

ACQUISITION OF DSM WITH HOME USE DIGITAL CAMERA

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- Photog-CAD
 - Back ground
 - Software configuration
 - Close range photogrammetry
 - Evaluation of precision
 - Exporting TIN with csv or dxf file
- Examples
- Application of UAV

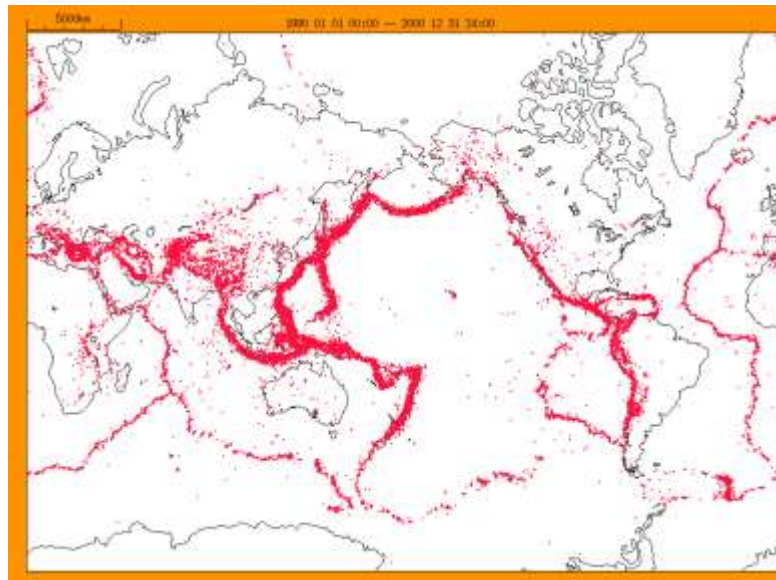
To restore infrastructure damaged by natural hazards,
Central government bear large part of cost for restoration

BACK GROUND

Japanese territory lies in hazardous area



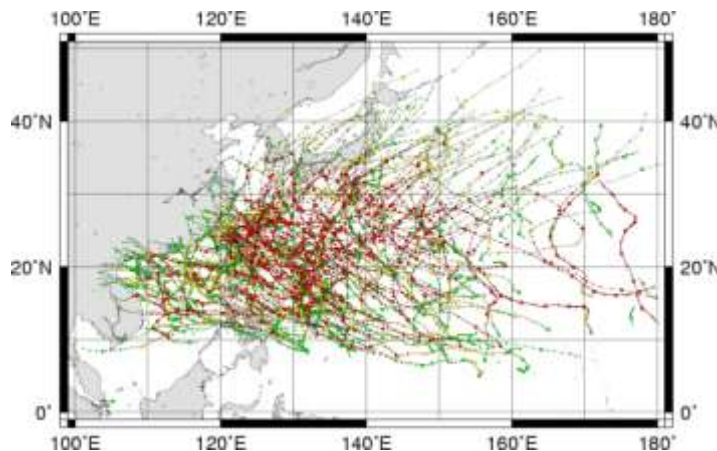
Slope failure due to earthquake
After Niigata Pref.



Earthquake epicenters (D<50km, M>4.0 1990-2000)
After JMA



Tsunami 03/11/2011
After Kyodo press



Trajectory of Typhoons (1951-1999)
After Digital Typhoon site



Mud flow caused by heavy rainfall
accompanied Typhoon 26th 2013
After Biglobe News

- When structures got damage, to prevent farther effect, it is necessary to restore quickly
- In Japan, Central government shares restoration expense according to 'Act on National Treasury's Sharing of Expenses for Project to Recover Public Civil Engineering Works Damaged by Disaster' to ease burden of local government and municipalities

- Small damages occur more frequently than large ones
- In case of small damages, share of cost of preparation for inspection of restoration cost allocation tend to be large
- Simplified treatment is necessary
 - ⇒ simple procedure is allowed
 - ⇒ simplified design is applicable
 - ⇒ simple tool -----Photog-CAD!

