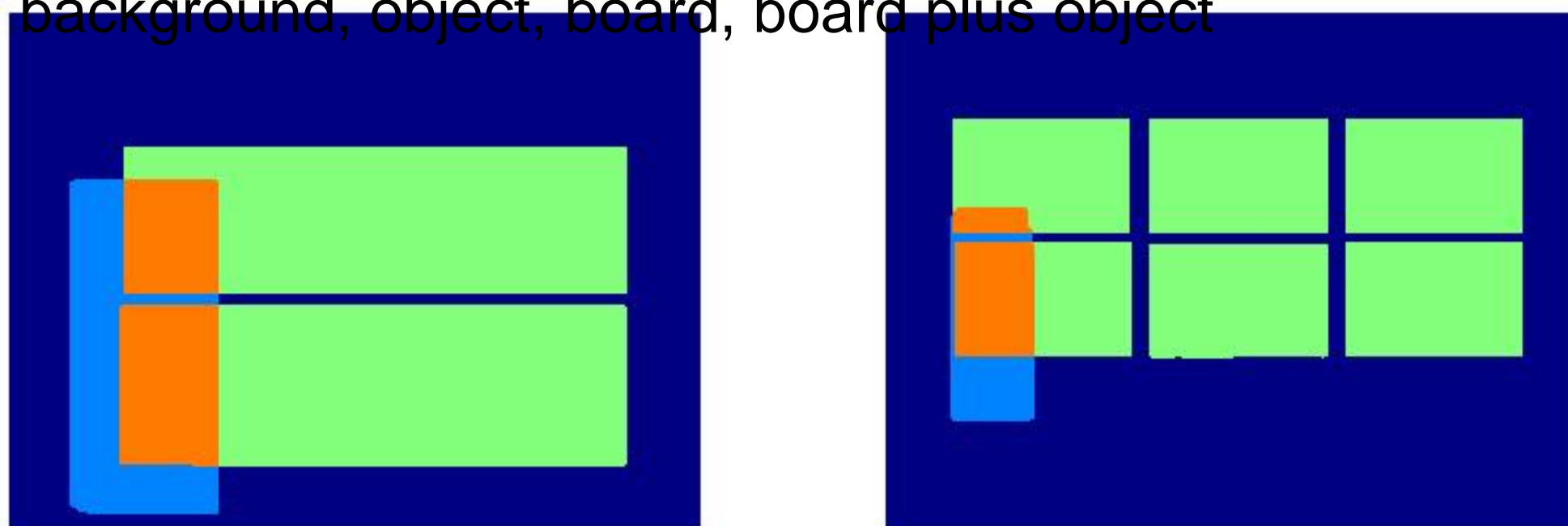


Figure 1. Four-level-image

Results

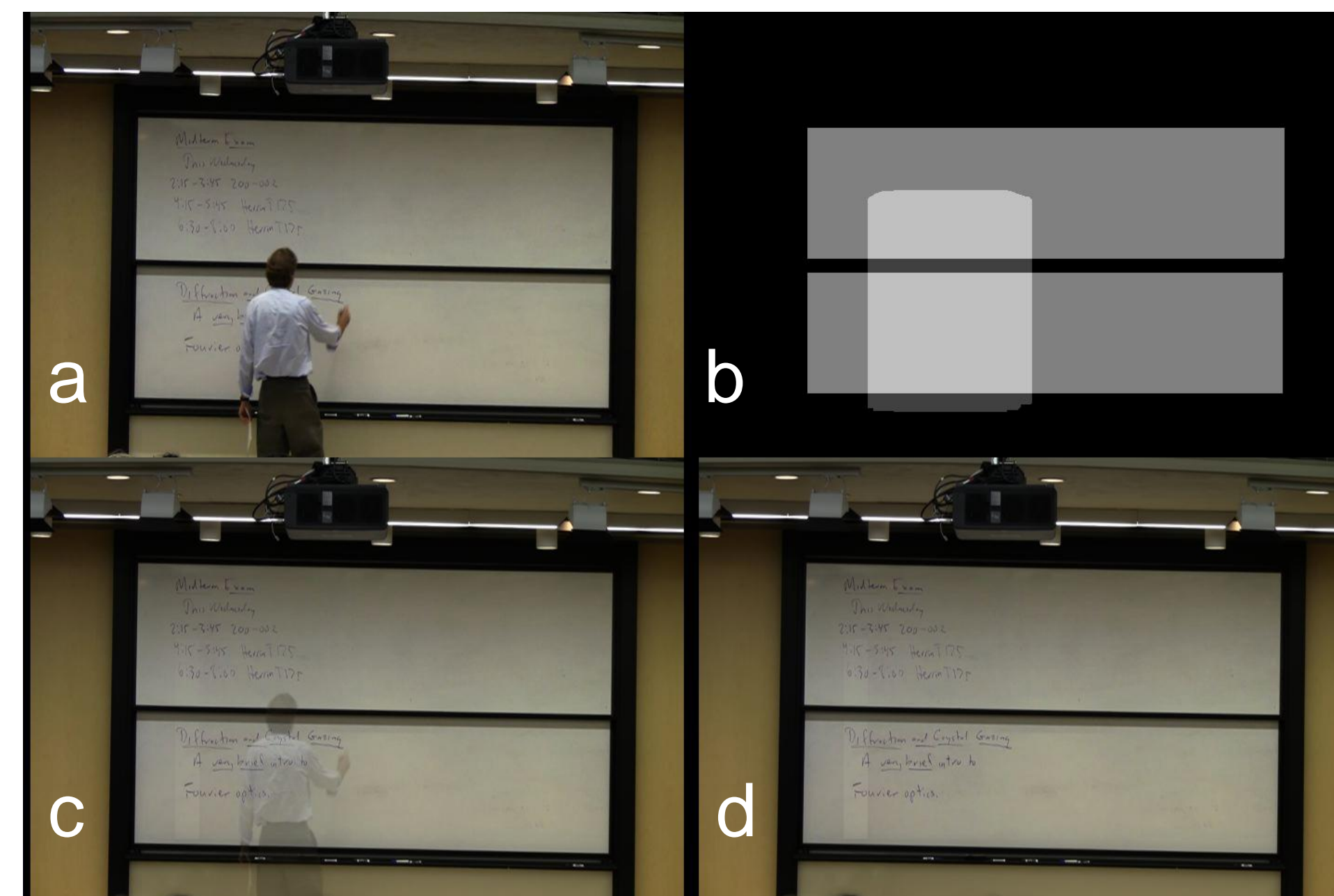


Figure 2. Classroom 1 : Whiteboard (low-contrast)

(a) Original Image (b) Four-level-image (gray scale version)

