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POSITIONAL STRENGTHENINGS OF THE MAXIMUM PRINCIPLE AND SUFFICIENT OPTIMALITY CONDITIONS

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We derive nonlocal necessary optimality conditions, which efficiently strengthen the classical Pontryagin maximum principle and its modification obtained by B. Kaśkosz and S. Łojasiewicz as well as our previous result of a similar kind named the "feedback minimum principle." The strengthening of the feedback minimum principle (and, hence, of the Pontryagin principle) is owing to the employment of two types of feedback controls "compatible" with a reference trajectory (i.e., producing this trajectory as a Carathéodory solution). In each of the versions, the strengthened feedback minimum principle states that the optimality of a reference process implies the optimality of its trajectory in a certain family of variational problems generated by adjoint trajectories of the original and compatible controls.

The basic construction of the feedback minimum principle — a perturbation of a solution to the adjoint system — is employed to prove an exact formula for the increment of the cost functional. We use this formula to obtain sufficient conditions for the strong and global minimum of Pontryagin's extremals. These conditions are much milder than their known analogs, which require the convexity in the state variable of the functional and of the lower Hamiltonian.

Our study is focused on a nonlinear smooth Mayer problem with free terminal states. All assertions are illustrated by examples.

Keywords: maximum principle, extremal, adjoint trajectory, necessary and sufficient conditions, feedback controls.

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