

# VIDEO MOSAICKING IN UNDERWATER RESEARCH



Aleksej Šaškov

KU CORPI

Juri Rzhanov

CCOM/JHC

University of New Hampshire

# Visual data collection

- The very first photo camera for underwater use was created by French zoologist Louis Boutan in 1892
- The first known usage of video equipment underwater was during “Operation Crossroads”, the first USA nuclear bomb testing after Hiroshima and Nagasaki bombardments. Testing was conducted on Bikini Atoll in 1946 (“Baker” Shot, first ever documented underwater video can be found on YouTube)
- Since then underwater video was also used in more meaningful ways, and first results were published by Harvey Barnes in “Nature”, 1952 (Barnes, H. (1952); Underwater television and marine biology; Nature, 169, pp. 477-479)

# Visual data collection

- Currently, means to collect underwater imagery could be classified as:
  - Divers photo and video
  - Remotely operated photo and video cameras
  - Imagery obtained using underwater vehicles:
    - Manned
    - Unmanned
      - Remotely operated (ROV)
      - Autonomous (AUV)

# Why mosaic?

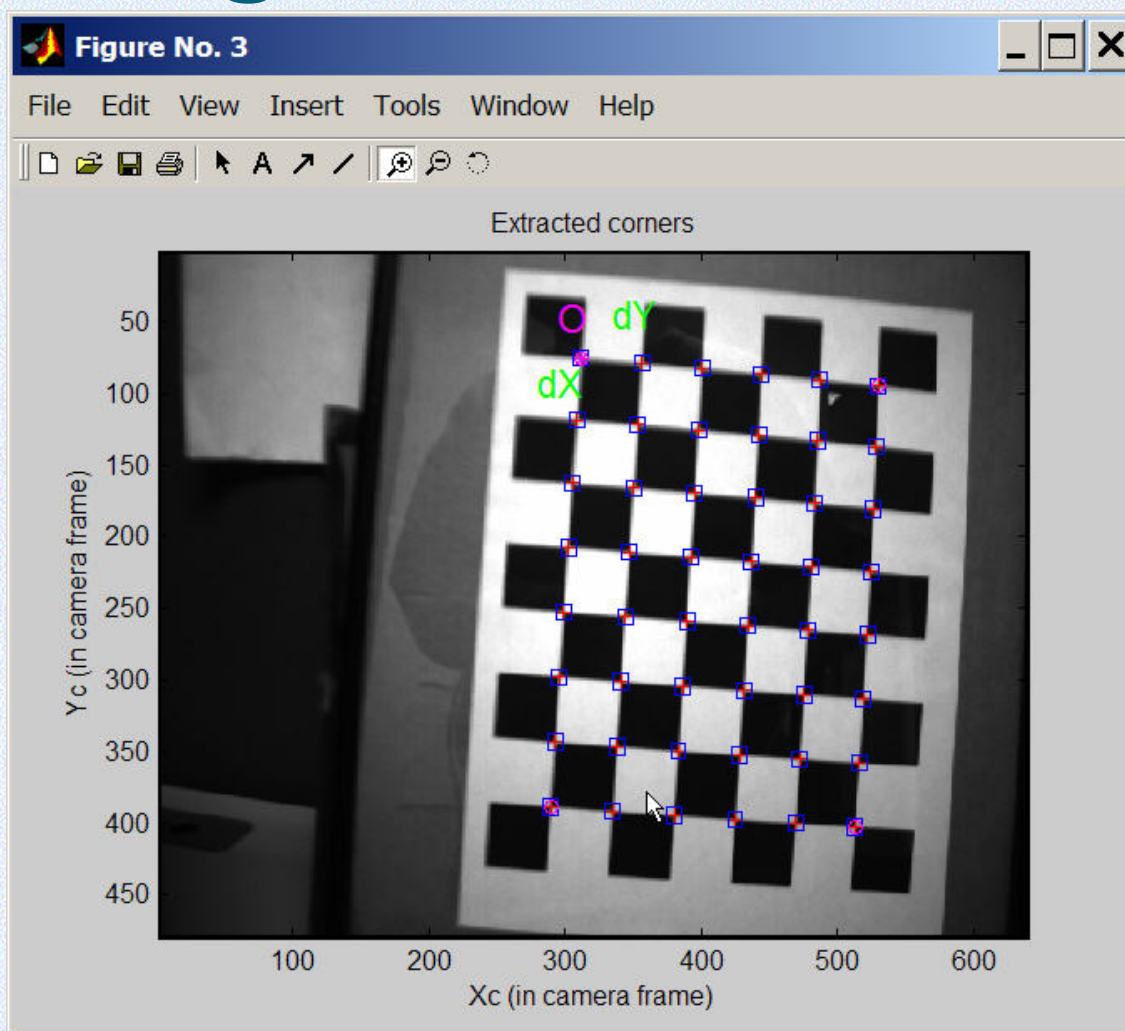
- Regardless of system type, frame size is limited due to fast light adsorption by water. Additionally, photons with lower energy are absorbed faster, and red spectrum vanishing more quickly. This results in significant distortion of colors in visible spectrum
- Because of the frame size, objects of interest often do not fit in a single image. It is possible to image whole object using continuous frames sequence, but even then only its fraction will be seen at any given time
- General overview can be produced combining overlapping frames. This is a main idea behind videomosaicing