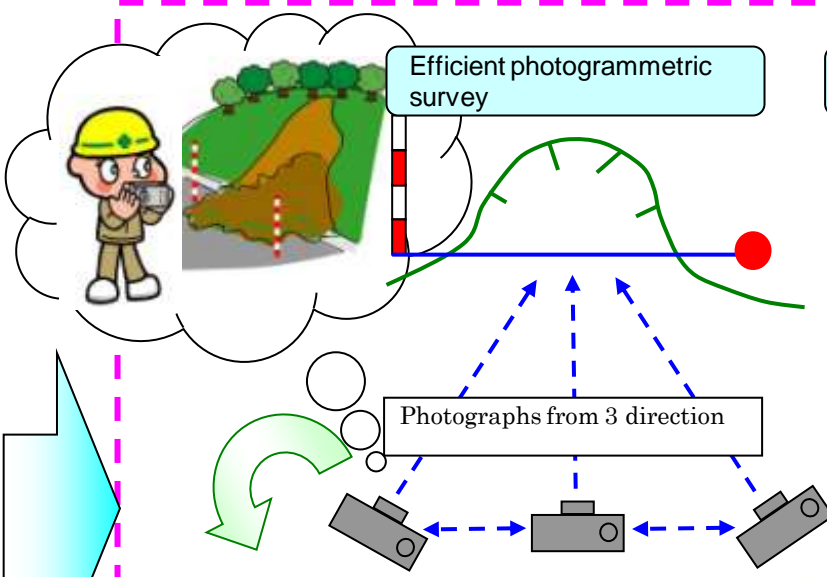
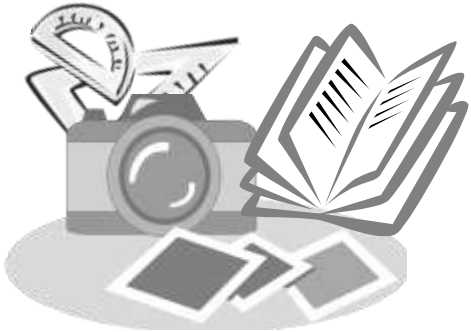
Acquisition of DSM with home-use compact digital camera

Low cost easy tool for ease procedure for requesting recovery cost for infrastructure with home-use compact digital camera and PC

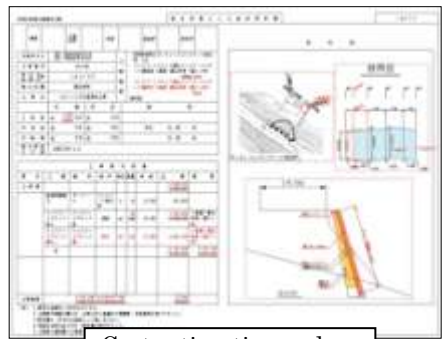
PHOTOG-CAD

Outline of Photog-CAD

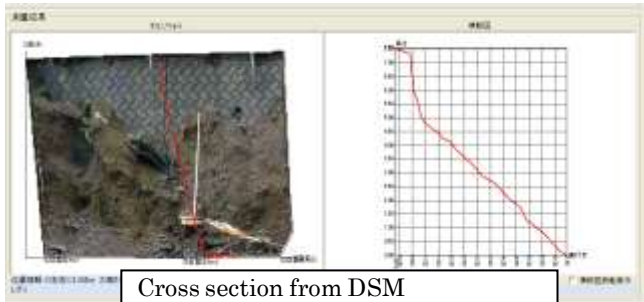
Old days' pole travers



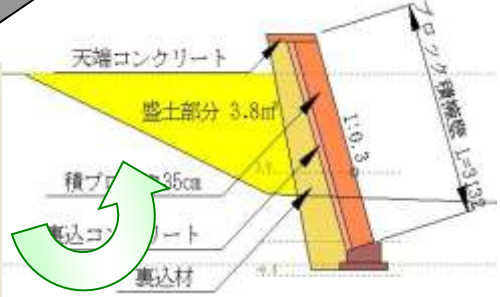
Restoration design using CAD



Cost estimation and documentation



Cross section from DSM



Design

Reasonably priced ¥150,000+tax=ca. US\$1,500+tax

$$x = f \frac{a_{11}(X - X_0) + a_{12}(Y - Y_0) + a_{13}(Z - Z_0)}{a_{31}(X - X_0) + a_{32}(Y - Y_0) + a_{33}(Z - Z_0)}$$

$$y = f \frac{a_{21}(X - X_0) + a_{22}(Y - Y_0) + a_{23}(Z - Z_0)}{a_{31}(X - X_0) + a_{32}(Y - Y_0) + a_{33}(Z - Z_0)}$$

