UAV Aerial Survey for Large Scale Map Updating

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Background

- **JUPEM, sole national government mapping; 4800 personnel, Annual Budget US80 millions;**
- **Map Update Policy at 3, 5 and 10 years interval for Topographic maps;**
- **Updating focussed in developed, urban and rural part;**
- **Updating using MAV are tedious, timely and costly**
- **Cloudy weather & wasted images captured**
- **Integrate UAV orthophoto with existing orthophoto**
- **UAV can fly under the cloud and cheaper cost**

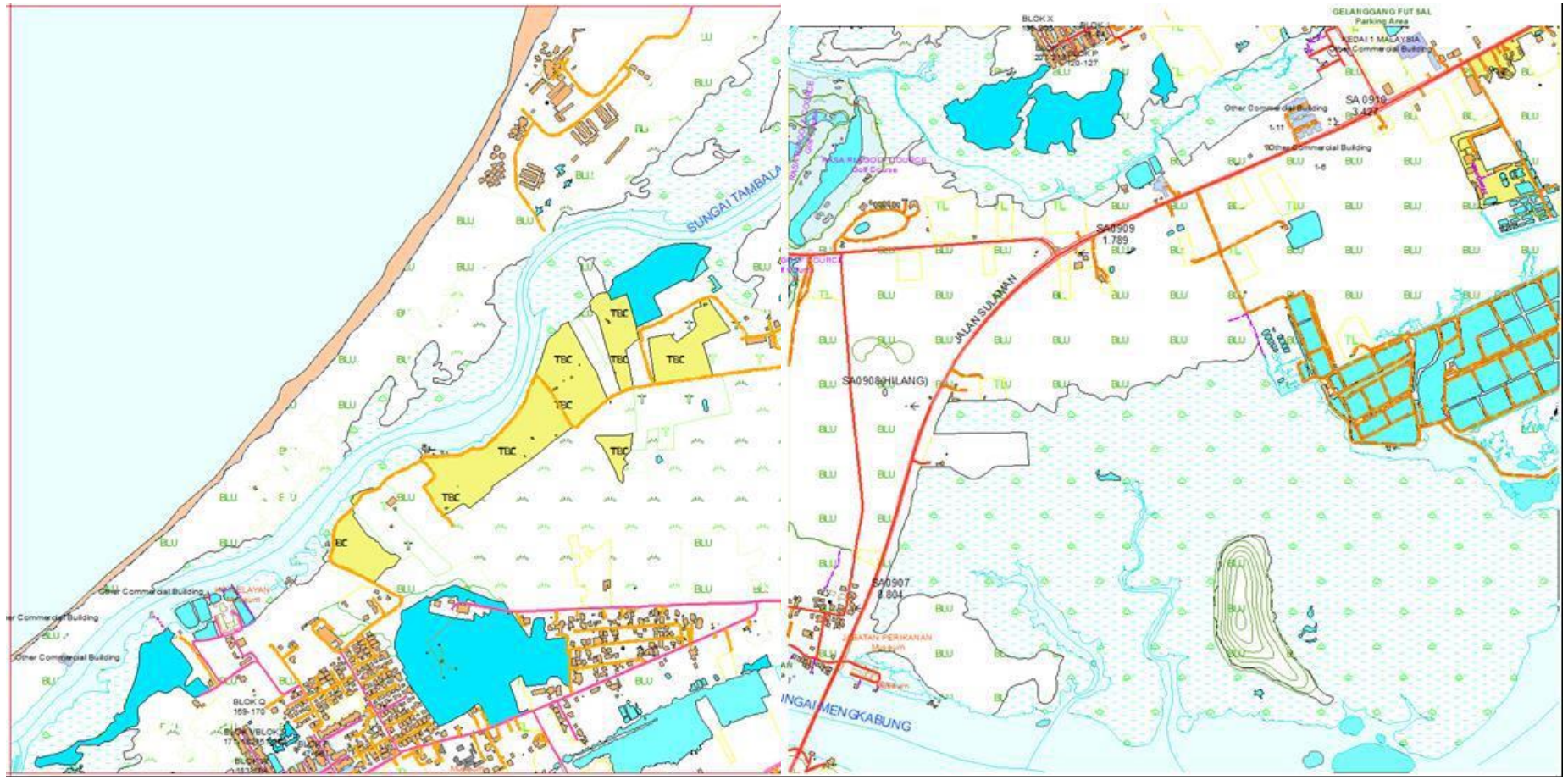
Background

- **The use UAV orthophotos are investigated issues of map updating.**
- **UAV technology can be used to update existing orthophoto previously generated from MAV platform.**
- **Integrate new orthophoto with existing to yield single orthophoto output.**
- **The process was implemented by cut and append, and cautiously assemble parts of them.**
- **This new updated orthophoto should be usable to form a image to update topographic map.**

Study area at Kampung Laya-Laya, Tuaran, Sabah, Malaysia

Orthophotos taken using MAV Feb 2014 (left) and via UAV system in Sept 2016 (right)