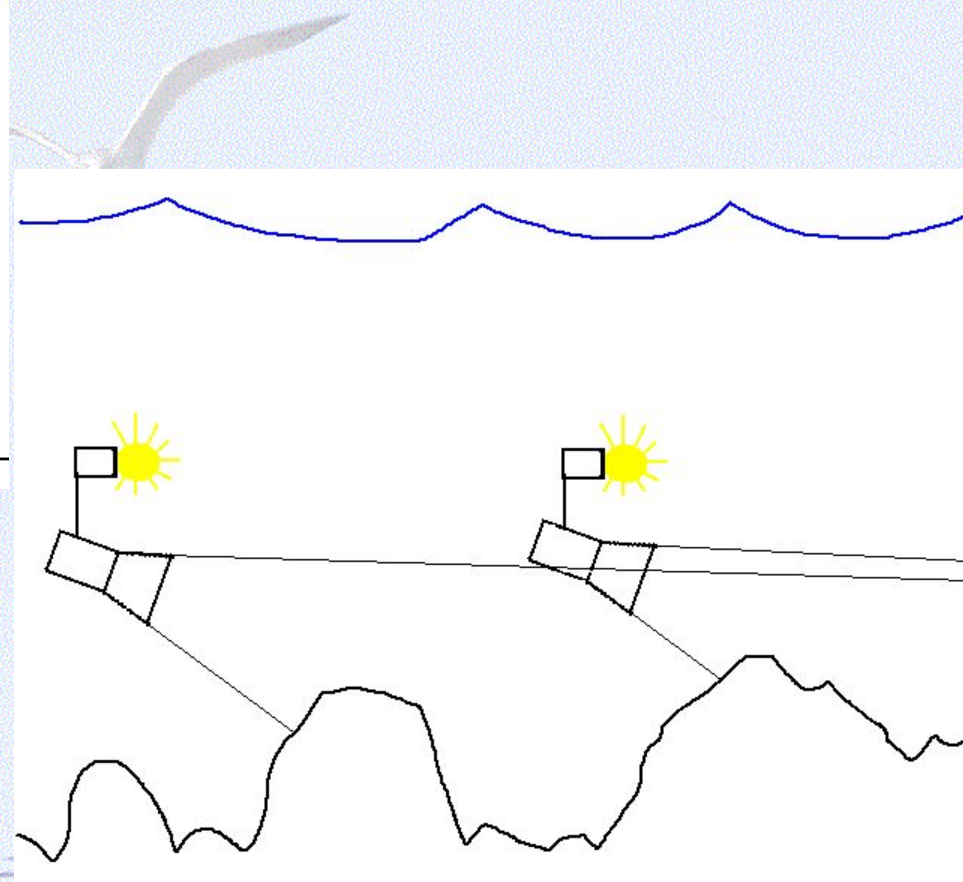
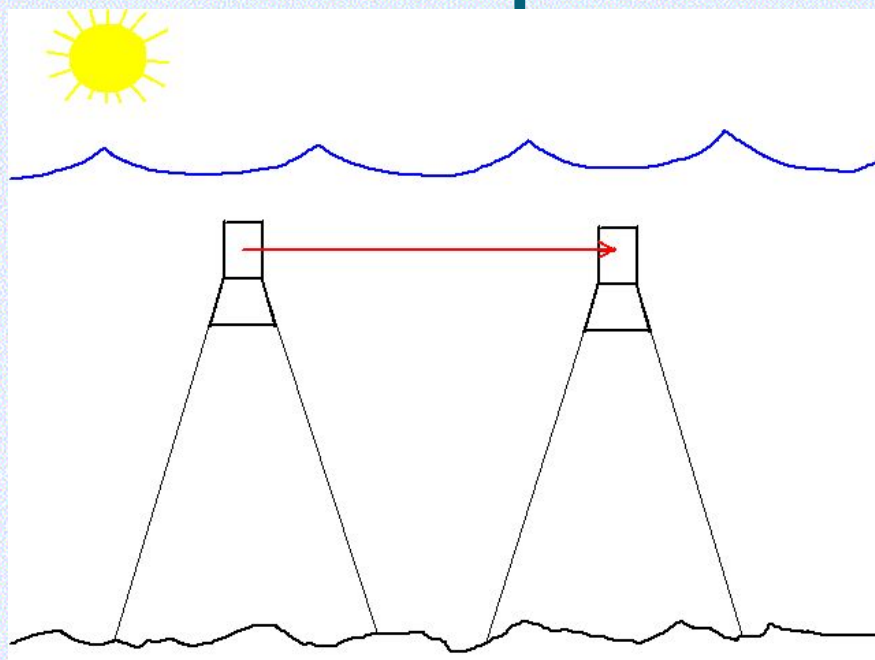
# Creating the mosaic

