Design Expert System to Simulate Control System of Gas Generating Stations

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Abstract:
The use of computer technology to support technical decisions and training is now widespread and pervasive across a broad range of technical areas. Accordingly, computer-aided diagnosis has become an increasingly important area for intelligent computational systems. The objective of project research is to design an expert system able to provide the way to simulate the technical crew training , technical crew evaluating, testing of station parts, fault diagnosing of gas turbine power plant which uses natural gas to help the technical maintenance crew and others trainees to reduce the error of the technical crew as minimum as possible and significantly reduce the cost of the training technical crew ,and in same time can be applied this proposed system in all generating stations which work in ministry of electricity and private sector stations. The proposed system contains two main modules first one is the System Information and the second model is Expert system. Those two models creates our system simulators. The Information System of proposed system contains the static information about different malfunctions of the gas turbine power plant field which is used for training crews by showing pictures and videos about affected part of the station and giving the correct action, and containing exam question for evaluating technical crew level to give the correct decision about them such as an increase training period of the crew, and containing testing procedure steps of the station parts with given correct action to start up the station or wait according to test result ,and containing fault diagnosing of the station with advice and required solution, and containing information related to monitoring and remote control the station with given correct action using visual Basic 6.0, and can make the prediction and warning according to environment information and received parameters from station compared with the standard level which is stored in system and giving the required advice to protect the system from damage .The second model of proposed system is Expert system of which performs the program, so this system represents a computer program design to simulate human ability to solve the problem, and it consists of knowledge base which contain all knowledge and information which are collected from experts (engineers) about specific problems in specific domain and inference machine to search for knowledge base to find the solution of the problem in this restricted domain, this research clearly also describes how the neural computing system designed to support the technical decision process to save the station from damage and continuously prepare good technical crew and develop their capability . The most prominent feature of our proposed system is simplicity, flexibility and friendly user interface with high speed of the execution.
Keywords: Gas Turbine, Expert system, Simulation, power Generation, control System

1. Introduction:

The gas turbine is the most versatile item of turbo machinery today. It can be used in several different modes in critical industries such as power generation, oil and gas, process plants, aviation, as well domestic and smaller related industries. A gas turbine essentially brings together air that it compresses in its compressor module, and fuel, that are then ignited. Resulting gases are expanded through a turbine. That turbine's shaft continues to rotate and drive the compressor which is on the same shaft, and operation continues. A separate starter unit is used to provide the first rotor motion, until the turbine's rotation is up to design speed and can keep the entire unit running. The compressor module, combustor module and turbine module connected by one or more shafts are collectively called the gas generator. The figures below Figure (1) illustrate a typical gas power plant in cutaway and schematic format. [1]

In the gas turbine world, it is essential for all industry sectors to learn from each other. Despite how expensive rein- venting the wheel might be, this does not happen enough or sufficiently. The extent, to which it does happen however, is owed largely to the inception of the aero derivative gas turbine engine. In part fostered by the offshore industry's need for a lighter-than-industrial-engine-frame, (original engine manufacturers) took specific aircraft engines and placed them on a light, strong, and flexible base. Some of industry's largest fleets are aero derivative. The logic for the panel that I discussed in the Preface continues. It is now commonplace in modern power plants. The concept of a cycle of gas turbine life used versus a calendar hour evolved from realizing that the leader of an aerobatics squadron might only develop one twentieth of the wear on his engines, as compared with the engines of his followers who have to "hunt and follow" a specific distance from his wings.