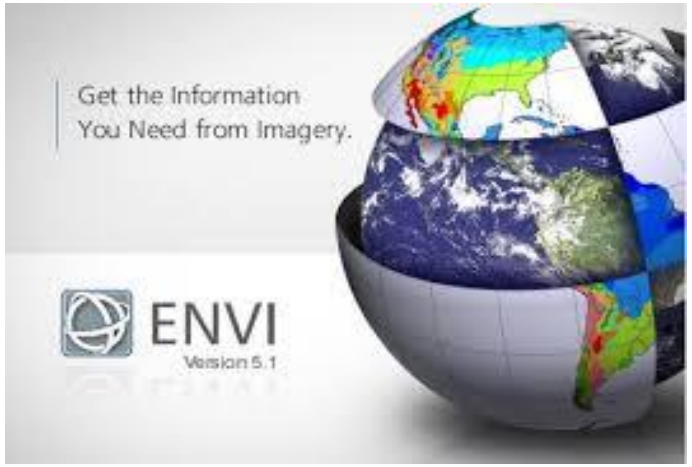
Dataset of the vector map sheet of the study area produced through digital mapping.

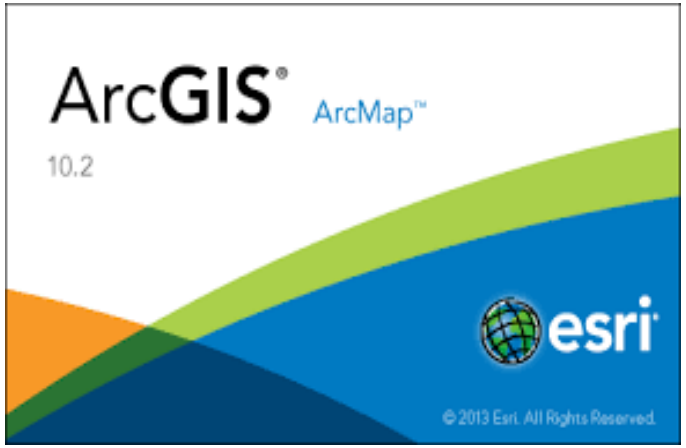


Equipment

- **Digital aerial camera Vexcel UltraCam Eagle 80 captured images with 60% front overlap and 50% side overlap.**
- **Ground Sample Distance (GSD) was set to 10cm. Rectified Skew Orthomorphic (RSO) was applied. GDM 2000 reference datum.**
- **A series of aerial photography were taken on 21 September 2016 along a stretch of area 2km x 2 km**
- **We used a UAV eBEE RTK, employing camera Sony Cybershot DSC-WX 220 RGB 18.2 MP.**
- **GSD was set at 8.3cm with flying height of 600 feet with needed overlap capture**

Equipment and Software





HALE, MID-RANGE and MICRO

Flow chart of the photograph aerial acquisition and geospatial data updating process.

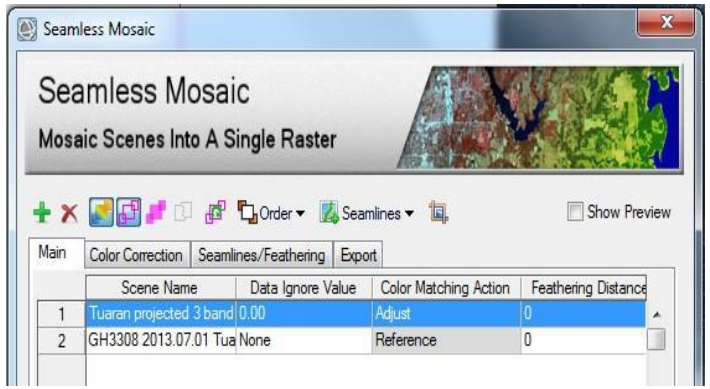
Rectified Skew Orthomorphic (RSO)
East Malaysia coordinates system and
GDM2000 Malaysia as datum