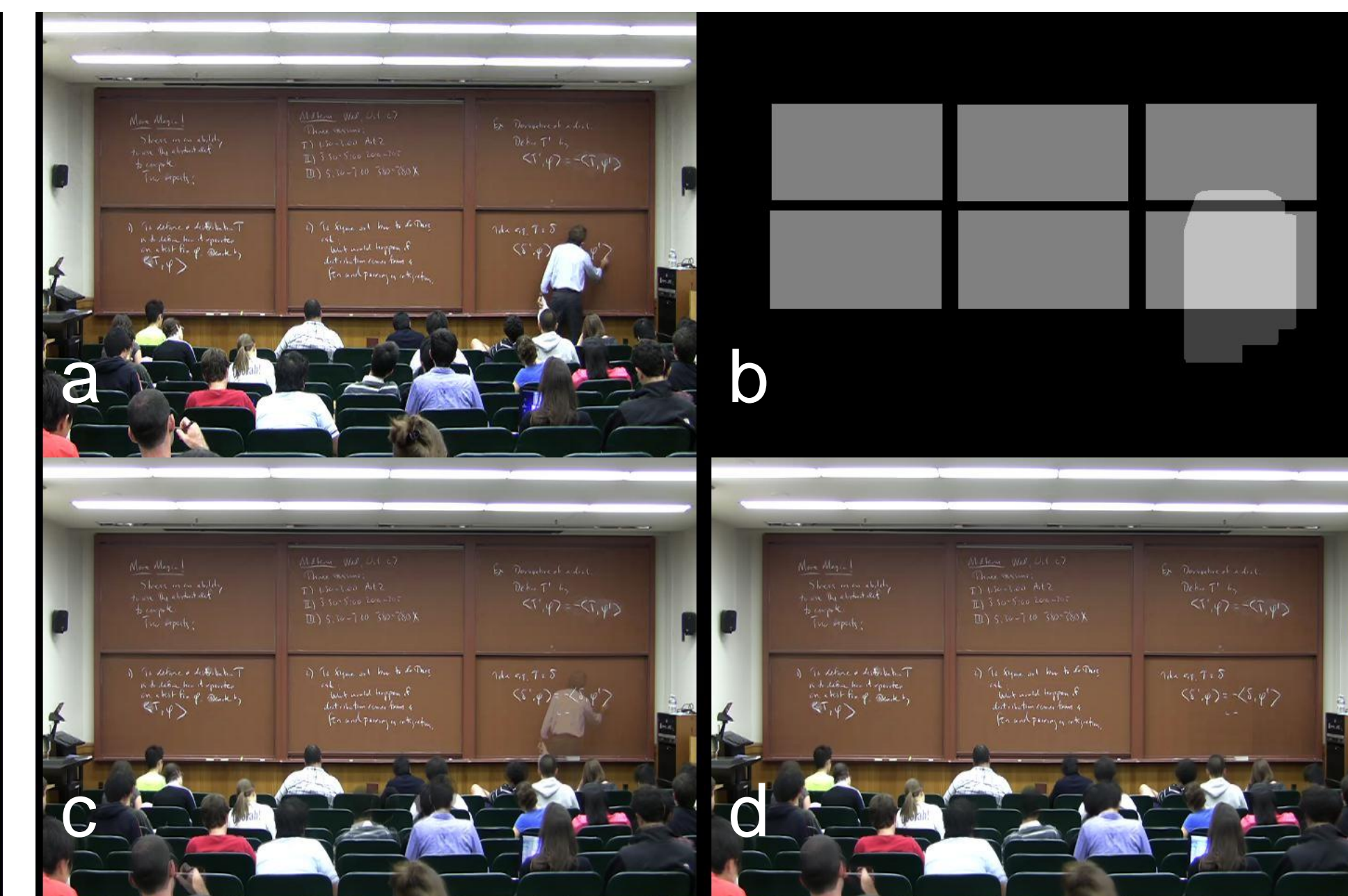
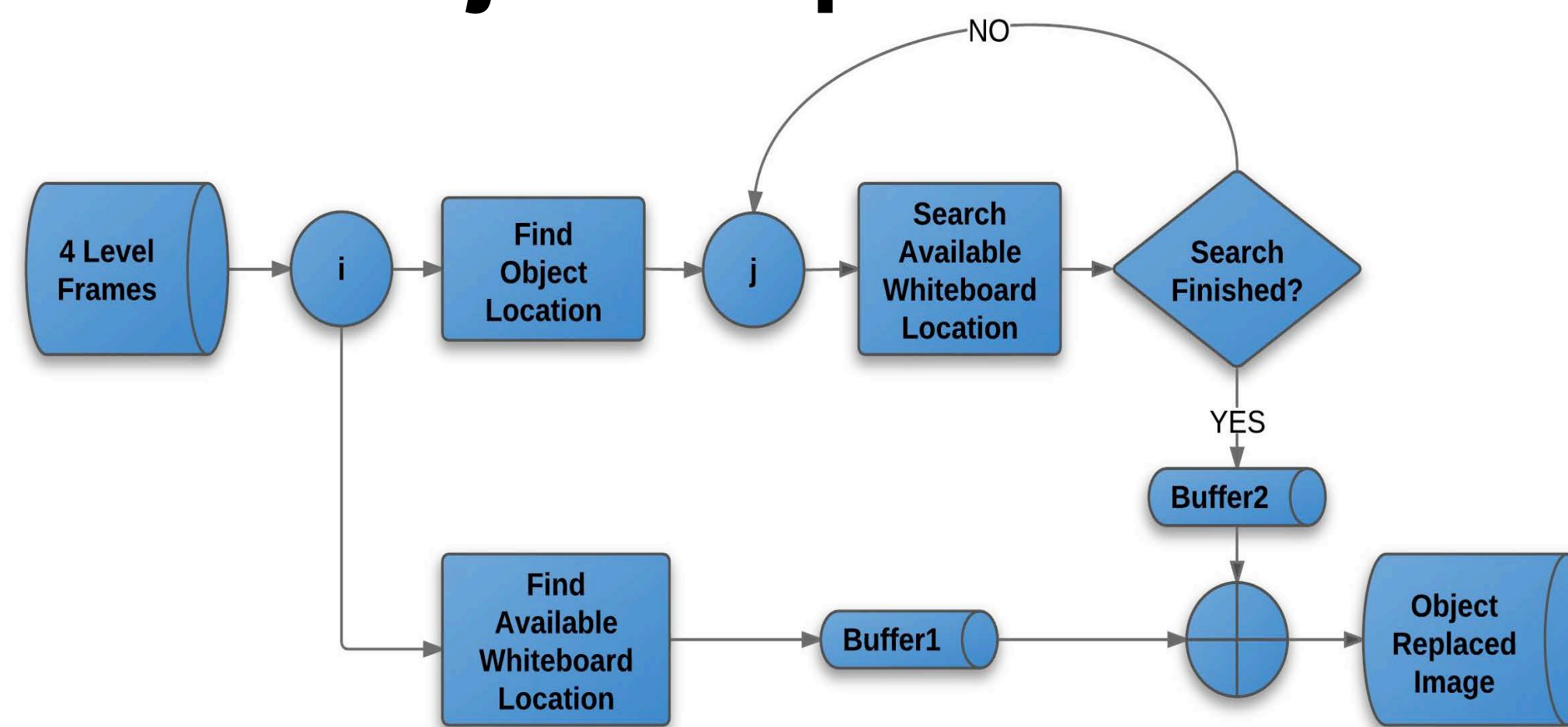


Figure 3. Classroom 2 : Brown-board (high contrast)

(c) Integrated Image (d) Whiteboard reconstructed(object-replaced) image

Object Replacement



- Using the four-level-image, the exact object pixel locations blocking the whiteboard and the available whiteboard pixel locations are trackable.
- Object-blocked whiteboard information can be replaced with the whiteboard information from the future or the past frames.

Image Integration

$$w * \text{Hello!} + (1-w) * \text{Hello!} = \text{Helio!}$$

- Original and object-replaced images are weighted and integrated as shown in the Figure 2&3(c). (where $0 < w < 1$)

Reference

- [1] He L., Zhang Z. *Real Time Whiteboard Capture and Processing Using a Video Camera for Teleconferencing*. ICASSP2005
- [2] Piccardi, M., 2004, *Background Subtraction Techniques: A Review*
- [3] Maddalena, L., Petrosino, A. *A Self-Organizing Approach to Background Subtraction for Visual Surveillance Applications*. IEEE TIP 2008
- [4] Lecture notes of the class EE368 Digital Image Process