DYNAMIC SPEED REGULATION OF PERMANENT MAGNET SYNCHRONOUS MOTOR USING GA BASED PI CONTROLLER

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Abstract— **In this paper we propose the genetic algorithm based controller for Permanent Magnet Synchronous motor. By the help of Genetic algorithm we observer motor acceleration as well as speed correction is designed. The proposed topology consists of single phase ac supply, bridge rectifier, three phase MOSFET inverters, PMSM, Genetic Algorithm and PI controller. PMSM has a feature of high torque, high output power and compact compare to induction motor.**

Keywords— **Permanent magnet Synchronous motor, Genetic Algorithm, proportional-integral controller, n-channel MOSFET.**

I.INTRODUCTION

In industrial applications, speed sensors, as well as sensor less solutions are used .Because of existing speed sensors has a noise for maintenance and economic aspects the current trend is to speed sensors by using computational solutions.[1].During the 1970s, digital control systems have become more attractive as they allow implementation of control strategies with powerful calculation and math-intensive algorithms, until 1990s power converter were mostly analog and difficulty to handle.[3].The development and availability of very high-energy density Permanent magnet materials has contributed to an increased use of Permanent Magnet Synchronous motor(PMSM) in high performance applications. High speed electrical machines are of interest as direct drives for high-speed electrical machines, compressors and pumps, yielding a high output power at rather small machine dimensions.in order to apply BLDC motors to home appliance, it is required to minimize the commutation torque ripple, because the torque ripple generate noise vibrations and causes errors in sensor less motor drives.[10].The speed estimation is the last step of the estimation, and it is affected by noise and errors. The speed estimator is driven by the observation error and this causes a lagging estimate of the speed in induction motor.[8].It has a rare earth magnet used in the mover are

having relative permeability nearly equal to unity and therefore the magnetic circuit under consideration will be unsaturated due to the presence of air in the flux.[2].The PMSM eliminates rotational cogging torque due to Permanent magnet preferred solutions, decreases core loss and thus increases efficiency also has a linear current versus torque relation. In the PMSM in order to generate smooth torque and thus reduces noise and vibration, the current waveform should match the shape of the motor electromotive force (emf).use of Hall sensor increases constructional cost. Field programmable Gate Array dissipates high output power and complexity to control. Since then the development of microprocessor more prototypes started to develop. An important application of PMSM, the motion control requires not only the accurate knowledge of rotor position for field orientation but also some information of rotor speed for closed-loop control; thus position transducers such as optical encoder and resolver to be installed on the shaft.[3].The LC filter is used to smooth the motor currents and voltages.

All the controls are based on the measurement of the inverter output currents and dc input voltage. Genetic algorithm has been widely used in control applications.[3]. The GA methods have been made successfully to solve complex optimization problems, GA is mainly preferred for fast convergence and reasonable accuracy. PI controller is mostly used in the industries for control purpose. PI controller has two parameters namely proportional gain (KP) and proportional integral (KI).n-channel MOSFET consists of depletion and enhancement modes. On this enhancement MOSFET is used for the operation purpose.[1].The performance of three-phase machines is described by using their voltage and inductances. Park's transformation, a revolution in machines analysis has the unique of eliminating all time-varying from the voltage of the machines due to motor spinning. [4].Park's transformation is a well-known three phase to two phase transformation in the synchronous motor. Current limiter is used to limit the current

in the closed loop operation.[6].In each phase two switches turn on. The gating signals are applied and removed at 60 degree intervals of the output voltage waveforms[11]-[29].