3 colour bands of blue, green and red

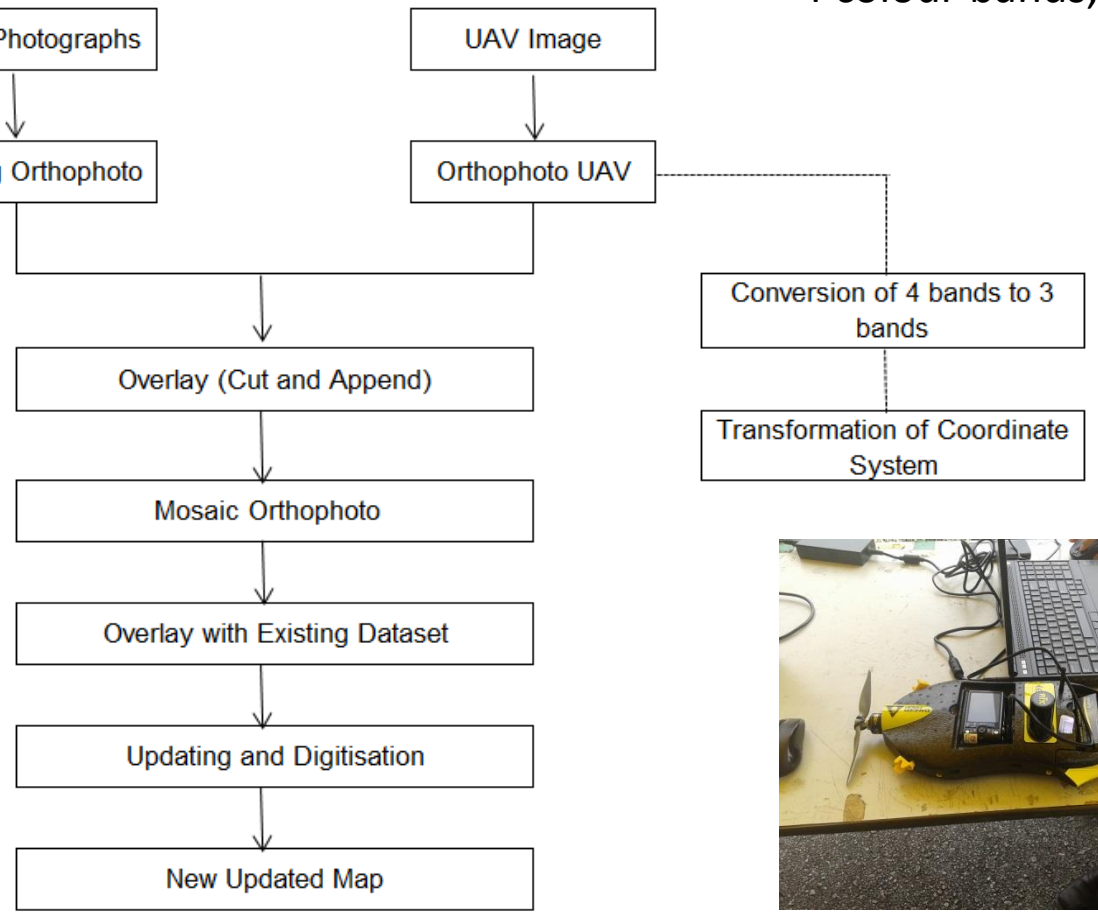
Coordinate system of
UTM Zone 50N and WGS84 as datum.
4 colour bands, i.e. blue, green, red, near infrared

similar colour bands in order to obtain a single raster image; eliminate the fourth band, near-infrared

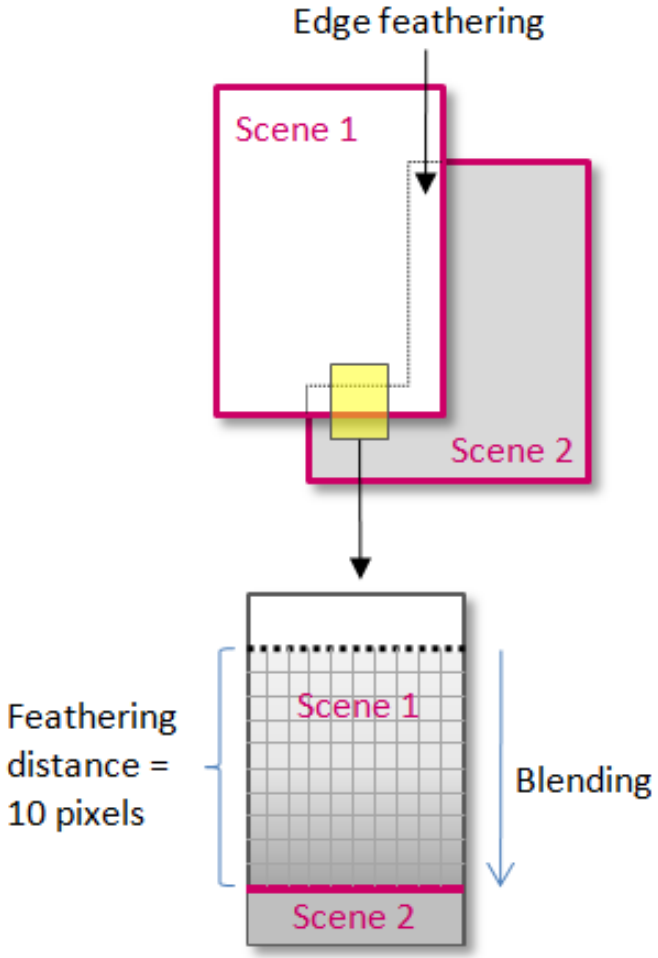
RSO East Malaysia with GDM2000 Malaysia as the reference datum.

