The cycloidal reducer finds widespread applications in various fields due to its capability of significant speed and torque transformation. Its long service life, compact structure, and robust load capacity make it a frequently utilized solution within constrained spaces.

Botsiber and Kingston [1] proposed the application of the involute gear mechanism, which essentially comprises four components: a high-speed input shaft composed of an eccentric cam, an involute wheel, a pinion, and a low-speed output shaft. Taking the fixed ring gear type as an example, as the input shaft rotates, it causes the involute wheel to roll along the inner edge of the fixed pinion (ring gear), exhibiting a motion pattern akin to planetary gears. As the involute wheel revolves around the center of the pinion, it also slowly rotates in the opposite direction about the center of the eccentric cam.

Based on the distinction between the profile of the involute wheel and the fixed elements, four types of involute driving mechanisms can be identified: fixed ring gear external involute gear reducer, rotating ring gear external involute gear reducer, fixed ring gear internal involute gear reducer, and rotating ring gear internal involute gear reducer.

In practical applications, it is necessary to consider the influence of profile machining errors on motion; however, information on involute gear reducer errors is limited in published literature, and software assistance may be required. Malhotra and Parameswaran [2] studied the effects of design parameters on the forces of various components of the involute gear reducer, as well as its theoretical efficiency. Blanche and Yang [3] developed an analysis model for involute driving based on machining tolerances and proposed a computer-aided analysis program to verify the performance of involute driving.

Shin and Kwon [4] proposed a new method for seeking the involute wheel profile using coordinate transformation.

The advantage of equivalent linkages lies in simplifying the motion patterns of complex mechanisms, converting the contact forms of most components into two-joint rods and rotational pairs, facilitating forward and reverse kinematic analyses of various mechanisms, and conducting error analysis using the displacement equations of linkage mechanisms. This method's advantage lies in the ability to analyze the errors of involute gear reducers solely based on the contour expressions of components. Chang and Wu [5], as referenced, utilized equivalent linkages to analyze planar cam errors.

In this paper, we propose a new method to calculate the geometric profile of the involute wheel using the instantaneous center vector method and conduct error analysis using the equivalent four-linkage of the involute gear reducer. Since the distinction of fixed elements does not affect the parameters of the equivalent linkages, for simplification purposes, this study only considers two types of involute gear reducers represented by pinions and involute wheels in Figure 1a and Figure 1b: fixed ring gear external involute gear reducer and fixed ring gear internal involute gear reducer, respectively, without considering the output shaft.