Algorithm development uses the parameters of time, temperature, and speed essentially, to calculate cycles. Unless the engine is among specific models of Rolls Royce that can use just time and speed parameters for the most part. Additional cooling may cost in some ways but pays off in others. Land based users slowly caught on with experimental work on how much a stop and start to a conventional industrial machine versus a much smaller workhorse was worth. Profit margins are directly affected by how quickly different sectors can learn from each other. Note also that as personnel and technology travel across national boundaries, proprietary technical innovations follow them. The wide chord fan blade is an acknowledged Rolls Royce "first." It was an enviable one as its performance attributes, both in terms of aerodynamic performance and bird foreign object damage chopping ability, verified. In fairly short order, the wide chord fan blade has appeared on other original engine manufacturers models, albeit with different "internals." [2]

Gas turbines and their development are plagued with the whims and dips of global finance and politics. The gas turbine prime movers were first used in 1919 for large central station service. Since then several stations have been built with gas turbine to drive electric generators. This is due to some inherent advantages of the gas turbine, such as, simplicity and flexibility of design and installation, compactness, low first cost, small building space requirement, little cooling water requirement, etc.

The delivery and installation time for these plans is much less than for steam plants. These prime Movers can be started quickly and can be put on load within a few minutes. Efficiency can be improved considerably of employing heat reclaiming devices. However, fuel costs in these plants are usually higher than those in other plants, though maintenance costs are lower than these costs for diesel plants. Since the fuel costs are relatively higher and initial cost lower, these plants are well suited for meeting peak load demands. [3]

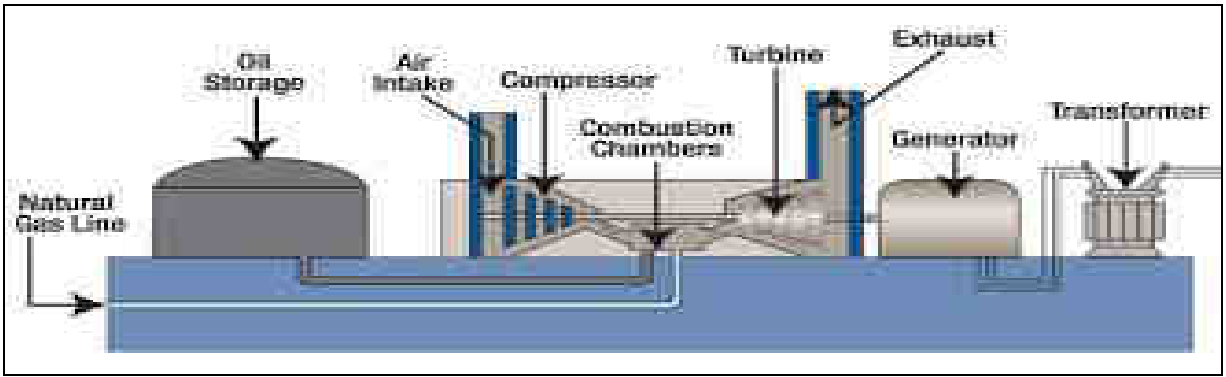

Figure (1) gas turbine power plant

2. What is Gas Turbine:

A gas turbine, also called a combustion turbine, is a type of internal combustion engine. It has an upstream rotating compressor coupled to a downstream turbine, and a combustion chamber in-between. The basic operation of the gas turbine is similar to that of the steam power plant except that air is used instead of water. Fresh atmospheric air flows through a compressor that brings it to higher pressure. Energy is then added by spraying fuel into the air and igniting it so the combustion generates a high-temperature flow. This high-temperature high-pressure gas enters a turbine, where it expands down to the exhaust pressure, producing a shaft work output in the process. The turbine shaft work is used to drive the compressor and other devices such as an electric generator that may be coupled to the shaft. The energy that is not used for shaft work comes out in the exhaust gases, so these have either a high temperature or a high velocity. The purpose of the gas turbine determines the design so that the most desirable energy form is maximized. Gas turbines are used to power aircraft, trains, ships, electrical generators, or even tanks. [4]

3. Gas Turbine Theory of Operation:

Gases passing through an ideal gas turbine undergo three thermodynamic processes. These are isentropic compression, isobaric (constant pressure) combustion and isentropic expansion. Together, these make up the Brayton cycle. In a practical gas turbine, gases are first accelerated in either a centrifugal or axial compressor.