- Nowadays simplest mosaicing algorithms are widespread. Even entry level digital photo cameras often have a “panoramic” mode, which implements mosaicing. But these simple methods work well only with a fairly small amount of frames with good illumination
- In real world the above conditions are rarely satisfied. Number of frames is usually quite large, illumination is far from being perfect, and there are additional sources of image distortions
- During mosaic building process these effects accumulate, and final result could be quite unexpected...

# Cameras geometric aberrations

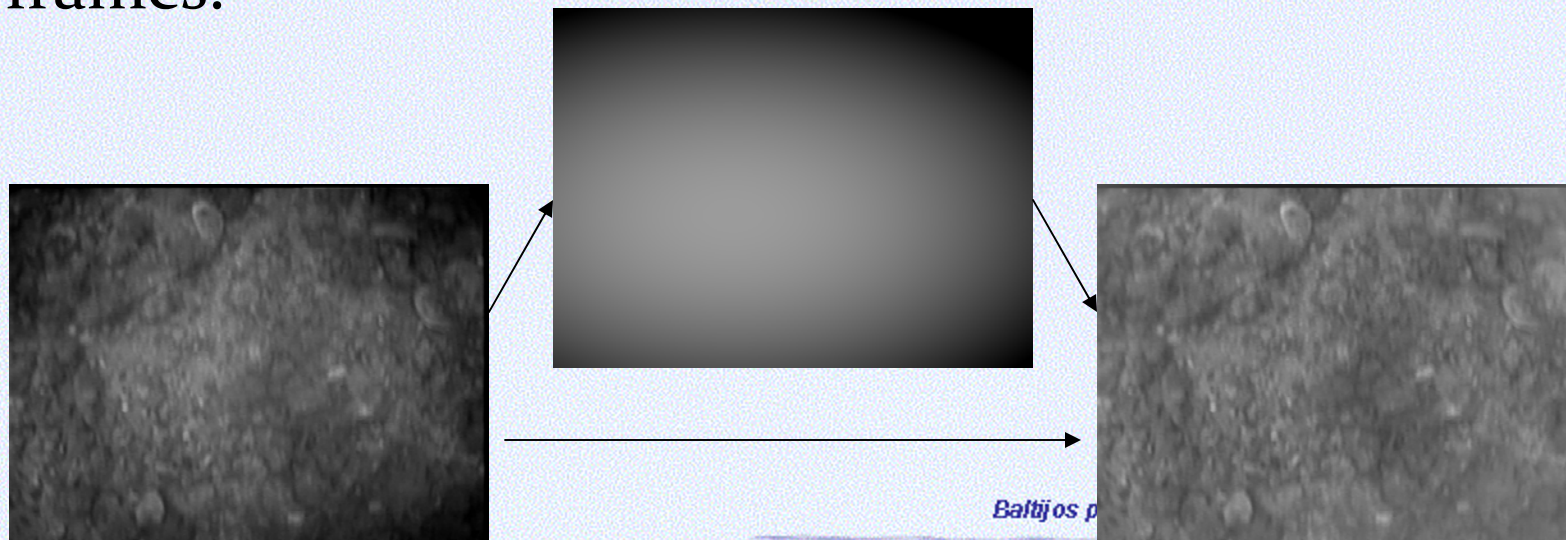


# Camera position and lights



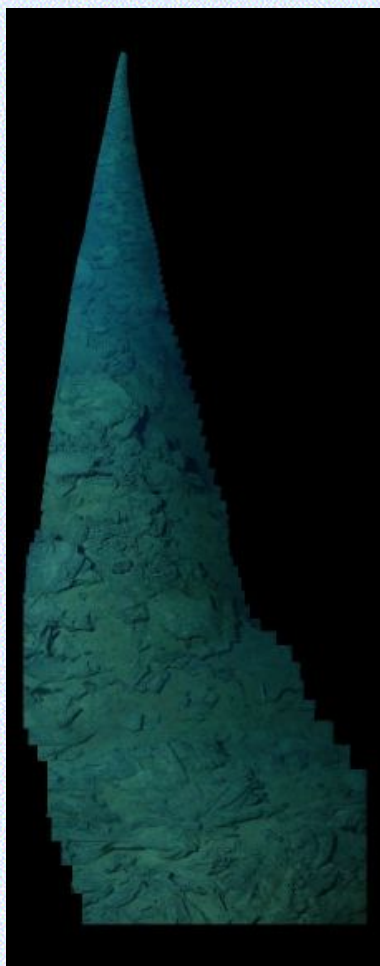
# Inhomogeneous illumination

- Fitting surface to a height map.
- Knowledge about light source may suggest best shape.
- Typically: general low-order 2D polynomial spline.
- Accumulation of spline coefficients over several frames.