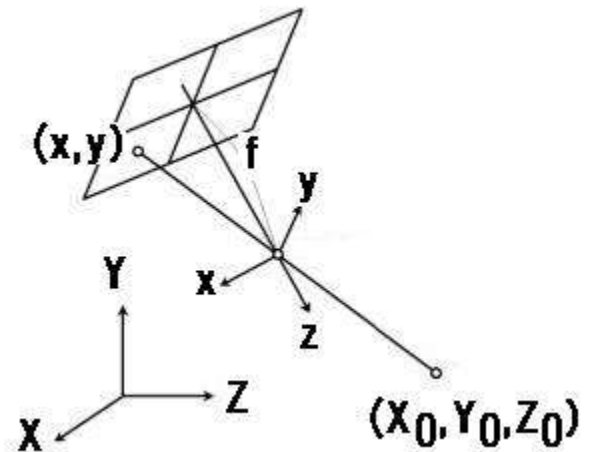
where

$$\begin{pmatrix} a_{11}, a_{12}, a_{13} \\ a_{21}, a_{22}, a_{23} \\ a_{31}, a_{32}, a_{33} \end{pmatrix} = R_x(\omega)R_y(\kappa)R_z(\phi)$$

$$R_x(\omega) = \begin{pmatrix} 1, & 0, & 0 \\ 0, & \cos(\omega), & \sin(\omega) \\ 0, & -\sin(\omega), & \cos(\omega) \end{pmatrix}$$

$$R_y(\kappa) = \begin{pmatrix} \cos(\kappa), & 0, & -\sin(\kappa) \\ 0, & 1, & 0 \\ \sin(\kappa), & 0, & \cos(\kappa) \end{pmatrix}$$

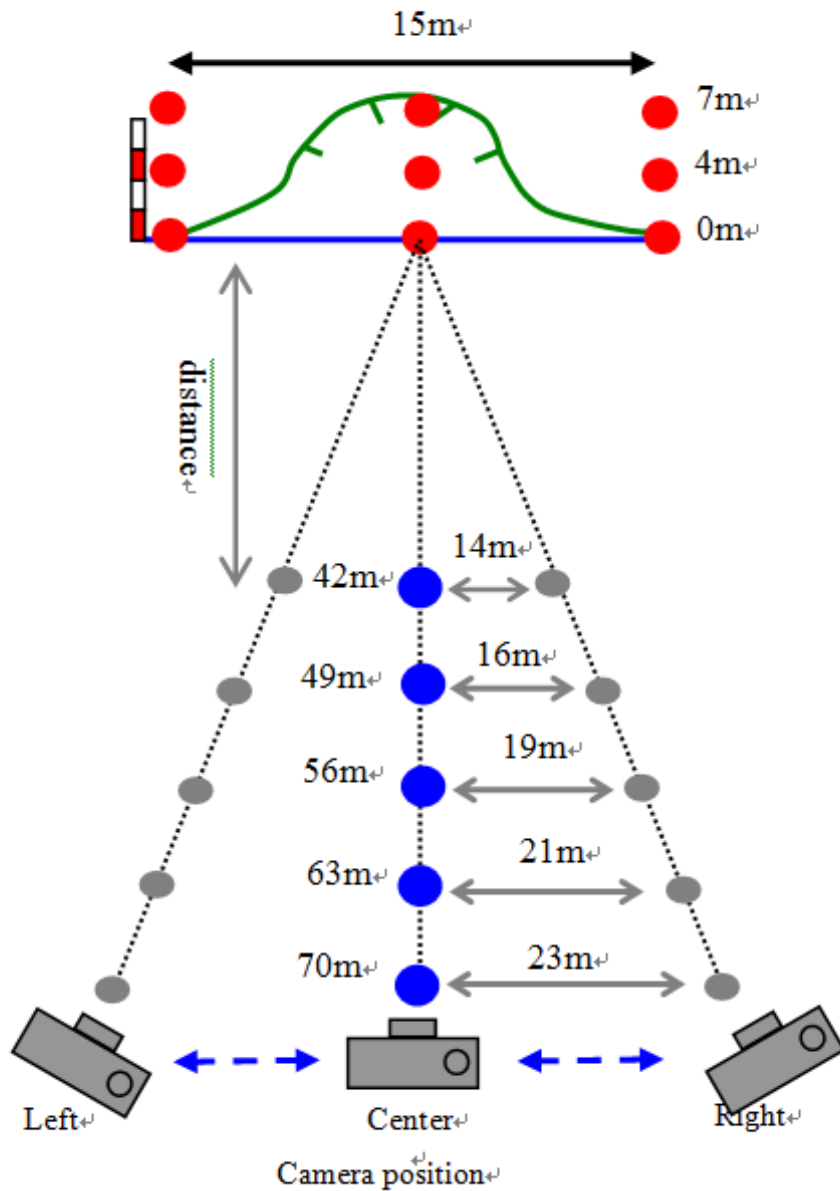
$$R_z(\phi) = \begin{pmatrix} \cos(\phi), & \sin(\phi), & 0 \\ -\sin(\phi), & \cos(\phi), & 0 \\ 0, & 0, & 1 \end{pmatrix}$$



