First integrals for systems via complex partial Lagrangians

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The Noether operators and Euler-Lagrange equations are developed for a system of m second-order ordinary differential equations (ODEs) with m dependent variables in the complex domain with the help of complex Lagrangians. The system of m ODEs in the complex domain can be split into $2m$ coupled real partial differential equations (PDEs) along with the constraint of the $2m$ Cauchy-Riemann (CR) equations. Thus a system of $4m$ PDEs for $2m$ real functions of two real variables is obtained. The complex Lagrangian splits into two real Lagarangians for a system of $4m$ PDEs which satisfy Euler-Lagrange equations in the real domain. Each complex Noether operator yields two real Noether operators of the real Lagrangians. The complex first integrals result in two real first integrals for the system of $4m$ PDEs obtained after splitting the system of m ODEs in the real domain.