The orbital angular momentum of light, unlike spin, is an infinite-dimensional discrete variable and may hence offer enhanced performances for encoding, transmitting, and processing quantum information. Hitherto, this degree of freedom of light has been studied mainly in the context of quantum states with definite number of photons. On the other hand, field-quadrature continuous-variable quantum states of light allow implementing many important quantum protocols not accessible with photon-number states. Here, we realize a scheme based on a q-plate device for endowing a bipartite continuous-variable Gaussian entangled state with nonzero orbital angular momentum. We then apply a reconfigurable homodyne detector working directly with such nonzero orbital angular momentum modes in order to retrieve experimentally their entire quantum-state covariance matrix, thus providing a full characterization of their quantum fluctuation properties. Our work is a step towards generating multipartite continuous-variable entanglement in a single optical beam.