***Title*—Robust safety critical control for multi-agent systems with bearing-only measurements**

***Keywords*—Bearing-only formation control, multi-agent systems, safety critical control, control barrier functions.**

***Abstract*—In this paper, we focus on the robust safety-critical control problem for multiagent systems (MASs) with bearing-only measurements under model uncertainty. First, a nominal bearing-only control law is derived in which the uncertainty is considered, and the global stability is proven by using Barbalat's lemma. Then, safe sets for obstacle avoidance are defined by safety constraints, and exponential control barrier functions (ECBFs) are introduced to deal with these high relative-degree safety constraints. Furthermore, considering that uncertainty may lead to violation of the constraints, we propose robust ECBFs by combining ECBFs and min–max inequality constraints, which guarantees the forward invariance of the safe set despite model uncertainty. Based on this, the nominal control law is optimized under robust safety-critical constraints via a quadratic program (QP), which means that the control law is modified only when a collision is imminent and the trade-off between performance and safety is balanced to the fullest extent possible. Finally, the simulation results verify the validity of the proposed method.**

Main contribution:

(i) Few works have been focused on the safety of bearing-only control subject to obstacles. In this paper, the ECBF is combined with a bearing-only control law for the first time, which provides provable high relative degree safety-critical constraints for obstacle avoidance. Based on this, the nominal control law is optimized via quadratic program with safety constraints, which balances the trade-off between performance and safety to the fullest extent possible.

(ii) Confronted the fact that uncertainty leads to the violation of the safety constraints, we propose robust ECBFs designed by combining ECBFs and min–max inequality constraints, which is an extension of the work in [1] and guarantees the forward invariance of the safe set established by ECBFs despite model uncertainty.

(iii) The effect of bounded uncertainty is taken into account in the bearing-only control law; meanwhile, the need for bearing rate that may contain measurement noise is eliminated by introducing two auxiliary variables, which is more practical compared to that of the approach in [2].

[1] Q. Nguyen, and K. Sreenath, "Robust safety-critical control for dynamic robotics," *IEEE Trans. Autom. Control*, Mar., 2022.
[2] S. Zhao, Z. Li, and Z. Ding, "Bearing-only formation tracking control of multiagent systems," *IEEE Trans. Autom. Control*, Nov., 2019.

***Conclusion*—In this paper, we propose a robust safety-critical bearing-only control law for MASs with uncertainty. The bearing-only control problem subject to uncertainty and the safety assurance problem with obstacles are addressed simultaneously. The nominal bearing-only control law is first derived and then optimized within the QP framework under robust safety constraints. The robust safety constraints are devised by combining min–max inequality constraints and ECBFs, in which the first is to enhance robustness subject to uncertainty and the second is to deal with the high relative-degree safety constraints. The global stability when using the bearing-only control law is proven by using Barbalat's lemma, and safety assurance is proven by the forward invariance of the safe set despite model uncertainty. For future works, it may be interesting to focus on dealing with more general uncertainty in bearing-only control and safety-critical control.**