These gases are then slowed using a diverging nozzle known as a diffuser; these processes increase the pressure and temperature of the flow. In an ideal system, this is isentropic. However, in practice, energy is lost to heat, due to friction and turbulence. Gases then pass from the diffuser to a combustion chamber, or similar device, where heat is added.

In an ideal system, this occurs at constant pressure (isobaric heat addition). As there is no change in pressure the specific volume of the gases increases. In practical situations this process is usually accompanied by a slight loss in pressure, due to friction. Finally, this larger volume of gases is expanded and accelerated by nozzle guide vanes before energy is extracted by a turbine.

In an ideal system, these gases are expanded isentropic ally and leave the turbine at their original pressure. In practice this process is not isentropic as energy is once again lost to friction and turbulence. If the device has been designed to power a shaft as with an industrial generator or a turboprop, the exit pressure will be as close to the entry pressure as possible.

In practice it is necessary that some pressure remains at the outlet in order to fully expel the exhaust gases. In the case of a jet engine only enough pressure and energy is extracted from the flow to drive the compressor and other components. The remaining high pressure gases are accelerated to provide a jet that can, for example, be used to propel an aircraft.

As with all cyclic heat engines, higher combustion temperatures can allow for greater efficiencies. However, temperatures are limited by ability of the steel, nickel, ceramic, or other materials that make up the engine to withstand high temperatures and stresses. To combat this many turbines feature complex blade cooling systems.[5]

4. Electrical Power Generation:

In electricity generating applications the turbine is used to drive a synchronous generator which provides the electrical power output but because the turbine normally operates at very high rotational speeds of 12,000 R.P.M or more it must be connected to the generator through a high ratio reduction gear since the generators run at speeds of 1,000 or 1,200 R.P.M. depending on the AC frequency of the electricity grid.[6]

5. Turbine Configurations:

Gas turbine power generators are used in two basic configurations Simple Systems consisting of the gas turbine driving an electrical power generator as shown in Figure (2). Combined Cycle Systems which are designed for maximum efficiency in which the hot exhaust gases from the gas turbine are used to raise steam to power a steam turbine with both turbines being connected to electricity generators as shown in Figure (3).[6]