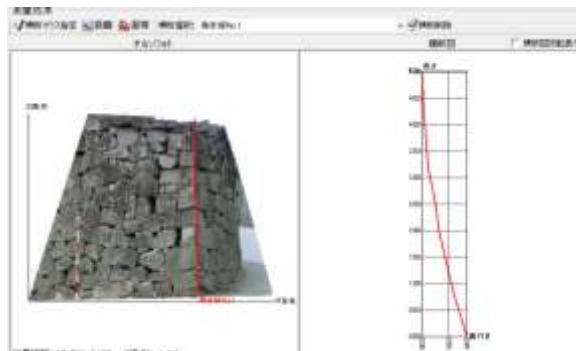
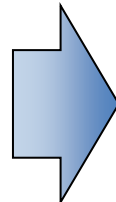
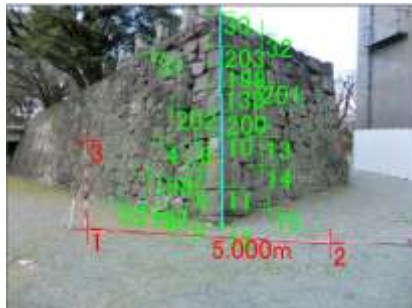
External orientation:
=> collinearity relation

Internal calibration:
=> Lens distortion

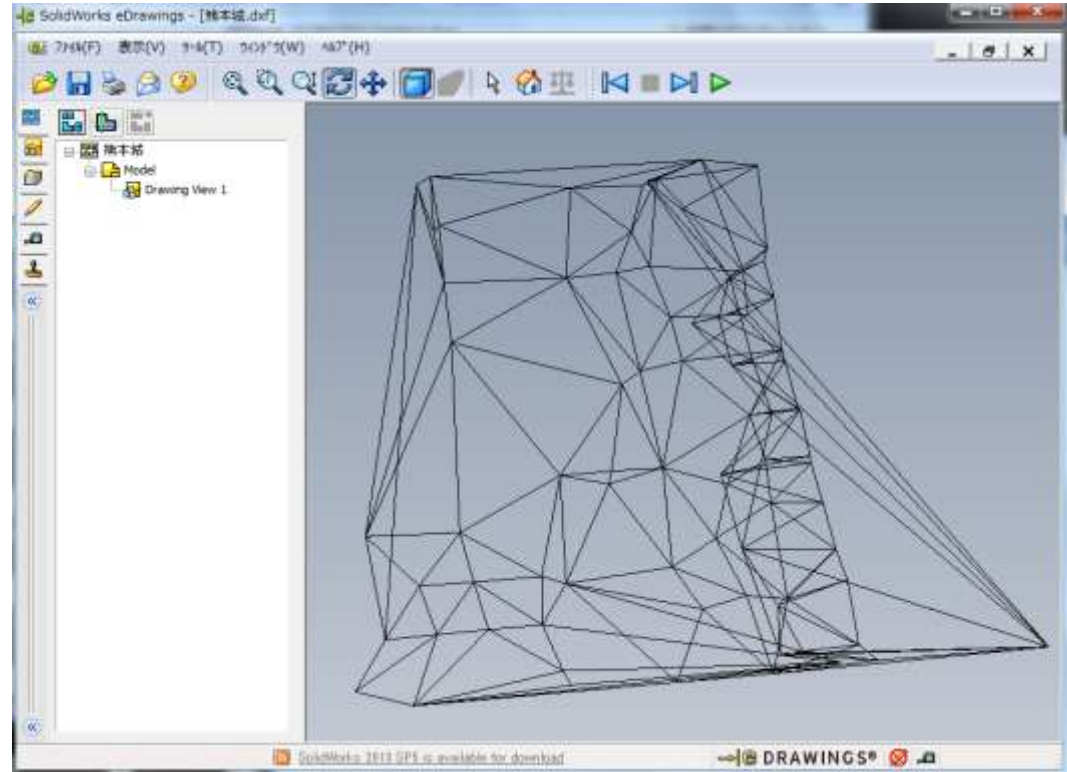
Assessment of precision