II.BLOCK DIAGRAM

The Figure.1 shows the block diagram for proposed system having components consists of voltage source, step-down transformer, rectifier, three-phase inverter, encoder, GA controller and PWM technique. Let us see each component in details.
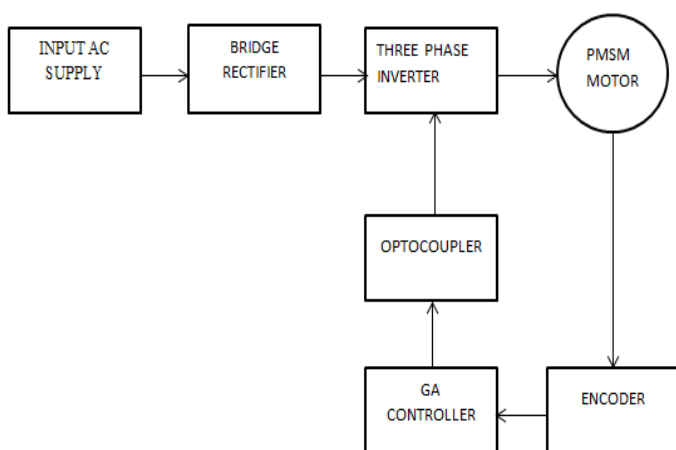

FIG. 1 Block Diagram

A. INPUT SOURCE:

A single phase 230v AC supply is given to the bridge rectifier as shown in the figure. As we aware of that any component won't work without source.so it plays a vital role in this case. Apart the rectifier the supply is given to other components too.

B. BRIDGE RECTIFIER:

A 230V ac supply is stepped down to 24V AC supply using step down transformer and then it gets regulated using voltage regulator. Bridge rectifier consists of four diodes namely D1, D2, D3& D4 as shown in the figure. Rectifier converts AC to DC supply. The purpose of using rectifier is to reduce the torque ripple content.

C. ENCODER:

The encoder is mounted at the shaft of the motor to sense the rotor position. It is used externally to sense the motor speed. It reduces the cost and it is a sensor-less method.

D. THREE-PHASE INVERTER:

Here we are using inverter as N-MOSFET as shown in the figure. Here it consists of six N-MOSFET's in which upper layer has three Mosfet's and lower layer has three mosfet's.in

each mode two switches turns on. Each switch operates for 60 degree which converts DC supply into AC supply and given to the PMSM motor as shown in the figure.

E. PMSM MOTOR:

It is a cross-section between induction motor and BLDC motor. Slip rings and brush are absent in the PMSM motor. Materials that present in this magnet are Alconio-5, ferrites, samarium-cobalt and so on. They are used in many applications like aerospace, satellite and so on. PMSM operates at variable speed and variable frequency. Electronic commutation takes place in the PMSM motor.

III.CIRCUIT DIAGRAM DESCRIPTION

The figure shows the circuit diagram for the proposed system. Let us see the operation in detail manner.

A. PI CONTROLLER:

PI controller is the reduction of the PID controller. Many of the industries still preferring PI controller for the control purpose. Because of having good dynamic response and overshoot. It is the combination of proportional and integral values.

B. GENETIC ALGORITHM:

This algorithm stated by Darwin based on the concept of natural selection At first this theory was suggested by john Holland and his colleagues in the year 1975.this theory is very much got recognized because of effective and efficient technique to solve the optimization problem. Early this theory used in the science and medical fields. Now we are using in the industries for the motor control purpose. It act as the tuner to the controller.it is the best optimization technique and suitable for the industrial purpose.GA operate with four cases .they are population, selection, crossover and mutation. On these the operation begins with population .This is a repeated process takes until the optimum solution is obtained .let us see the operation of circuit diagram in detail manner.

