COMPUTER VISION

MOVING OBJECT DETECTION

With Optical flow

GROUP MEMBERS

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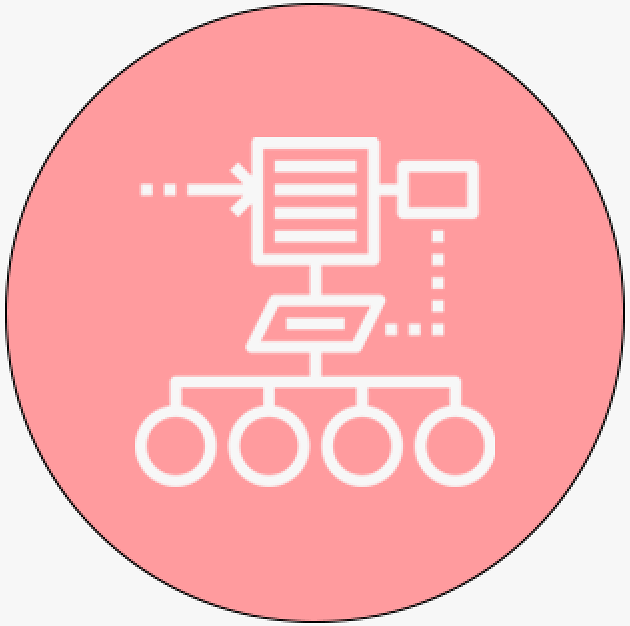
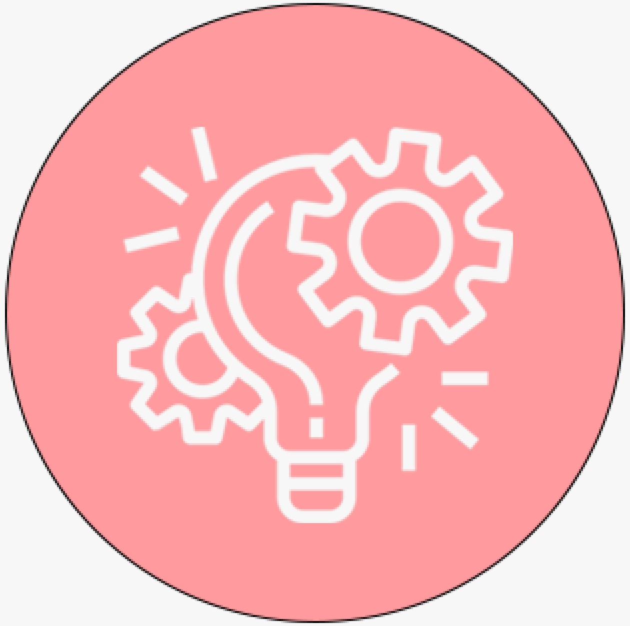
OUTLINE



CONCEPT & ALGORITHM



OUR PROJECT

SOFTWARE DEMONSTRATION

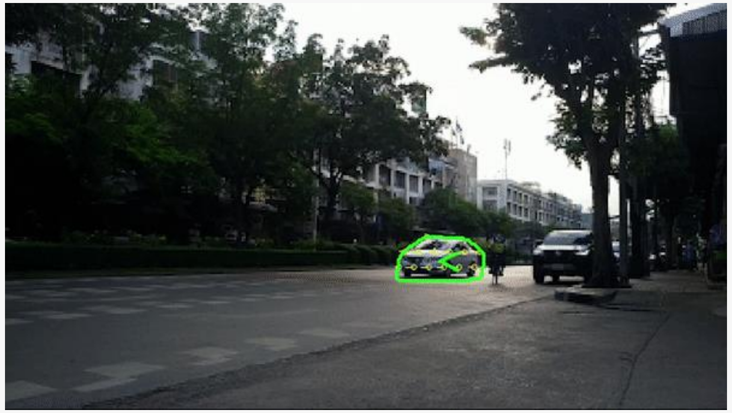
WHAT IS OPTICAL FLOW?