Focal distance (mm)	Distance (m)	Mean difference from TS surveyed coordinates (cm)		
		X	Y	Z
18	42	-1.7	-4.2	6.4
	49	-2.8	-0.5	-0.6
55	42	-2.4	-4.9	-0.5
	49	-0.8	-3.5	-3.1
	56	-1.9	-0.8	-1.6
	63	0.3	-5.3	-2.0
	70	-0.7	-4.1	6.0

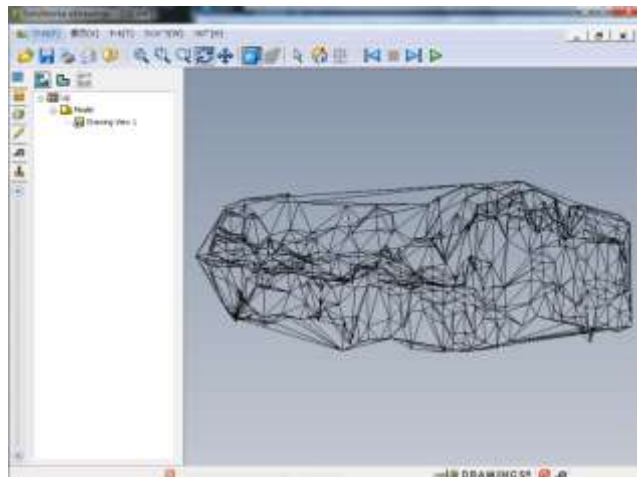
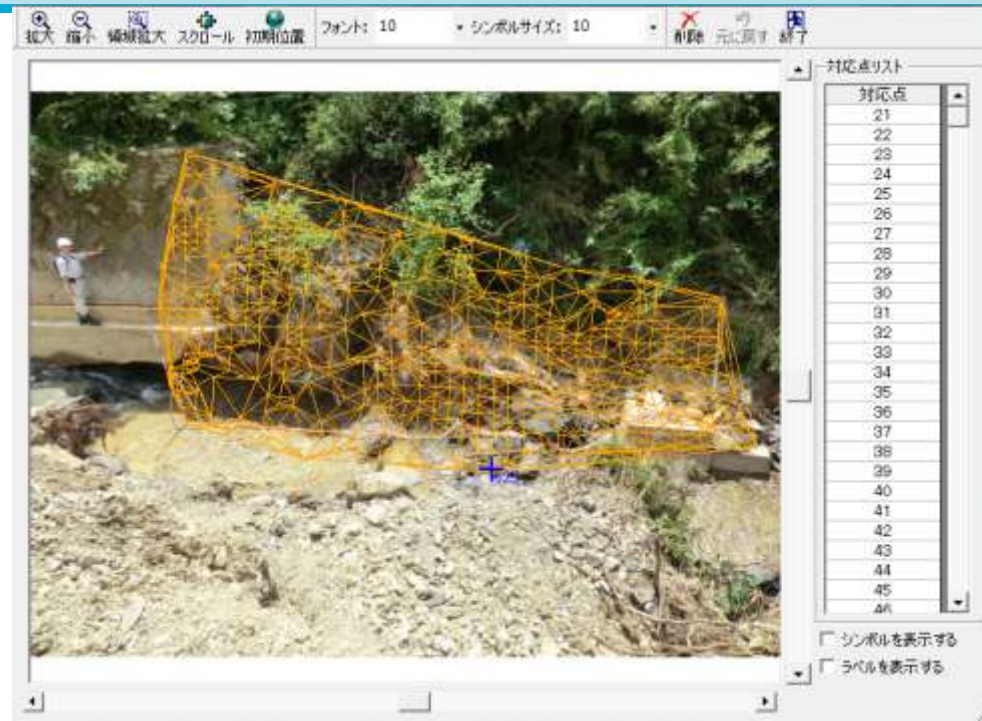