The primary part is retaining as it is operation to be carried out from the three phase inverter. Here inverter is n-channel MOSFET in which the ac supply is given to the PMSM via inverter. The motor starts to rotate and the speed of the motor is measured using the external device like slot sensor.it sense the rotor position and the sensed rotor speed, voltage and current values are send to the estimation blocks. The estimation blocks estimate the values and given as feedback to the PI controller.
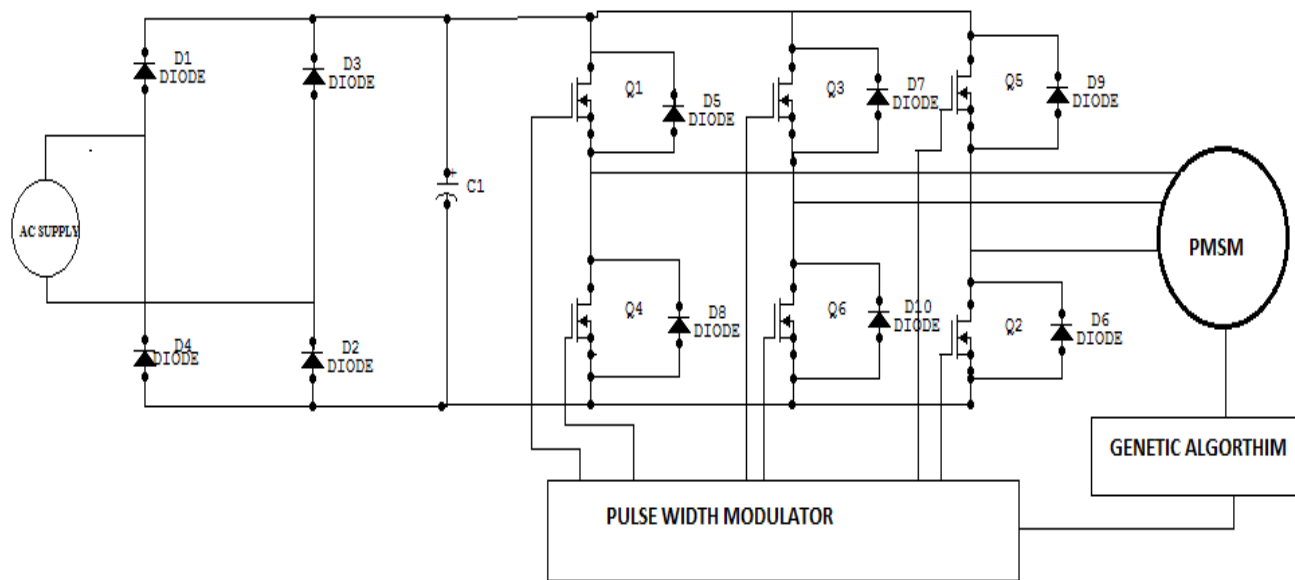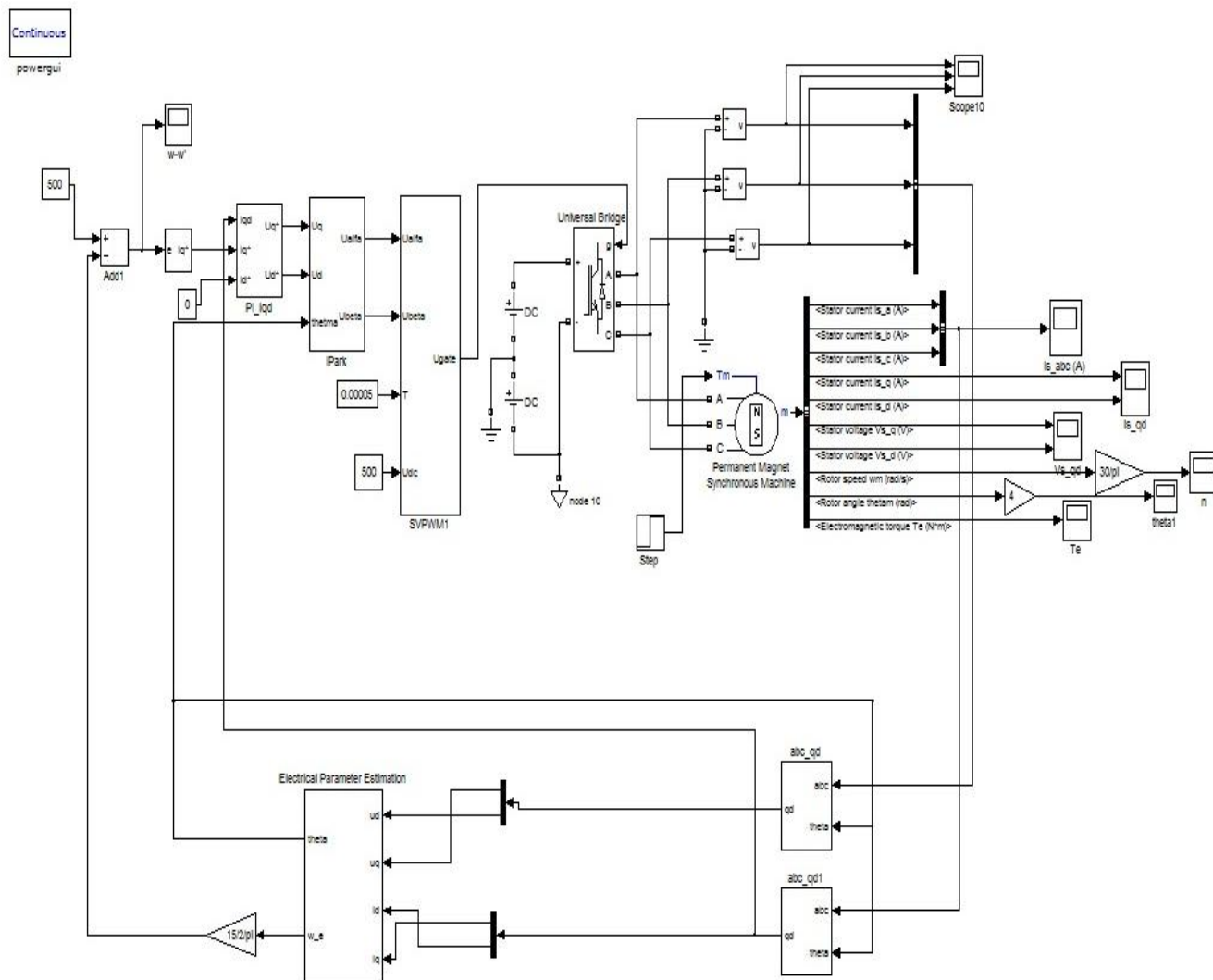
FIG. 2 Circuit Diagram

