

Convenient aeromagnetic survey by a model helicopter SF40 at the ruin of ironwork refinement

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It is difficult to detect the magnetic anomaly by a helicopter at the archeological or historical ruins due to the restraint of the low altitude flights in the narrow area. Although a relatively small unmanned helicopter has been commercialized for agriculture use etc., it is too expensive for aeromagnetic surveys. We have developed a small autonomous unmanned helicopter which modified a model helicopter for aeromagnetic survey.

A model helicopter (Hirobo Co.; SF40) with a 40cc gasoline engine, length of 143cm from the nose to the tail and dry weight of 15 kg is selected in this study. The irradiated magnetic field from SF40 was $(R)=3511$ nT of the total magnetic field, inclination $(I)=12^\circ$ and declination $(D)=138^\circ$ at the bottom-center of skid. It was reduced to about 1 nT at 3 m downward from the skid during the hovering. When SF40 was covered with a magnetic shield film (Amolic sheet), the distance to measure 1nT diminished to 2 m. As the shield of whole body with the film is not effective for the reliable and safety flights, only servomotors having the strong magnetization were shielded by the film. The autonomous flights based on GPS for SF40 succeeded, but the control system was too large and heavy. We are developing more simple and small navigation system for this project.

Magnetometer system consists of a 3-axis fluxgate magnetometer, data logger, GPS and battery, recording every second of x, y and z magnetic fields, latitude, longitude, altitude and satellite number during 3 hours. The total weight of the system is 400g. The system was hanged by a rope to 2 m lower from the skid (Bird magnetometer) or 2m front from the nose by a carbon fiber pipe (Stinger magnetometer) in order to avoid the magnetic field of SF40. The magnetic noise during flight of the singer magnetometer was not so high, but the bird magnetometer was extremely large due to the swing of the sensor. So the former magnetometer was employed in this study.

An archeological ruin of the ironwork refinement aged 15th century at Unnan-City, Shimane Prefecture, Japan was measured by the stinger magnetometer. The survey area was 70x20m with a gentle slop. The helicopter was controlled by the manual keeping up the roughly same altitude (the 4-8m height from the surface) and speed (1m/s). The result showed the strong anomalies of 500 nT at the NW corner of the area where consists with the refinement. From these viewpoints the model helicopter is useful to find the ironwork refinements instead of the identification based on the feeling and the experience of archeologists.