Lab 1

Camera Communication

Platform – Same as in-class #2

- USRP + LED as Tx
- Raspberry pi camera
- Boost your data rate !! Up to 8kbps

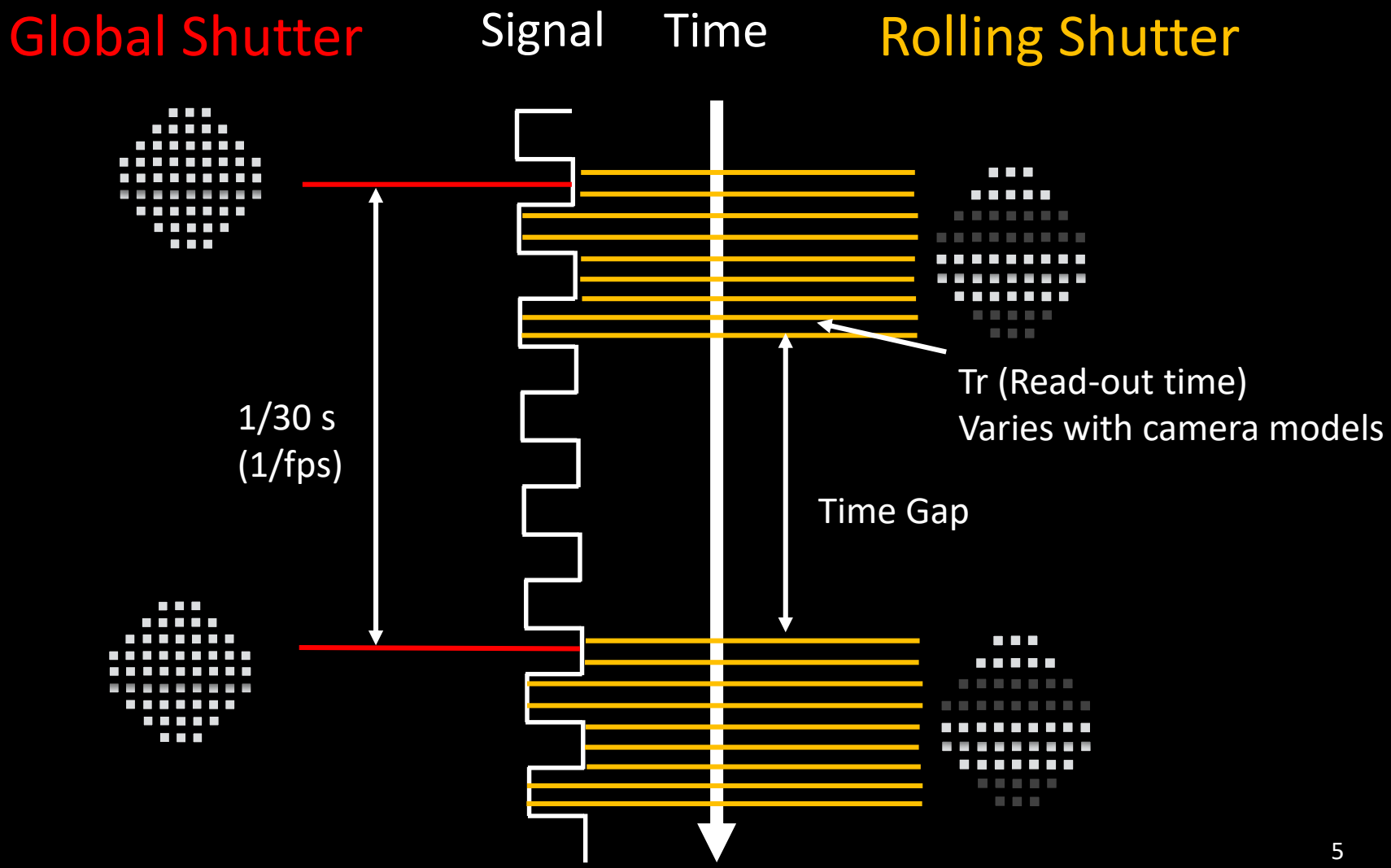
Camera

- Raspberry pi
- Frame rate 30fps
- Shutter speed = 1us
- Resolution 1920*1080

Grading criteria

- Unawareness + workable – 20%
  - Intensity stays constant over any 15ms (60Hz)
  - Transmit 8bps (in-class #2)
- Baseline – 40%
  - 128 bps
- Boost data rate – 30%
  - 5% for each 2x. Maximum rate up to $128 \times 2^6 = 8192$ bps
- Report – 10%
  - Encode / decode explanation + work division

How rolling shutter works ?