FIG. 3 Proposed simulation diagram

The values of PI are set by using Genetic Algorithm .we set the reference speed in the Pl controller using this technique. Suppose the set speed is tr while the motor achieve speed is ta, then ta value compare with the tr value in the PI controller as shown in the figure. It is a step by step process which takes place periodically. It is a continuous process takes place until the set value is achieve. Opt coupler is used in these which gate pulse to the switches given via opt coupler, it protects the switches from the overvoltage,.The rotor position is dependent upon the switches turn on .here we are using SVPWM technique.

IV.EXPERIMENTAL RESULTS

The Proposed circuit is developed and analyzed   the speed regulation operation in the PMSM motor using MATLAB software. The feedback is taken from the motor using encoder and given back to the estimation block. The estimated parameters are given as input to achieve the required outputs using GA. From the Figure.3 shows the waveforms for output speed, out torque, output stator voltage and output stator current. All the waveforms are simulated using MATLAB software.
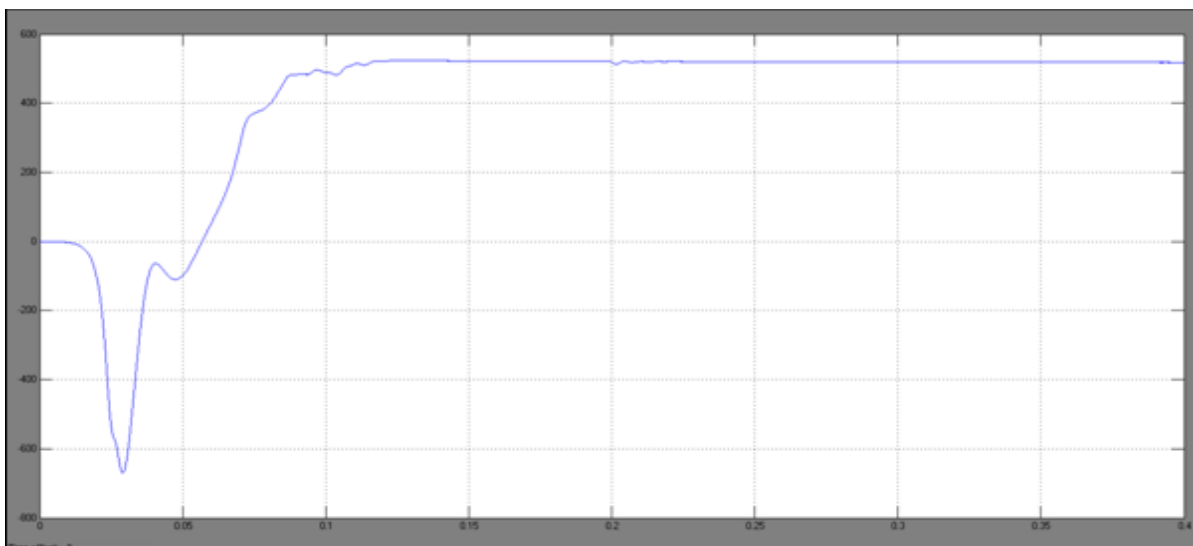