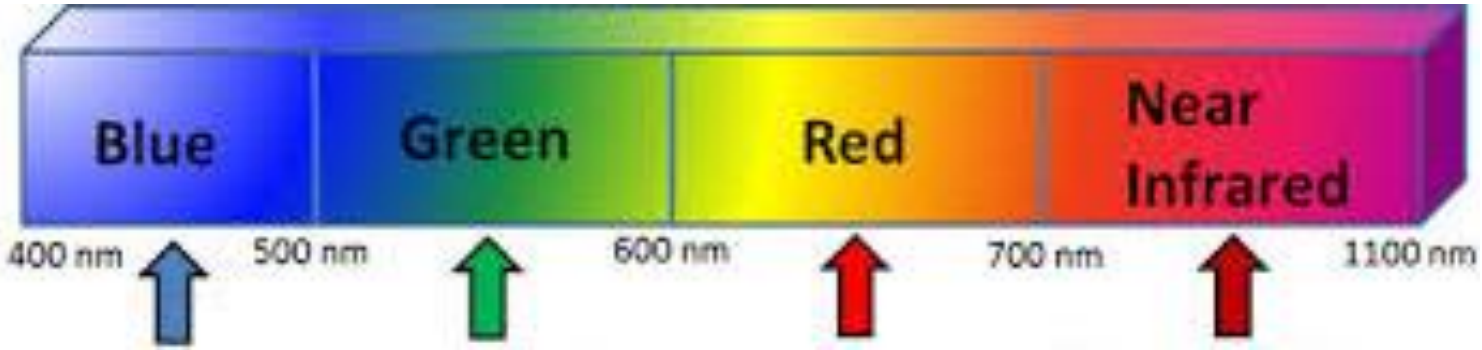


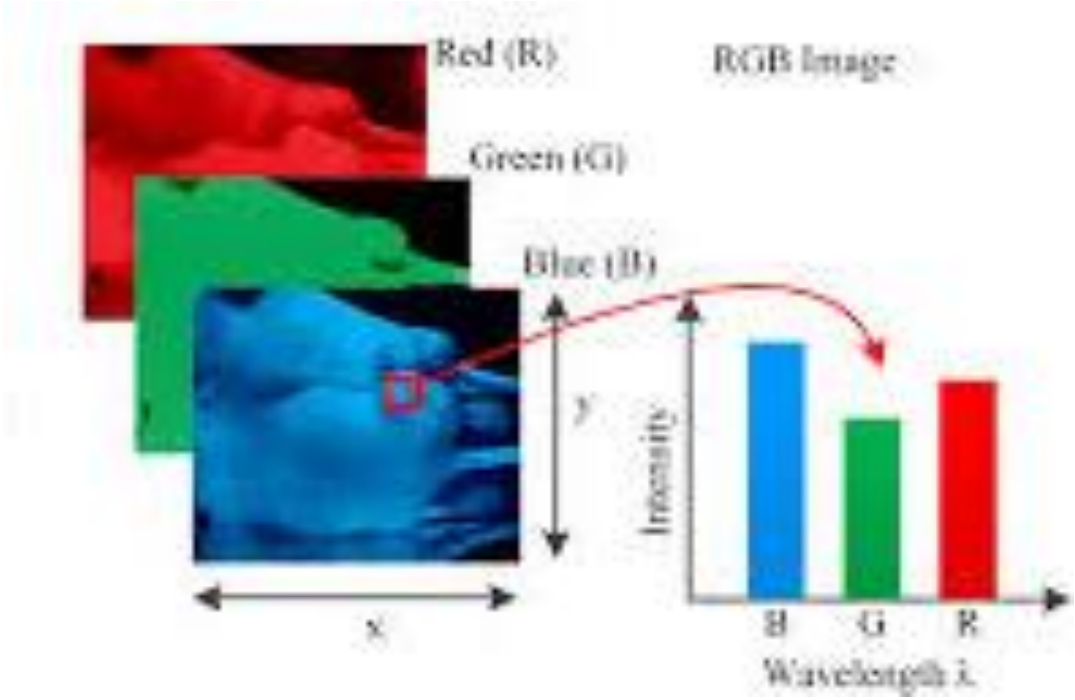
Seamless mosaic interface



Layer stacking in ENVI 5.2 & Edge Matching

