# RADAR PLATFORM MOTION ESTIMATION BY ONBOARD FORMED IMAGE GRAVITY CENTER DISPLACEMENT

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*Abstract* — An accuracy estimation of the presented in [1] autofocus algorithm for synthetic aperture radar are investigated. Some measures to improve quality of the algorithm are presented.

## 1. Introduction

Synthetic aperture radar (SAR) requires correction of phase errors provoked by different sources for getting high quality radar images (RI). The most critical phase errors in SAR are provoked by motion estimation errors supplied by navigation system (NS). Correction of these phase errors can be made using one of autofocus (AF) algorithms.

AF algorithm of a radar image by estimating its fragment's gravity center displacement is proposed in [1]. The advantages and disadvantages of this AF algorithm and the ways of improving its accuracy are described hereafter.

## 2. The main part

The AF algorithm proposed in [1] allows getting SAR platform speed estimations. Later these estimations are used to correct navigation data from NS for making RI. The structure of making RI using this algorithm is shown in fig. 1.

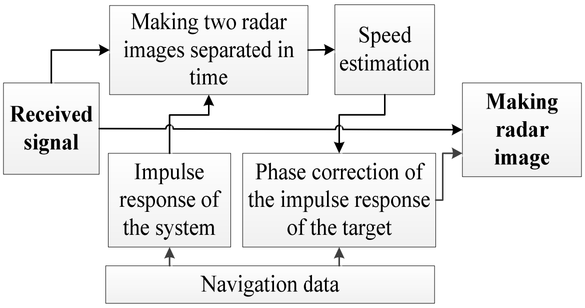


Fig. 1

If the proposed algorithm is used, speed estimation accuracy depends on some parameters: metric resolution (MR) of SAR, autofocus interval, features of reflective surface.

In the absence of NS errors and the absence of surface reflection fluctuations, the speed estimation error depends on AF interval as it is shown in fig. 2.

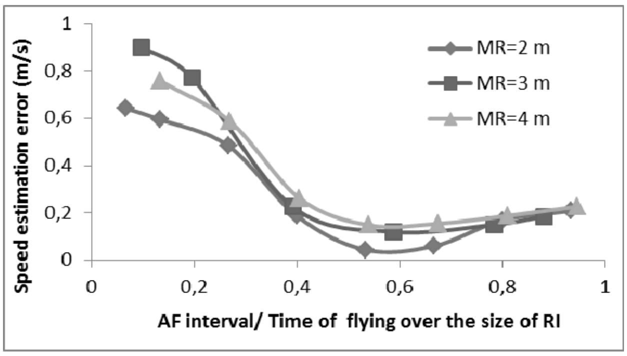


Fig. 2

Fig. 2 shows that to get the most accurate speed estimations, AF interval should be chosen so that during this time the SAR platform flies over (0.5…0.7) of RI. If an AF interval is short then the displacement of image's gravity center is also small. So the speed estimation error is an effect of discretization. In the event that an AF interval is long, the accuracy of speed estimation becomes worse because of decreasing of the common area in RI obtained from the beginning point and from the end point of an AF interval.

If SAR MR is in a range of (2…5) m and speed measure error of NS is no more than 1 m/s, then a usage of the proposed algorithm will allow to obtain speed estimation of SAR platform with accuracy of 0.2 m/s. This accuracy is enough for getting a focused RI. If NS speed measure error is more than 1 m/s, then AF must be done in 2 or more similar stages to get a focused image (using obtained at previous stage image instead of a received signal).

The dependence of the speed estimation error on features of reflective surface is evaluated on bright targets (BT) influence. The results of simulating at different average ratio “bright target / background noise” (b.t./n) are shown in figure 3 (SAR metric resolution equals 2 m).

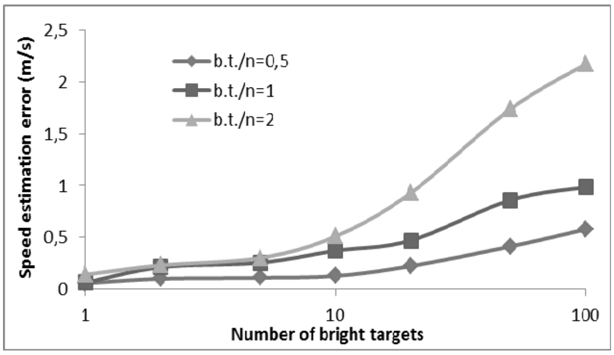


Fig. 3

The obtained estimations show that growth of fluctuations of a reflective surface (simulated as bright targets) makes accuracy of the proposed algorithm worth.

## 3. Conclusion

SAR platform motion estimation using the proposed algorithm allows getting high quality focused RIin the absence of surface reflection fluctuation. If there are great errors of NS then AF must be done in several stages. The best results of AF can be achieved if AF interval equals (0.5 … 0.7) of RI flying over time. If fluctuations of reflective surface are significant, the algorithm must be used in a complex with different AF algorithms.

## 4. References

[1] Maitre H. Processing of synthetic aperture radar image / H. Maitre. — Chippenham: Willey, 2008. — 384 p.