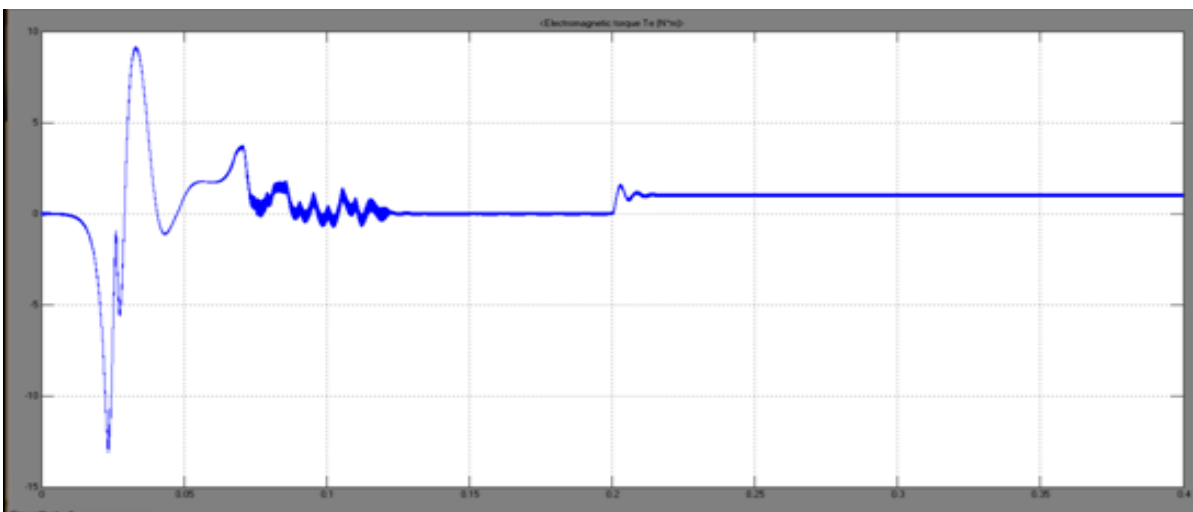
FIG. 4 Output Speed Waveform.
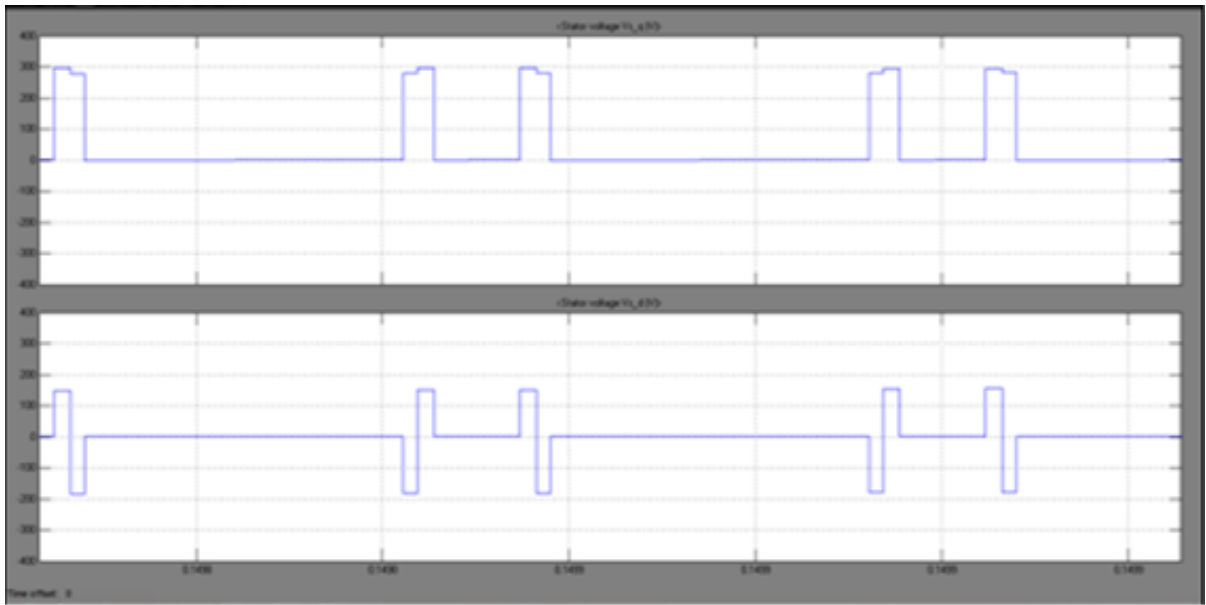