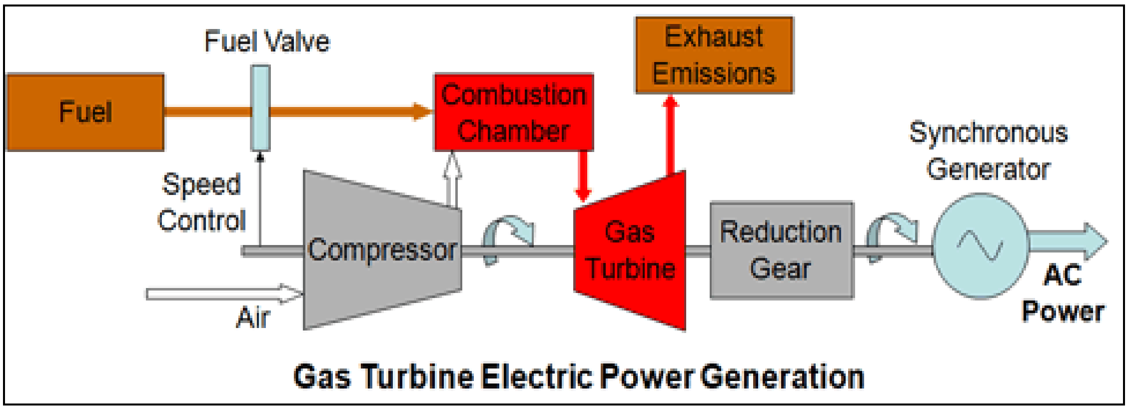

Figure (2) Simple System Power Generation

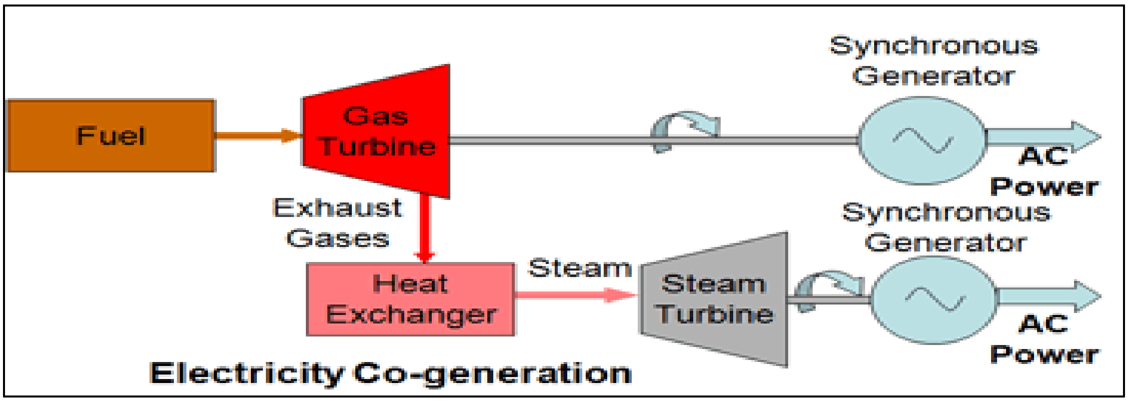

Figure (3) Combined System Power Generation

6. What is the Expert System:

Many definitions of artificial intelligence (AI) have been proposed. The most popular is still: "making computers think like people." No one particular technique of AI can deal successfully with all problems; rather, a combination of methods works best. In order for an expert system to effectively address any problem, there must be a well defined problem domain. Expert systems are a very successful application of artificial intelligence technology. The first step in solving any problem is defining the problem area or domain to be solved. It is worthwhile to examine how AI fits into the scheme of life itself. From a computer perspective, life is synonymous with software, but we also can view life from a biological perspective, including artificial life made possible through cloning. The notion of artificial life gives rise to artificial intelligence, intelligence being the capacity to learn, acquire, adapt, modify, and extend knowledge to solve problems. Hence we consider the desire to build intelligent machines that can react with the real-world, be endowed with consciousness, solve problems and communicate those solutions. One of the goals of expert systems technology, as defined by Professor Edward Feigenbaum of Stanford University, is the development of a computer system that emulates, or acts in all respects, with the decision-making capability of a human expert. Although we are nowhere close to creating a general-purpose problem-solver, expert systems can function very well within the confines of restricted domains. Expert system technology may include special expert system languages, programs, and hardware designed to facilitate the implementation of those systems. The knowledge in expert systems may come from expertise, or knowledge obtainable from various forms of media including books, magazines, or even knowledgeable persons. In an expert system, or knowledge-based system, the user supplies facts or other information to the system and receives expert advice or expertise in response. The system itself consists of two components − the knowledge-base and the inference engine, which draws conclusions from it. An expert's knowledge is specific to one problem domain − a special problem area such as medicine, finance, science, or engineering. The expert's knowledge about solving specific problems is called the knowledge domain of the expert. The problem domain is always a superset of the knowledge domain. In the knowledge domain that it knows about, the expert system reasons, or makes inferences about the solution of a problem. [7]

7. Benefits of Expert Systems:

Expert systems offer an environment where the good capabilities of humans and the power of computers can be incorporated to overcome many of the limitations discussed in the previous section. Expert systems: [8]

1. Increase the probability, frequency, and consistency of making good decision.
2. Help distribute human expertise.
3. Facilitate real-time, low-cost expert-level decisions by the non-expert.
4. Enhance the utilization of most of the available data.
5. Permit objectivity by weighing evidence without bias and without regard for the user's personal and emotional reactions.
6. Permit dynamism through modularity of structure.
7. Free up the mind and time of the human expert to enable him or her to concentrate on more creative activities.
8. Encourage investigations into the subtle areas of a problem.

