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(71)**Name of Applicant :**
1)KALINGA UNIVERSITY RAIPUR
Address of Applicant :NAYA RAIPUR, CHHATTISGARH 492101, INDIA Raipur ---------- ----------
Name of Applicant : NA
Address of Applicant : NA
(72)**Name of Inventor :**
1)MS. AYESHA BANO KHAN
Address of Applicant :ASSISTANT PROFESSOR, DEPARTMENT OF PHARMACY, KALINGA UNIVERSITY RAIPUR, NAYA RAIPUR, CHHATTISGARH, INDIA, PIN 492101 Raipur ---------- ----------
2)MR. ANIL KUMAR BANJARE
Address of Applicant :ASSISTANT PROFESSOR, DEPARTMENT OF PHARMACY, KALINGA UNIVERSITY RAIPUR, NAYA RAIPUR, CHHATTISGARH, INDIA, PIN 492101 Raipur ---------- ----------

(57) Abstract :
Disclosed herein is an AI-driven method (100) for optimizing pharmaceutical manufacturing processes, comprising initializing a multi-modal deep learning model to represent manufacturing process parameters and product quality attributes. The method (100) also involves applying the deep learning model to simulate manufacturing process dynamics. The method (100) also involves analyzing the output to obtain relevant process performance metrics. The method (100) also involves preprocessing the simulation data using advanced data processing algorithms. The method (100) also involves inputting the preprocessed data into a hybrid AI-physics machine learning model. The method (100) also involves analyzing the data using the hybrid model to predict process outcomes and product quality attributes. The method (100) also involves continuously refining the hybrid model using federated learning from multiple manufacturing sites and historical datasets. The method (100) also involves generating an adaptive optimization strategy that balances multiple manufacturing objectives. The method (100) also involves outputting optimized process parameters through an interactive visualization interface for implementation and validation.

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