FIG. 5 Output Torque Waveform.
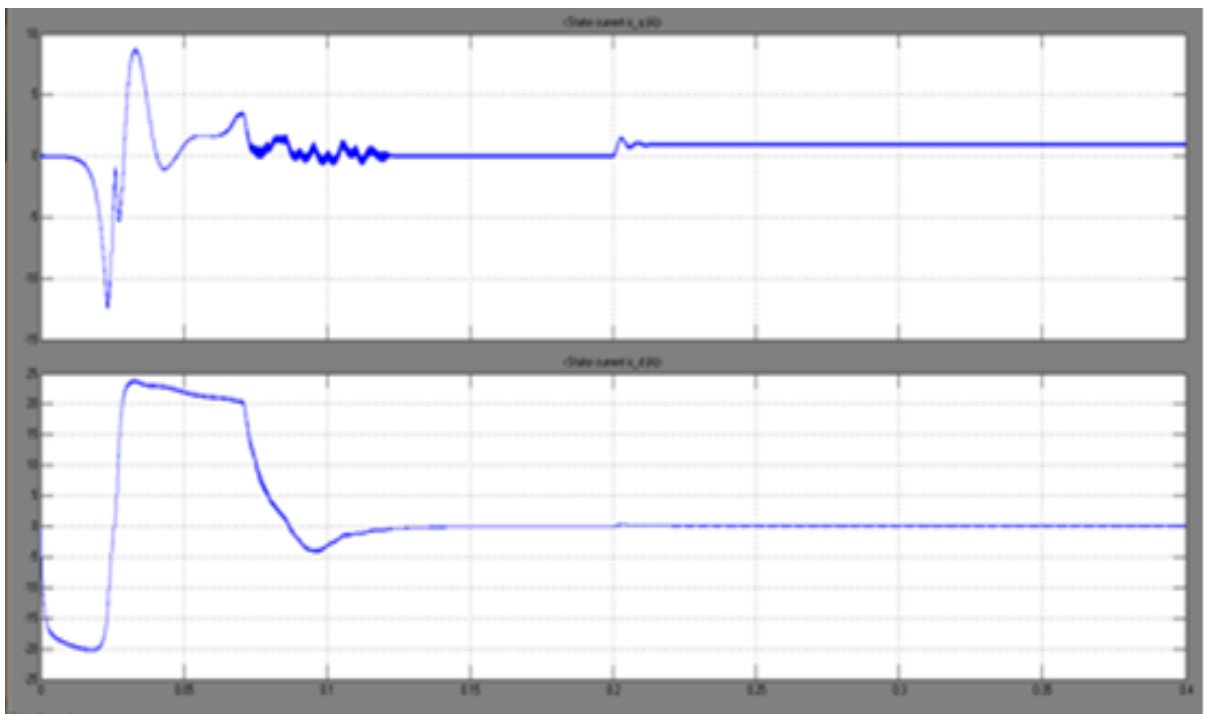
FIG: 6.Output Stator Voltage.

FIG. 7 Output Stator Current

V.CONCLUSION

In this paper we propose the Genetic algorithm based speed regulation operation in PMSM motor. Since GA has the capability of tuning the controller we go with this technique. Also that PMSM has good performances, long life and compact than IM. It also proves that proposed system gives very remarkable speed regulation under model parameter and load torque variations. It is also more effective than Existing system.

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