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SHIFTED GENOCCHI POLYNOMIALS OPERATIONAL MATRIX FOR SOLVING FREDHOLM FRACTIONAL INTEGRO-DIFFERENTIAL EQUATION (FIDE)

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It is known that Genocchi Polynomials having some advantages over classical orthogonal polynomials in approximating unknown function, such as less term and smaller coefficients. Motivated by our recent work which we derived the shifted Genocchi Poylnomials operational matrix for solving systems of fractional ordinary differential equations, this present work extends our earlier investigations to solve fractional integro-differential equations (FIDE) of the following Fredholm-type :

$$D^{\alpha} f(x) = g(x) + \lambda \int_0^1 K(x,t) f(t) dt \tag{1}$$

where $f(x)$ is the unknown function to be solved, $K(x,t)$ is the integral kernel, D^{α} is the Caputo's fractional derivative, $g(x)$ is non-homogeneous forced term. We derive the expressions of approximating $K(x,t)$ and $T = \int_0^1 G_n(t) G_m(t) dt$ (i.e. integral of product of Genocchi basis) in shifted Genocchi Polynomials. We shifted the polynomial from the interval $[0,1]$ to $[1,2]$ to overcome the problem for $f^{(n-1)}(x)$ which are not defined at $x = 0$. By using important properties of Genocchi Polynomials which are inherited by shifted Genocchi Polynomials, we able solve the Fredholm FIDE accurately. We achieve that by applying shifted Gennochi operational matrix of fractional differentiation for approximating D^{α} together with collocation method to reduce the Fredholm FIDE into a system of algebraic equations of Genocchi coefficients. A few examples of applying the expression derived and the shifted Genocchi Polynomial approximation will be presented. Results show that this technique provides very accurate approximation of the unknown function $f(x)$ and the expression derived for the Genocchi approximation of integral kernel gives the idea of extending the approximation in Genocchi Polynomials to 2 or more variables.

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