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ORBIT DETERMINATION APPROACH FOR EDUCATIONAL SATELLITES USING GROUND  
STATION NETWORKS

**Abstract**

In the scope of small satellite missions were many ground stations all over the world established. Several projects to network these stations were initiated, mainly to extend the available communication time to the satellites and to increase the utilization of the individual ground stations . The work presented in this paper goes one step further and uses a low cost ground station networks to determine the orbit of a small satellite.

Many small satellite projects rely for satellite tracking on the orbit data published by NORAD. The published TLE files contain all information necessary to reliably track a satellite. Nevertheless, a certain problem occurs in the first days after launch: When the satellites are ejected from the launch deployers, NORAD detects the corresponding orbits and publishes the data for the detected objects. Unfortunately there is no mapping between detected objects and launched satellites. It is not possible to determine which orbit belongs to which satellite, especially as the satellites are very close together in the first days. In this case an optimal satellite tracking is not possible. Hence, in these first days of operation would an additional orbit determination system be very useful. We developed a system, which is able to identify the orbit of small satellites solely on Doppler shift measurements.

The paper describes an approach how to use low cost ground station networks for orbit determination. The algorithm uses Doppler shift measurements to determine the distance between satellites and ground station. The Doppler shift measurements are fed into an Extended Kalman Filter to estimate the actual orbit of observed satellite. In this way it is possible to derive from the transmitted beacon signals additional orbit information. The novelty is to use the already available infrastructure in low cost ground station networks to support the LEOP phase of Cubesats or other educational small satellites.