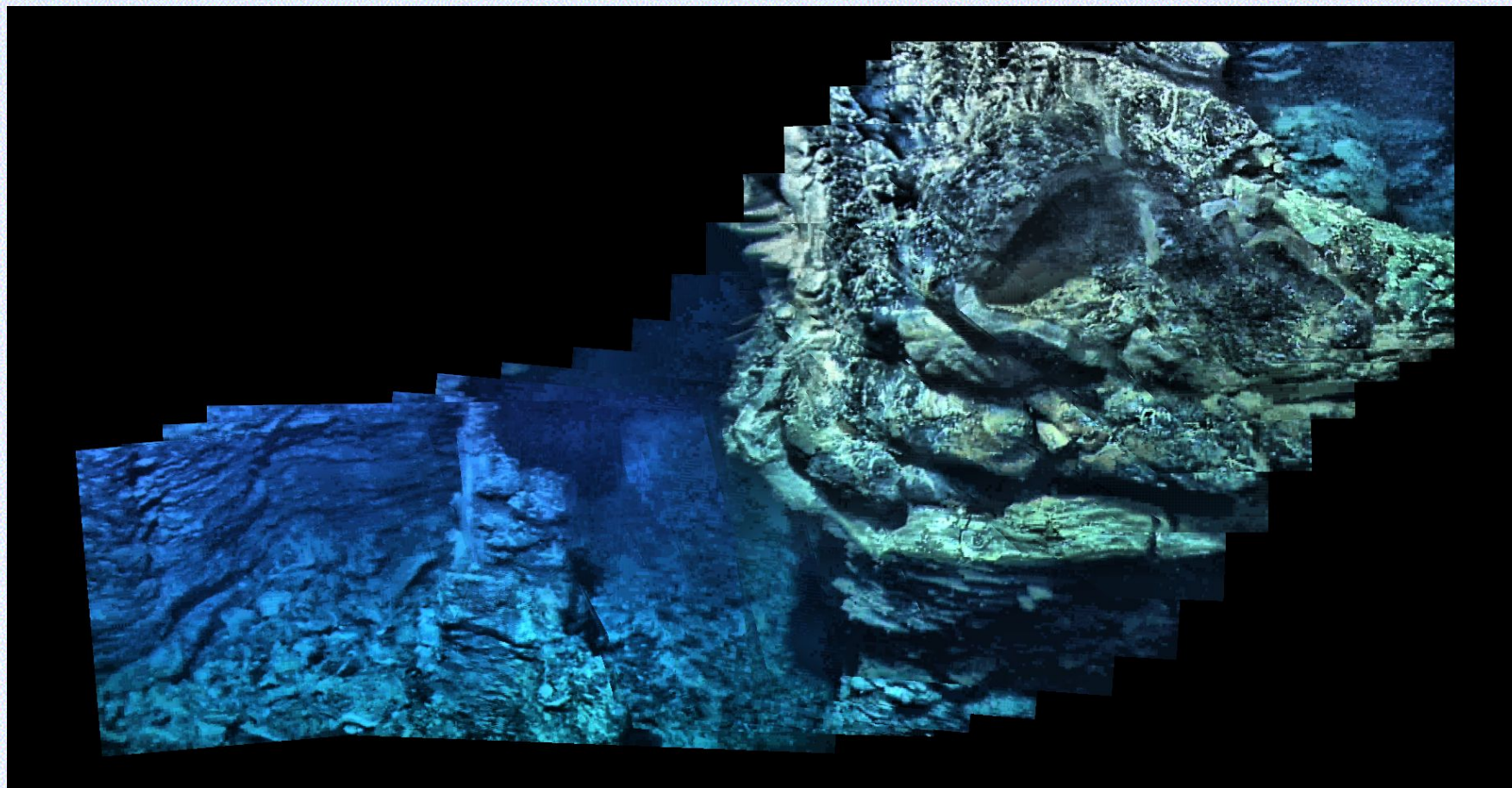




# Pitch and roll bias

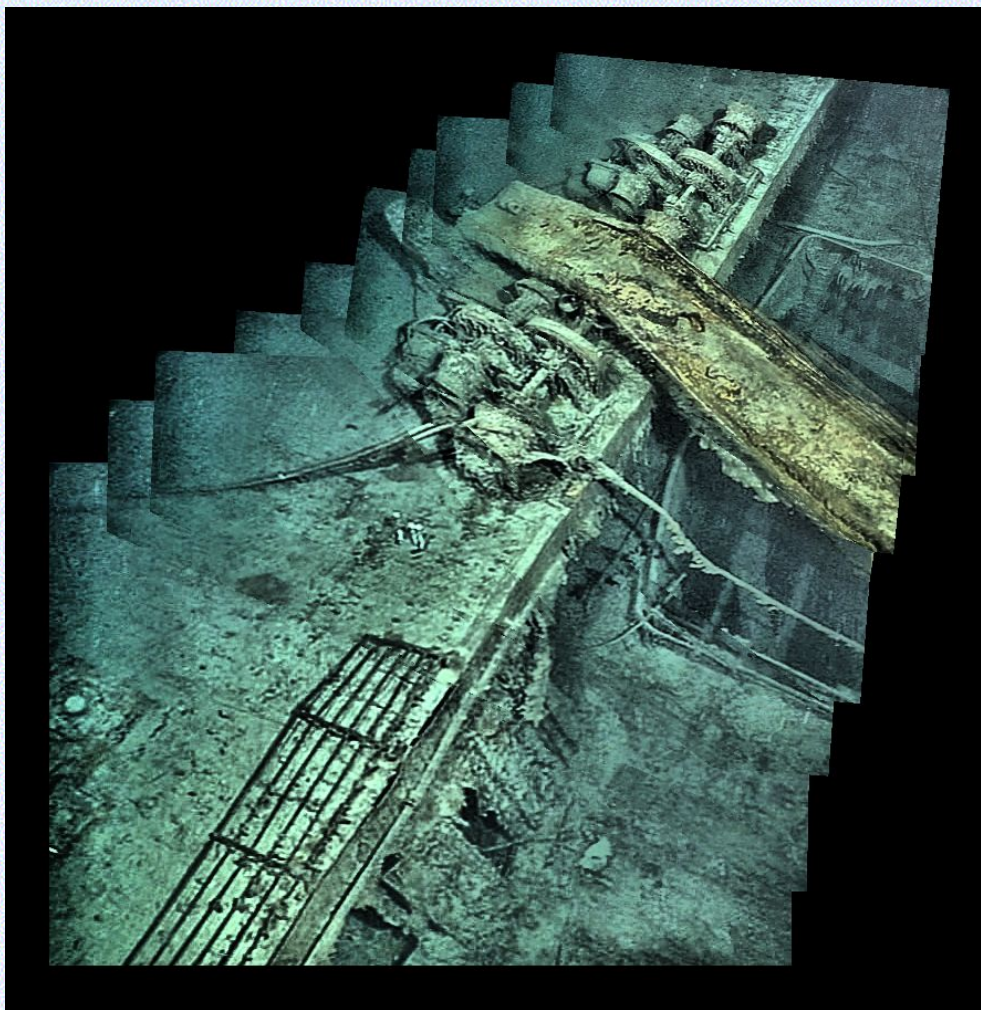


# Strong 3D content



Courtesy Dan Fornari, WHOI, Woods Hole

# Strong camera tilt



Courtesy LT Jeremy B.  
Weirich, OE NOAA

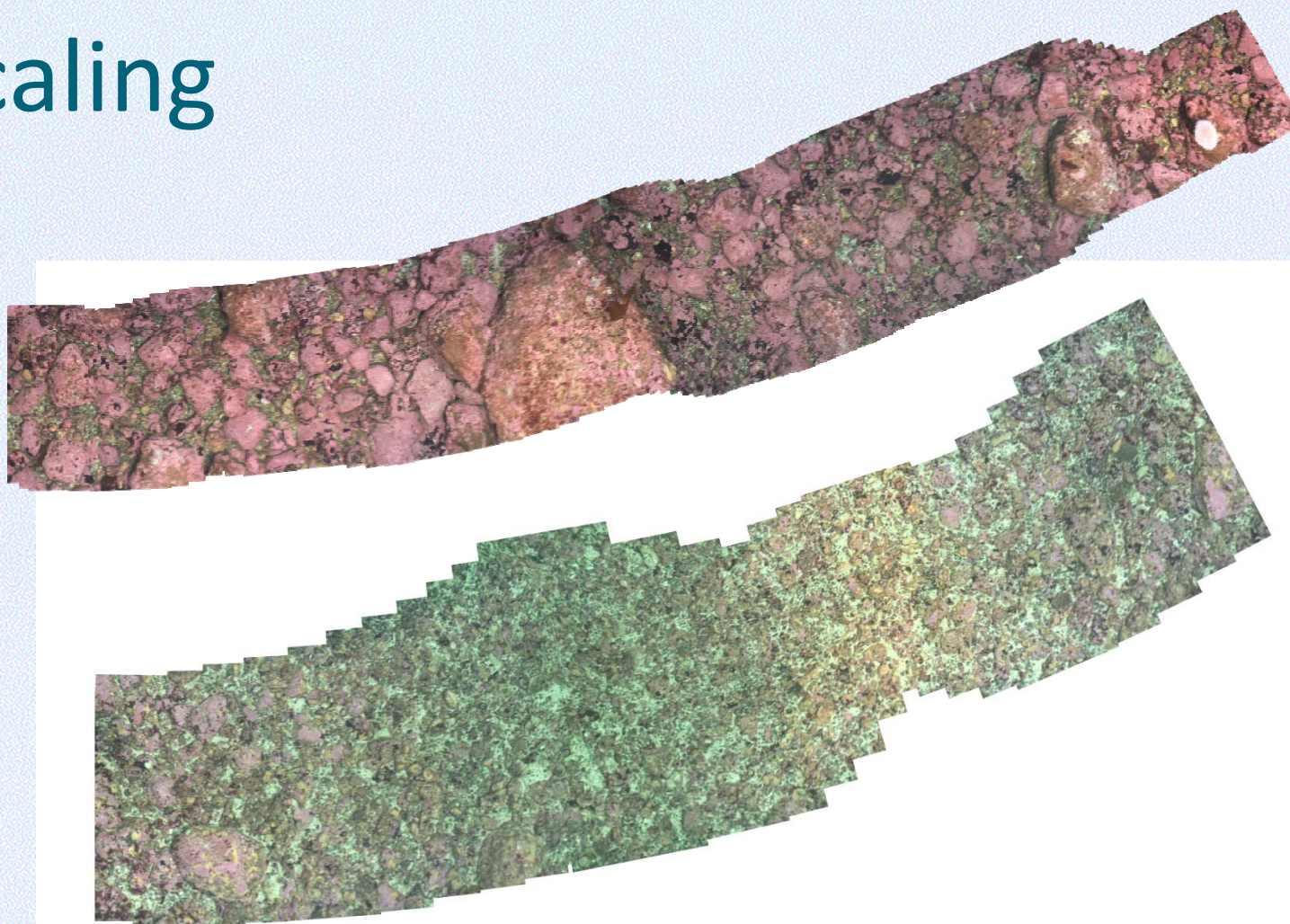
# Features estimation

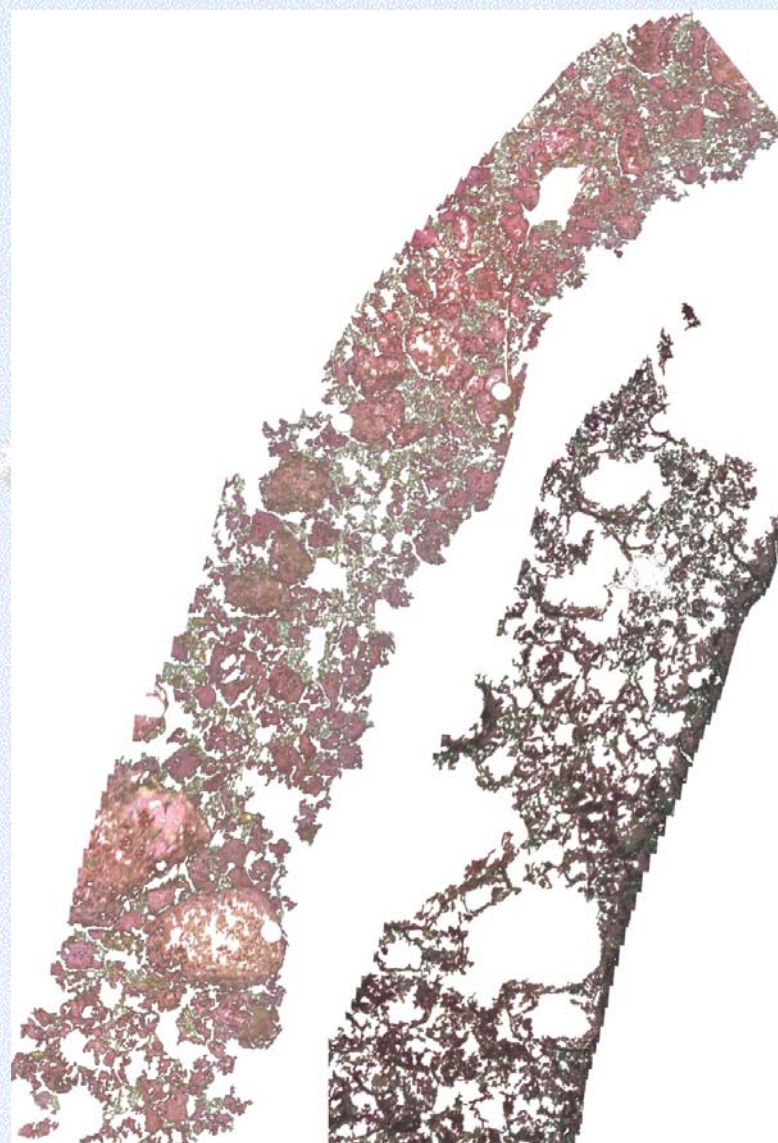
- Visual objects can be recognized by shape, texture and color
- Any of them could be important for underwater imagery analysis
- Although computer vision have been developed rapidly in recent years, shape recognition tools still have significant limitations and their performance could not be compared with human abilities
- However, in some areas (such as colors recognition) automatic processing even today demonstrate unmatched performance in both, speed and accuracy

# Features estimation

- It is easy to estimate qualitative features from the video
- When it comes to quantitative estimates, it becomes more complicated. We can easily count individual species (for example, sea urchins or sea stars) in the video segment, but without knowing area size, these numbers are not very useful. Of course, we can always estimate area by “fair guess”, but how accurate could this estimate be?
- Area size is not too important for relative features (such as percentage of cover) but the question arises, how cover needs to be estimated: from separate frames (if so, then how these frames should be chosen?) or from video segments (how?)

# Area estimation – mosaics self-scaling





# Conclusions

- Video mosaic allows to see more. Literally
- Usage of video mosaicing aids solving number of problems important for quantitative video analysis:
  - Estimation of area
  - Choosing frames for analysis and quality control (if images are rejected by mosaicing algorithm, their quality is not sufficient for further use)
  - How to guarantee that the same feature in continuous images stream is not counted twice if any kind of automatic technique is used
- Decent mosaicing algorithm needs to be able to deal with various distortions, inaccuracies and “unevenness”, typical for “real world” field data