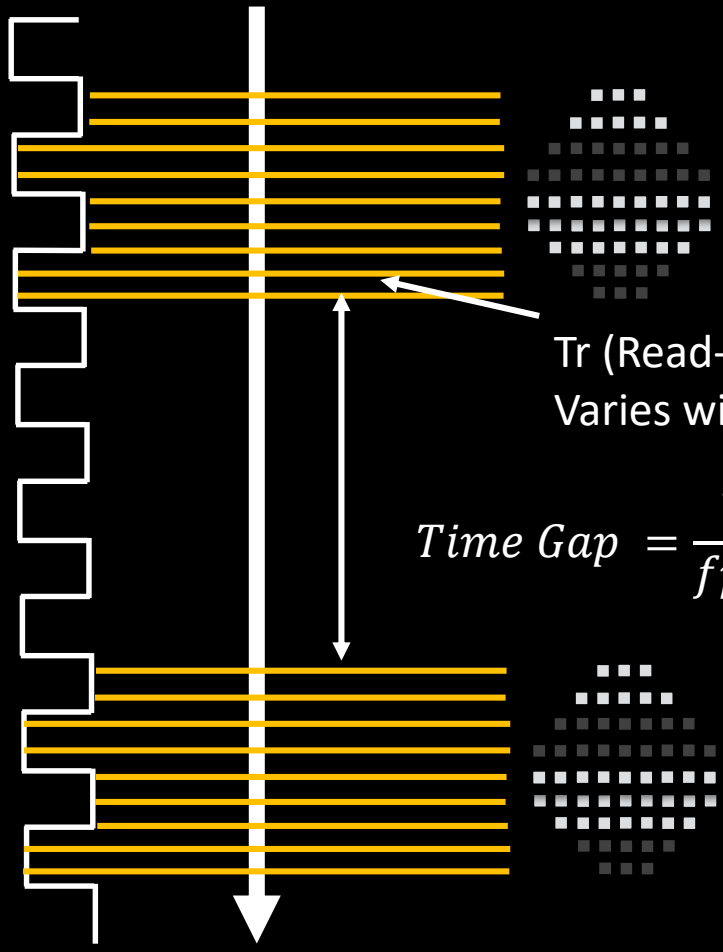
Find signal start

- Preamble
  - Indicate the start(/end) of the signal
    - Tx / Rx do not sync
    - E.g. Tx transmits -> random (10ms, 100ms) -> Rx camera start
  - Unique symbol (sequence)
    - Unused frequency in FSK
    - Long bright/dark in Manchester coding
    - May not follow symbol duration
    - Need to have a clear “ending”
      - Counter example : long bright + 1st symbol Manchester ‘0’ (bright/dark)

