Abstract—An experimental study of an active cooperative observation approach based on Extended Set-Membership Filter (ESMF) is completed. In the experiment, the two RFRs can keep the optimal observation formation while achieving the cooperative observation so that the observation accuracy is improved further. The most attracting advantages in this video is that the experimental results on the testbed showed the proposed method can achieve data fusion well to improve the observation accuracy and the real time performance and observation accuracy can meet the requirement of on-line application.

I. INTRODUCTION

The method research of cooperative observation is in-depth, on the other hand, the experimental study is relative weak for its the highly complicated system model and huge risk, which has been one of the most important bottlenecks during the researches of MRFs. Based on the active cooperative observation method an original experimental scenario is designed with respect to an indoor multiple-rotorcraft-platform and the results are listed out and analyzed in detail to verify the feasibility and validity of the proposed algorithm.

II. INTRODUCTION OF ACTIVE COOPERATIVE OBSERVATION METHOD BASED ON ESMF

Based on the ESMF[1], the measurement result of the sensor is an uncertainty which the target is ensured to lie within. If we use two robots to observe the same target, its real state must lie within the following three sets: two measurement sets and the ESMF prediction sets. Thus, finding an ellipsoid that bounds the intersection of the three sets a smaller uncertainty location can be obtained as shown in Fig. 1.

The algorithm involves two steps: prediction and cooperative update.

Prediction: predict the target state according to the last observation result;

Cooperative update: revise the prediction set with two robots’ measurement set.

III. MULTIPLE RFRS TESTBED

The vision based measurement system is designed and realized for testing the active cooperative observation method discussed before as shown in Fig. 3. The middle RFR (defined as RFR1) is supposed as the moving target and the other two RFRs (defined as RFR2 and 3) are equipped with
camera for observing and tracking the target cooperatively. The detail function and design of the testbed can be found in [7].

IV. EXPERIMENTS RESULTS

According to the attitude of the cameras, the optimal observation formation is 110° in the horizon direction. The observation formation is kept through some central formation control algorithm according to the cooperative observation result.

Fig. 4 Error distribution and envelope ellipses of two RFRs’ observation

The measurement error’s bound and corresponding envelope parameters are listed in Fig. 4 where ‘*’ and ‘·’ denotes measurement error vector for RFR2 and RFR3, respectively. The two ellipses are the estimated measurement error boundary for the two RFRs. It is obvious in Fig. 4 that the error is not Gaussian distribution, so the unknown but bounded assumption more conform to the reality.

Fig. 5 Comparison of the ellipse trace between cooperation and single observation

We take the trace of the envelope matrix as an index of the observation accuracy. The change of the trace in the whole observation process is shown in Fig. 5, the green line and blue line are the envelope matrix trace of the RFR2 and RFR3. The red one is the cooperative observation result. Along with the tracking and observation, more information of the target is obtained and the size of the ellipse converged to a smaller steady value. It is obvious in Fig. 5 that the cooperative observation accuracy is better than each single one.

Fig. 6 Cooperative angle

Along with the tracking and observation, more information of the target is obtained and the size of the ellipse converged to a smaller steady value. It is obvious in Fig. 5 that the cooperative observation accuracy is better than each single one.

Fig. 6 shows the change of the cooperative angle in the experiments. From the figure we can see clearly that the cooperative observation angle can always keep around 110 degree during the tracking process. From Fig. 6 the conclusion is that our method can achieve near-optimal cooperative observation actively with the moving of the target by path planning the path properly.

V. CONCLUSION

The experiment study of a cooperative observation algorithm of multiple robots locate a moving target based on ESMF was proposed in this video. Two RFRs in the testbed take the camera as the measurement sensors to achieve active cooperative observation and tracking a free moving target. The experimental results show that the method can achieve data fusion well to improve the observation accuracy and real-time performance can meet the requirements of the on-line application.

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