Processed stone wall of a castle

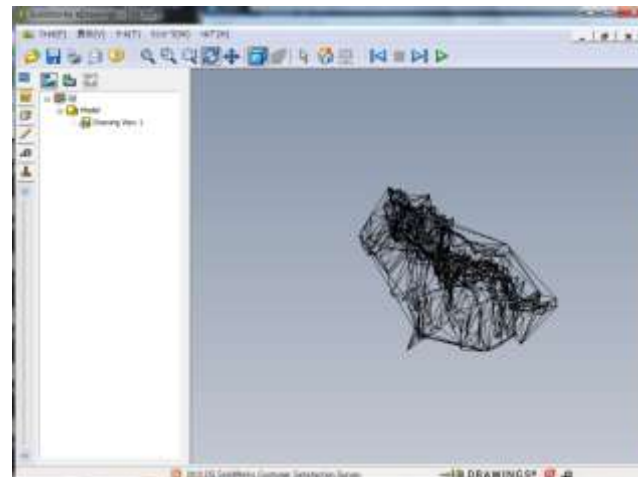


Exported TIN data imported to
3D CAD

Embankment flushed away



Front view



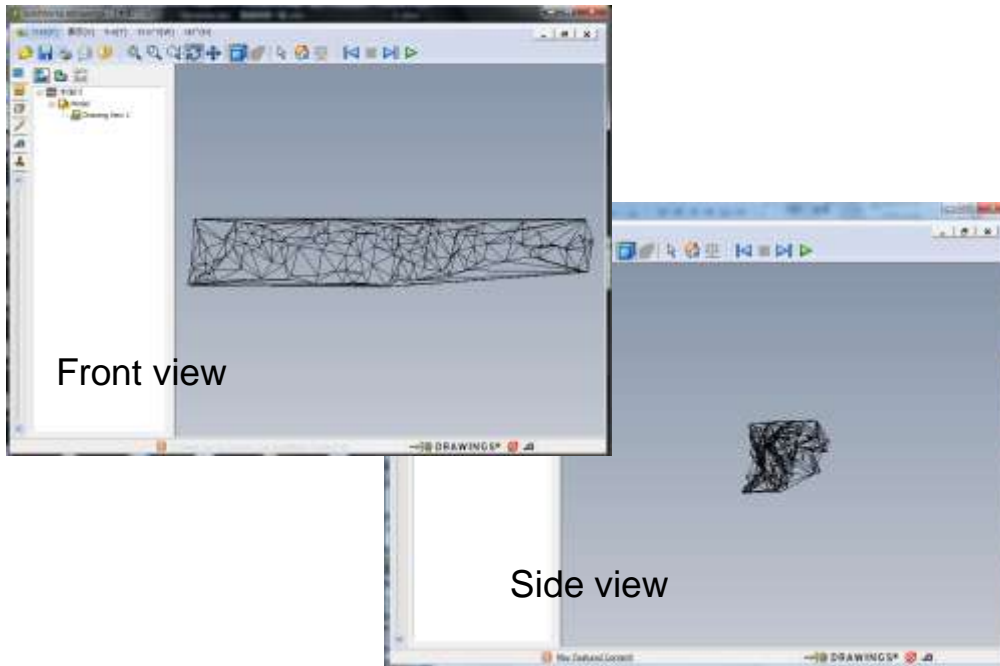
Side view



UAV



Damaged embankment from UAV



When damaged site is narrow and long,
UAV can take a long shot picture

Photogrammetry module of Photog-CAD, a easy to use and reasonably priced software, can be used for acquisition of digital surface model using low cost home-use digital camera

THANK YOU