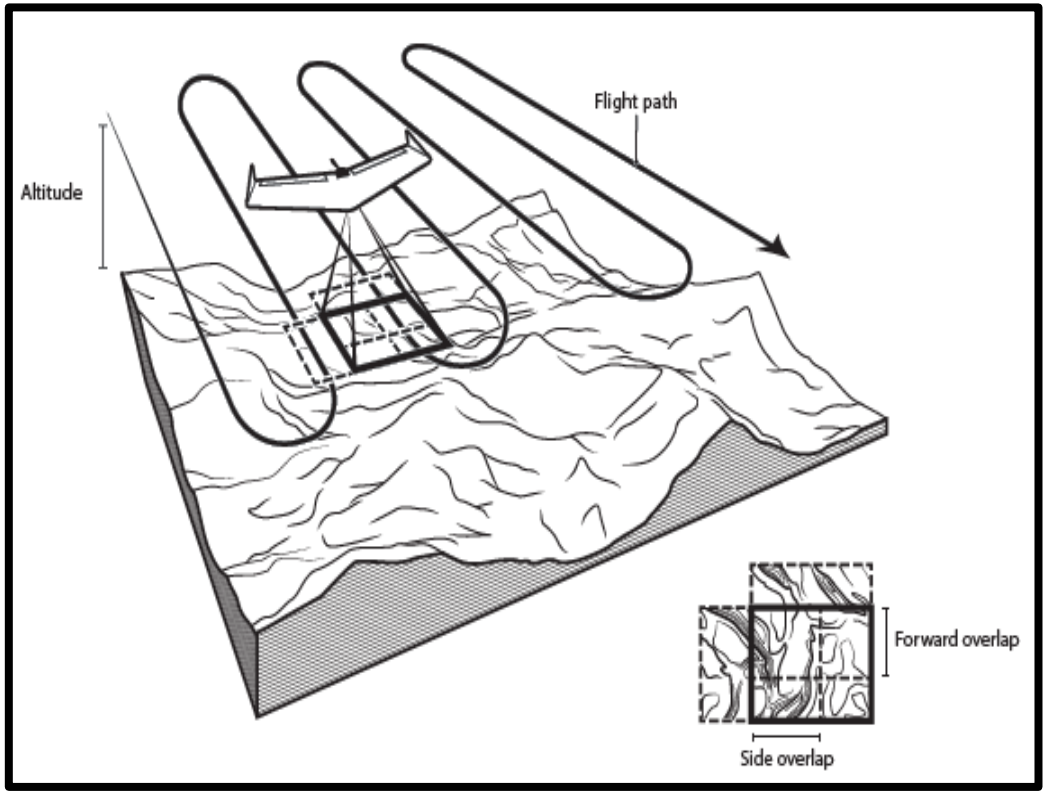


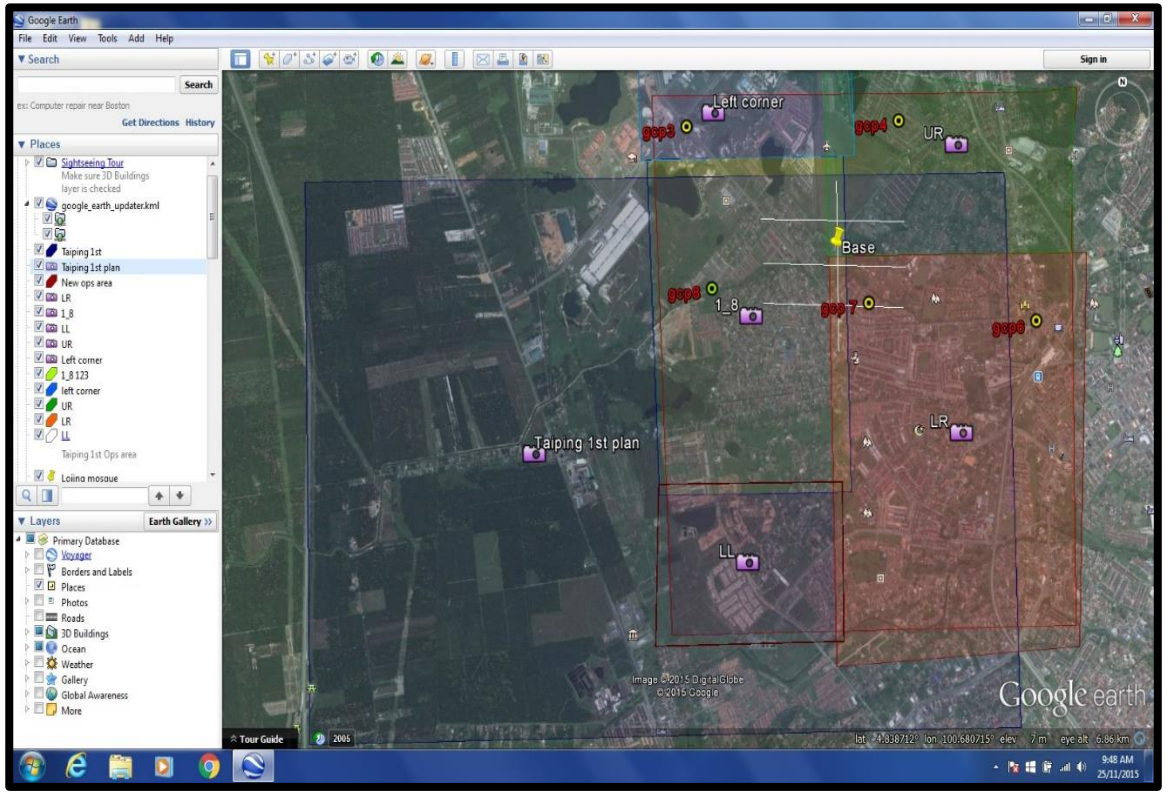




The UAV Flight

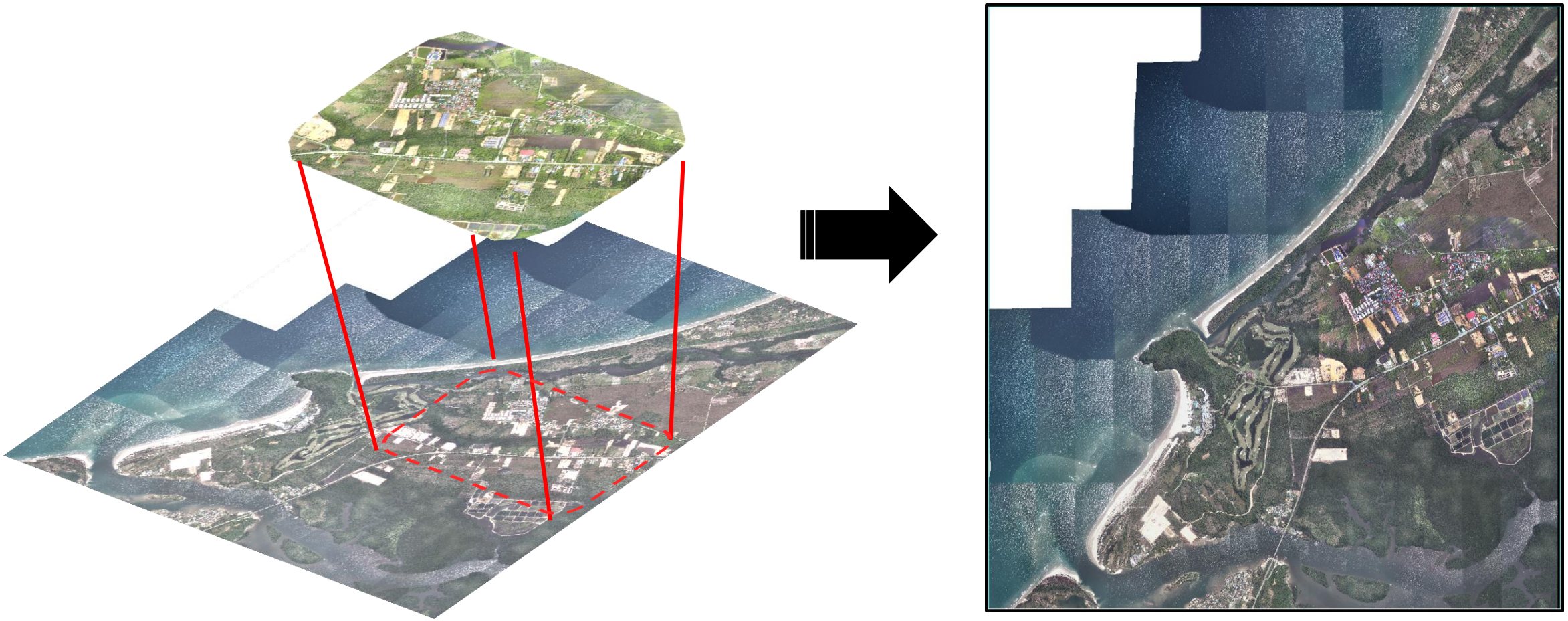