Signal Loss handling

Signal Time

Rolling Shutter



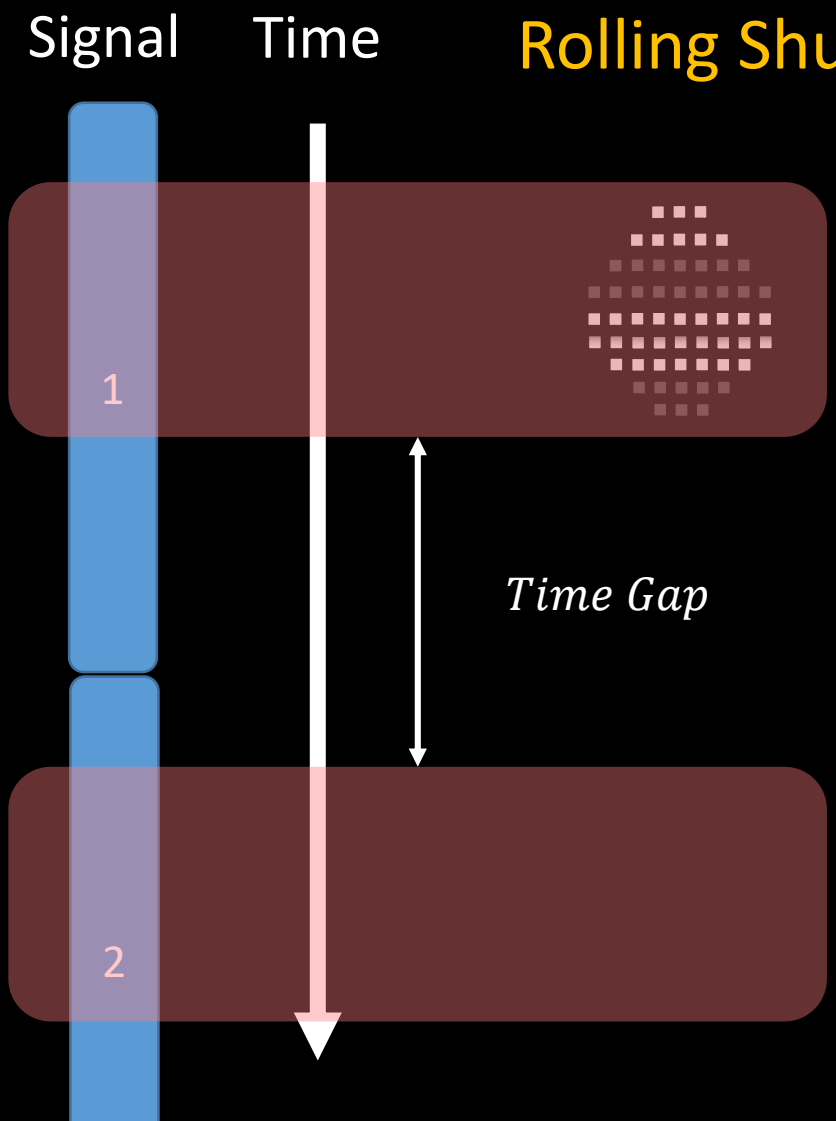
Tr (Read-out time)
Varies with camera models

$$Time\ Gap\ = \frac{1}{fps} - T_r \times \#rows$$

T_r Calculation

- Transmit a data of known frequency
- Calculate the strip width
- Example : transmit 1 kHz cosine wave, 1 bright + 1 dark = 1ms = 1 strip
- 19 strips in image (1 black + 1 white) occupying 888 pixels
- $T_r = \frac{1ms}{\#rows\ per\ cycle} = \frac{1ms}{(888/19)} = 21.4us$

Signal Loss handling – long symbol



- Symbol duration > Gap
  - Each symbol will be captured
  - e.g. 1/30 s
- Each symbol carry multiple bits
  - Multiple frequencies in FSK
  - Multiple amplitude in ASK