FRAME_1

FRAME_2

RESULTS

USAGE



STABILIZED DRONE

MOTION ESTIMATION

VIDEO STABILIZATION

CONCEPT

I (x,y,t)

(x,y)

displacement = (dx,dy)

time = t

I (x+dx ,y+dy ,t+dt)

(x+dx ,y+dy)

time = t+dt

I (x,y,t) = I (x+dx ,y+dy ,t+dt)

TAYLOR SERIES APPROXIMATION

$$I(x+\partial x, y+\partial y, t+\partial t) = I(x,y,y) + \frac{\partial I}{\partial x}\partial x + \frac{\partial I}{\partial y}\partial y + \frac{\partial I}{\partial t}\partial t + \cdots$$

$$\rightarrow \frac{\partial I}{\partial x}\partial x + \frac{\partial I}{\partial y}\partial y + \frac{\partial I}{\partial t}\partial t = 0$$

$$\frac{\partial I}{\partial x}u + \frac{\partial I}{\partial y}v + \frac{\partial I}{\partial t} = 0$$

TAYLOR SERIES APPROXIMATION

$$\frac{\partial I}{\partial x}u + \frac{\partial I}{\partial y}v + \frac{\partial I}{\partial t} = 0$$

Where: $u = \frac{dx}{dt}$ $\quad v = \frac{dy}{dt}$

$$\frac{dI}{dx}, \frac{dI}{dy}, \frac{dI}{dt} = gradients$$

Rewritten for the derivative in the following:

$$I_x u + I_y v = -I_t$$

$$I_x u + I_y v = -I_t$$

This equation has two unknowns with only one equations.

Thus, we cannot directly solve the optical flow equation.

To solve for u and v, we need additional method.

In our project, we use the FDRIG algorithm.(Halcon software)

FDRIG ALGORITHM

This approach is flow-driven, robust, isotropic,and uses a gradient constancy term.

The FDRIG algorithm is based on the minimization of an energy functional that contains the following assumptions..

FDRIG ASSUMPTIONS

- Constancy of the gray values
- Constancy of the spatial gray value derivatives
- Large displacements
- Statistical robustness in the data term
- Preservation of discontinuities in the flow field I

$$E(\mathbf{w}) = E_{\mathrm{D}}(\mathbf{w}) + \alpha E_{\mathrm{S}}(\mathbf{w}),$$

Can be expressed as:

$$\begin{aligned} E_{\mathrm{FDRIG}}(\mathbf{w}) \;=\; & \int \Psi_{\mathrm{S}}\Big(\underbrace{|f(\mathbf{x}+\mathbf{w}) - f(\mathbf{x})|^2}_{\text{gray value constancy}} + \gamma \underbrace{|\nabla_2 f(\mathbf{x}+\mathbf{w}) - \nabla_2 f(\mathbf{x})|^2}_{\text{gradient constancy}} \Big) dr\,dc \\ & + \alpha \int \Psi_{\mathrm{S}} \Big(\underbrace{|\nabla_2 u(\mathbf{x})|^2 + |\nabla_2 v(\mathbf{x})|^2}_{\text{smoothness assumption}} \Big) dr\,dc \end{aligned}$$

FDRIG COMPUTING STEP

STEP 1	Acquire the original two sequence images.
STEP 2	Preprocess image and convert a color motion sequence image into a monochrome gray image.
STEP 3	Use Gaussian filtering to smooth the image sequence and eliminate noise.
STEP 4	Solve the partial derivatives of the optical component.

REFERENCES

- Optical flow - Wikipedia
- Optical_flow_mg [HALCON Operator Reference] (mvtec.com)
- Image Stabilization - YouTube
- Research on Moving Target Tracking Based on FDRIG Optical Flow (mdpi.com)
- Introduction to Motion Estimation with Optical Flow (nanonets.com)

LET'S SEE THE
SOFTWARE DEMONSTRATION ...