80% forward and 60% side overlapped– 600 ft height





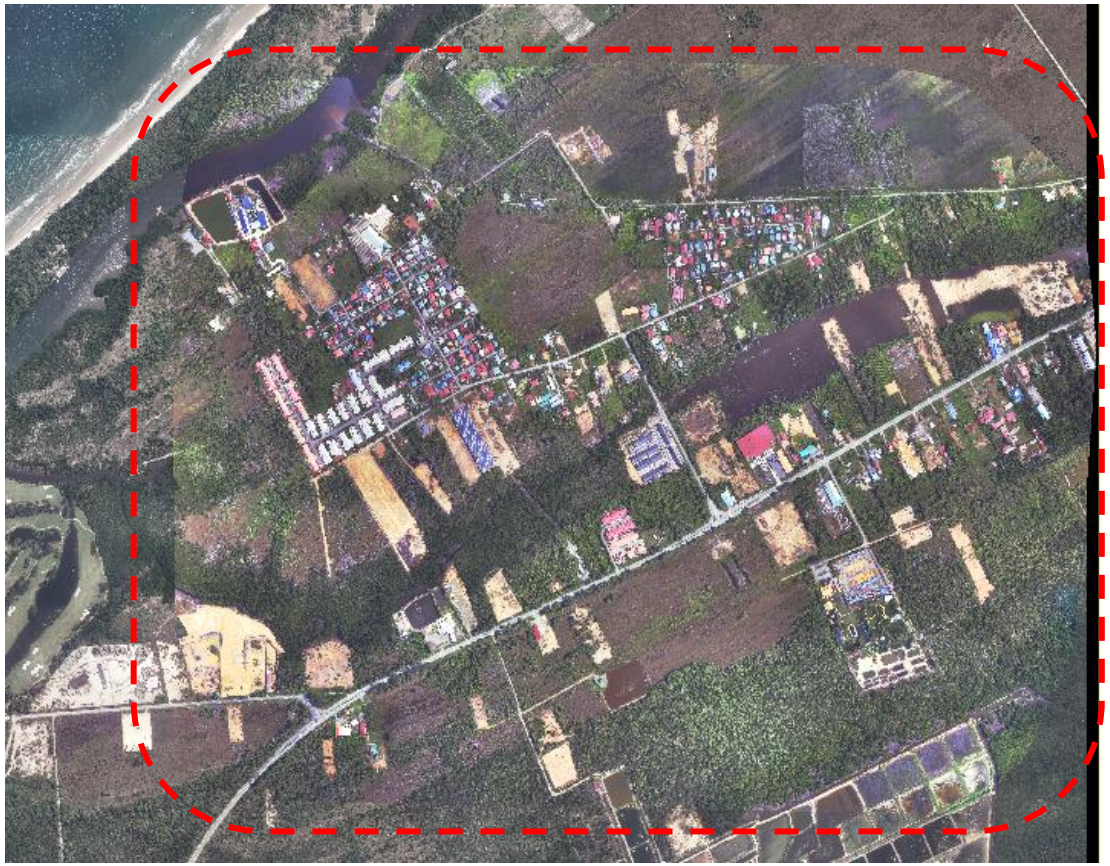
It took about 40 min using two eBee UAV for 4.3km