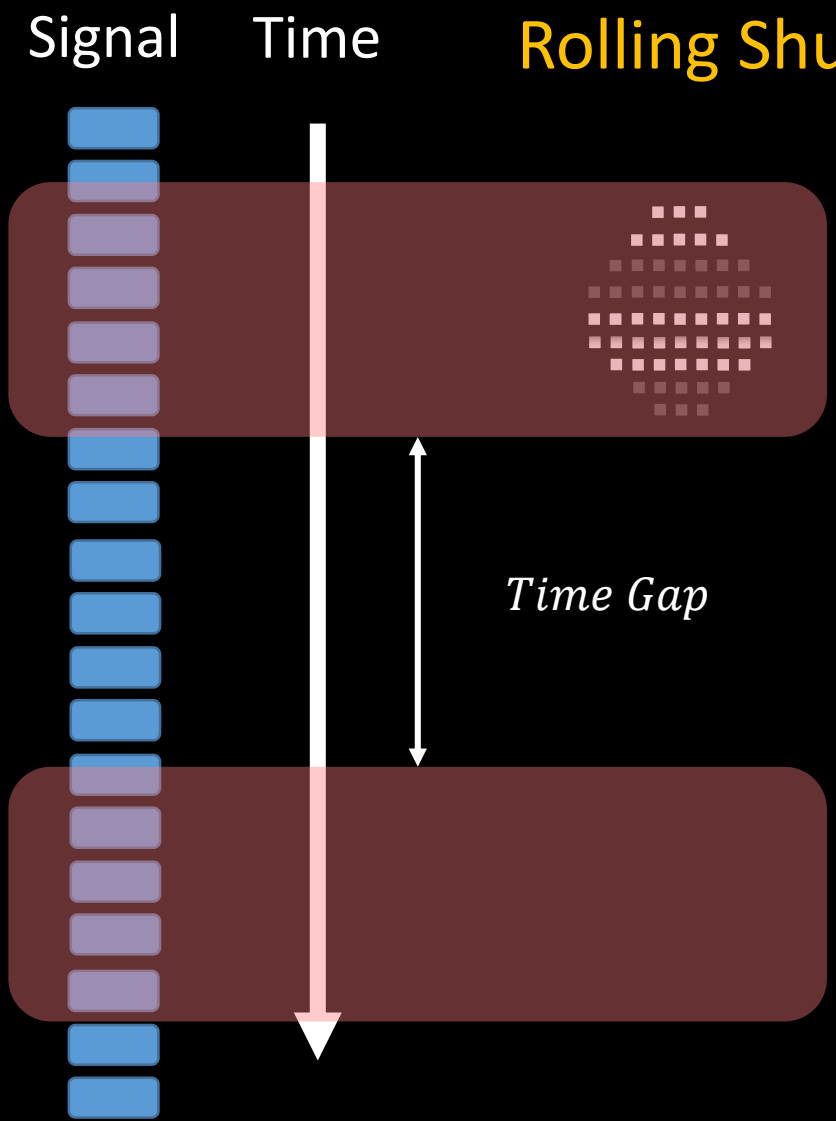
Signal Loss handling – long symbol

- Each symbol will last over 1 frames
- Large symbol – more complex decoding
- Reference
  - RollingLight : http://www.csie.ntu.edu.tw/~hsinmu/wiki/_media/paper/mobisys15.pdf

Symbol splitter (optional)

- A fixed small symbol << symbol duration
- between 2 symbols to split symbol (in case 2 consecutive same symbols)
- Similar to preamble, maybe a unique intensity in ASK or frequency in FSK

Signal Loss handling – short symbol



- Symbol duration < Gap and frame
  - Some symbol loss
- Need to calculate symbol loss rate

Signal Loss handling – small symbol

- Single frame contains multiple symbol
- Small symbol – heavy coding + parity to recover
  - Coding rate > symbol loss rate
  - https://en.wikipedia.org/wiki/Forward_error_correction#List_of_error-correcting_codes

Sequence number (optional)

- Detect loss symbol in time gap
- “number” each symbol
  - E.g. 24 symbols into 3 groups { A,B,C }, 8 symbols in each group = 3 bit per symbol
- Transmit symbol in group order (cyclic)
  - data = [110] [001] [010] [111] [101] [000]
  - Sym. = [A6] [B1] [C2] [A7] [B5] [C0]
- If group order skipped in decode -> symbol loss
  - E.g. [A6] [B1] [A7] -> [C?]

Lab #1 : CamCom

- Tx
  - USRP control LED
  - Fixed Sampling rate : 200K
  - 1 = bright, 0 = dark. Linear scale (0.5 = half intensity)
    Sample MATLAB file create bin file
    - https://drive.google.com/file/d/0B_Z-TUMjZ2A8ZDNLM0FMQ0U1TUU/view
  - Upload your bin file through
    - scp teamN_v#.bin wn@10.5.7.182:~/ook-vlc/
    - Password: wnfa2017

Lab #1 : CamCom

- Rx
  - Raspberry camera
  - Fixed 30fps 1920*1080 mp4
  - Captured video in
    - http://mvnl.csie.ntu.edu.tw/~wnfa/wn17fall/
    - CLEAR in 10/1 (Sun.) 23:59
    - test.mp4 – sample video for 1kHz cosine wave
  - Download the video and decode
    - Read video sample code in
    - https://www.dropbox.com/s/5zx14ozqg408san/OOKRxDemo.m?dl=0

Grading criteria

- Demo : Unawareness + workable – 20%
  - Intensity stays constant over any 15ms (60Hz)
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- Demo : Baseline – 40%
  - 128 bps
- Demo : Boost data rate – 30%
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- Report – 10%
  - Encode / decode explanation + work division

Demo

- 10/26 (Thur.)
- 15 min per team
- Whole day available, book the time slot at https://docs.google.com/spreadsheets/d/1Gt0kPkDGTFpR8MTsswOTMN4ZozkOdAH661KgcRgJIoc/edit?usp=sharing
- Please feel free to email us if both of you are not available

Submit

- courses.dlc.ntu.edu.tw
  - Lab > Lab1
  - .zip containing encode.m/ decode.m/ report.pdf