- **Mosaicking to produce single raster image**



Outcome and Analysis

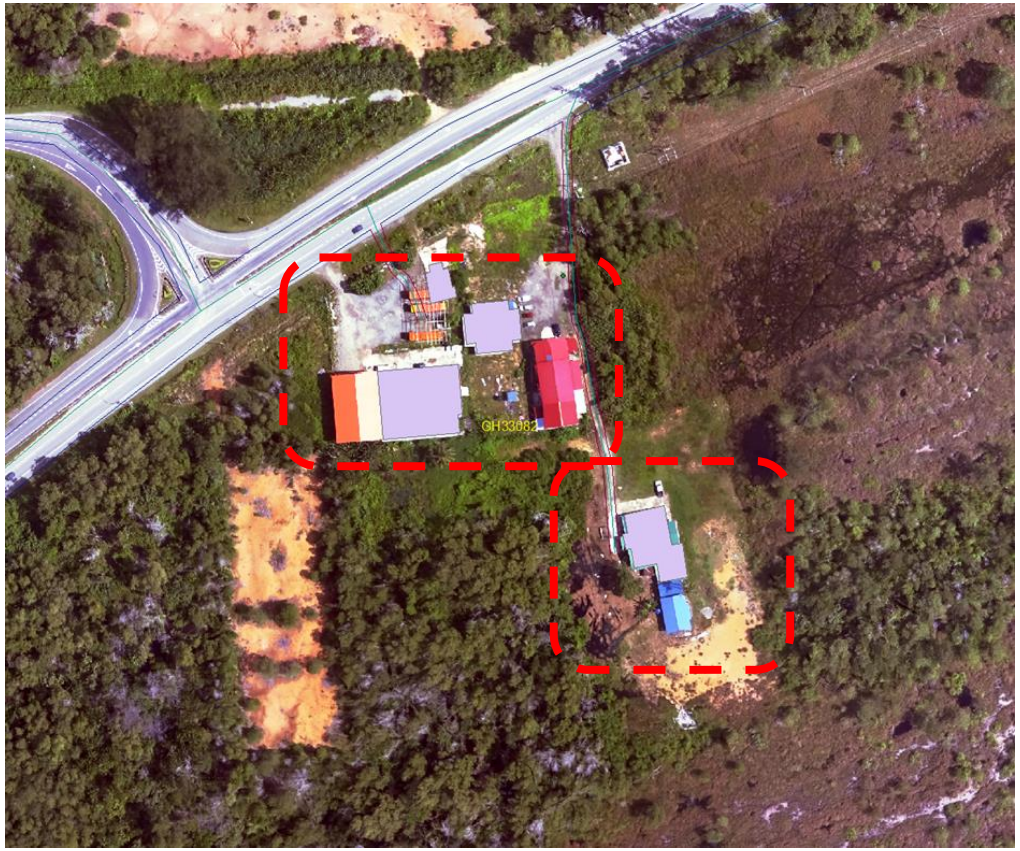
Before Mosaicking



After Mosacking

Outcome and Analysis

Before Mosaicking



After Mosacking

Outcome and Analysis

Before Mosaicking

After Mosacking

Digitization; New features identified were digitized as new spatial objects that would be used to update map sheets

EXISTING ORTHOPHOTO	MOSAICKED ORTHOPHOTO	DETAILS DIGITIZED
		1. Lake area amended and updated 2. Swamp area amended and updated 3. Mangrove forest amended and updated 4. Cleared land amended and updated 5. Scrub/Shrub (bushes) amended and updated 6. New residential buildings added 7. Substation & Switching Station added 8. Fence Line inserted 9. Irrigation Canal added 10. Culvert added 11. Road Line added 12. Road Edge line added 13. Road Surface polygon added 14. Footpath (Recreational) added

Results

- Deployed UAV has successfully to generate new orthophoto. The software Pix4UAV showed orthophoto production conformed the accuracy requirement for town
- UAV orthophoto was integrated with existing MAV orthophoto previously produced.
- Integration by means of mosaicking was carried out very well and a new mosaicked orthophoto provided for map updating.
- Quick result for a large scale map of 1:5000 around apparent area of changes.
- Fly low below the cloud is rewarding comparing to normal aircraft.
- Future plan; Vertical take-off type of UAV system with higher capability

UAV vs MAV in Aerial Mapping

		Manned Aircraft	eBee RTK UAV
No.	**Element**	**Summary (Comparison)**	
1.	Installation	Very expensive; 1. Aircraft rental 2. Camera systems 3. Customs aircraft 4. Aviation law	Inexpensive; 1. Ultra-light weight radio control aircraft 2. Digital compact camera
2.	Operation	Very expensive; 1. Need for pro pilot 2. Airport runway 3. Camera system calibration	Inexpensive; 1. Mobile 2. Do not need for runway 3. Easy setup
3.	Area	1. Cost effective for large mapping area bad for small area 2. Cost per km^2 is high 3. Processing cost per km^2 is Cheaper	1. Cost effective for small area and bad for large area 2. Cost per km^2 is cheaper 3. Processing cost per km^2 is slightly higher
4.	Application	For mapping small scale base map (scale up to 1:50,000)	1. Updating large scale map 2. Boundary/island monitoring & watch 3. Natural disaster monitoring

Analysis of images accuracy captured by MAV and UAV as compared to observed true coordinates using GNSS. Standard deviation of the differences between the two images coordinate are acceptable in the mapping accuracy of features to be plotted at large scale of 1: 10,000. The planimetric displacement allowable for smaller than 1: 20,000 scale map is 1/30 inches (0.85mm), within JUPEM's Procedure of Survey for Map Accuracy. RMSE has shown high value (1.416) when comparing coordinates of UAV versus MAV image.

Station No.	Coordinates of Orthophoto MAV		Observed Coordinates		Coordinates of Orthophoto UAV		Difference of Coordinates between Observed and Orthophoto MAV			Difference of Coordinates between Observed and Orthophoto UAV			Difference of Coordinates between Orthophoto MAV dan Orthophoto UAV		
	North	East	North	East	North	East	North	East	Magnitude	North	East	Magnitude	North	East	Magnitude
TK01	681746.128	718372.504	681745.442	718372.72	681745.943	718373.086	-0.686	0.216	0.719	-0.501	-0.366	0.620	0.185	-0.582	0.611
TK02	682247.446	719426.712	682246.882	719426.862	682246.017	719427.109	-0.564	0.150	0.583	0.865	-0.247	0.900	1.429	-0.397	1.483
TK03	682361.859	719559.253	682361.232	719559.423	682360.340	719559.493	-0.627	0.170	0.650	0.892	-0.070	0.895	1.519	-0.240	1.538
TK04	681996.365	719742.326	681995.754	719742.317	681994.989	719742.723	-0.611	-0.009	0.611	0.765	-0.406	0.866	1.376	-0.397	1.432
TK05	682579.787	720088.241	682579.076	720088.259	682578.622	720088.294	-0.711	0.018	0.711	0.454	-0.035	0.455	1.164	-0.053	1.165
TK06	682427.473	718364.931	682426.837	718364.784	682426.494	718365.566	-0.636	-0.147	0.652	0.343	-0.782	0.854	0.979	-0.635	1.167
TK07	682891.892	718249.253	682891.295	718249.394	682890.834	718250.523	-0.597	0.141	0.613	0.461	-1.129	1.220	1.058	-1.270	1.653
TK08	682837.963	718599.391	682837.22	718599.523	682836.402	718600.079	-0.743	0.132	0.754	0.818	-0.556	0.989	1.561	-0.688	1.706
TK09	682689.482	718669.372	682688.711	718669.377	682688.026	718670.060	-0.771	0.005	0.771	0.685	-0.683	0.967	1.455	-0.688	1.610
TK10	682514.375	718523.851	682513.74	718523.89	682513.184	718524.618	-0.635	0.039	0.636	0.556	-0.728	0.916	1.191	-0.767	1.416
TK11	682565.224	718735.666	682564.382	718735.634	682564.060	718736.275	-0.842	-0.032	0.843	0.322	-0.641	0.717	1.164	-0.609	1.314
TK12	682748.088	718441.527	682747.513	718441.623	682746.659	718442.321	-0.575	0.096	0.582	0.854	-0.698	1.103	1.429	-0.794	1.634
TK13	682605.678	718295.359	682605.162	718295.469	682604.646	718296.179	-0.516	0.110	0.528	0.516	-0.710	0.878	1.032	-0.820	1.318
Average							-0.213	0.022	0.216	0.176	-0.176	0.284	0.389	-0.198	0.451
Value Maximum							0.000	0.216	0.843	0.892	0.000	1.220	1.561	0.000	1.706
Value Minimum							-0.842	-0.147	0.000	-0.501	-1.129	0.000	0.000	-1.270	0.000
Std Deviation									0.316			0.424			0.670
RMSE									0.671			0.895			1.416
% Precision									100%			100%			100%


Color indicates mission type:
Agriculture
Archaeology
Armed Conflict Monitoring
Cargo
Community Mapping
Current Events
Disaster Response
Environmental Surveying
Search and Rescue
Training
Other
Wildlife Surveying
Shape indicates drone type:
Multirotor Drone
Fixed wing or Other
Size indicates cost of drone
Beaufort Sea
Baffin Bay
GREENLAND
Norwegian Sea
ICELAND
SWEDEN
FINLAND
NORWAY
RUSSIA
CANADA
DENMARK
UNITED KINGDOM
BELARUS
GERMANY
FRANCE
UKRAINE
ROMANIA
KAZAKHSTAN
MONGOLIA
North Atlantic Ocean
SPAIN
ITALY
UZBEKISTAN
TAJIKISTAN
TURKEY
CHINA
JAPAN
MOROCCO
ALGERIA
LIBYA
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IRAQ
IRAN
KUWAIT
PAKISTAN
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SOUTH AFRICA
Indian Ocean
AUSTRALIA
NEW ZEALAND


THANK YOU
FOR LISTENING TO MY IDEAS