8. Problems and Limitations of Expert Systems:

There are some problems and limitations of expert system are: [9]

1- Knowledge is not always readily available.
2- Expertise can be hard to extract from humans.
3-Each expert's approach may be different, yet correct.
4- Hard, even for a highly skilled expert, to work under time pressure.
5-Expert system users have natural cognitive limits.

8. The concept of the expert system in gas Turbine:

Presently available knowledge-based systems used for diagnostics of gas turbine system performance are based on the monitoring and processing of a number of control variables. These variables reflect integral processes in the gas turbine system. Fault diagnosis in these systems is aimed towards detecting those situations, these systems is aimed towards detecting those situations, which are of general nature and reflect events, which have either already taken place in the system or have been degrading the gas turbine system elements. The stability of the flame in the gas turbine combustion chamber is an imminent problem in the gas turbine operation. There are two approaches to the flame stability problem, the first one is based on the organization of the combustion process in the chamber with high gas velocity and respective flow arrangement inside the chamber and the second approach is based on introduction of a diagnostic system which recognizes the change of characteristic parameters in the combustion chamber responding to flame instability. The current diagnostic system of gas turbine combustion chambers detects and also predicts flame instability. In addition diagnostic variables are used for the lifetime assessment of combustion chambers and of the first blade row of the downstream turbine unit. The diagnostic strategy is organized to recognize the following main operational situations: [10]

1.Diagnosis of pulsating regimes inside the combustion chamber (combustion noise).

2.Control and diagnosis of low-emission combustion chamber with outlet NOx concentration less than50 mg/Nm3.
3.Diagnosis of low-NOx combustion chamber operation with temperature level up to 1500–1700 K.
4.Monitoring of reliable combustion at various regimes of combustion chamber operation.
5.Assessment of lifetime of combustion chamber and first row of gas turbine blades by monitoring gas temperature.
6.Control and monitoring of the circumferential gas temperature distribution at the turbine outlet.
7.Control of the flame breakthrough to the premixing zones.

9. System design:

Before the 1970´s the use of simulators to train the operation personnel of the power plants was not widely diffused. In these times, the operators acquire skills by working head to head with some experienced operators in the actual plant. So they have learned all the knowledge of their mentor. This means, all the virtues and defects of the experienced people. As expected, the trainees also receive the classic classroom lessons with the aim to complement their training. The training finished when the manager of the plant decided the trainee was ready to operate and control the plant. In the majority of the cases, the main problem of this kind of training was that the operator has just learned the typical actions related with the start-up of the equipment and operation of the plant in nominal conditions. Therefore, operators had not been trained in and operation of the plant in nominal conditions. Therefore, operators had not been trained in abnormal situations, where they needed to act rapidly to keep the power plant in safety conditions. Naturally any operative mistake could lead to a unit trip, equipment damage or risk to staff with all the economic losses related with this type of problems**.** The modern distributed control systems of the power plants provide the operator with the elements to get a power generation stable, safe and reliable, but as a consequence, there is a reduction of the operator's confidence to carry out unusual man behavior, e.g. a start-up in manual mode or the requested actions after a feed water pump trip. Training simulators help operators to practise this type of man behavior. The main advantage of a simulator as a training tool is that the operator does not need to touch the actual unit to learn to operate it in a broad range of possible scenarios. These scenarios include normal operations like unit start-up from cold iron to full load and shutdown. Also can be defined scenarios for malfunctions in which the trainee practise the suitable operative actions when in the simulated unit there are events like: trips of pumps and turbine, tube ruptures, and "faulty" instrumentation. In other words, the operators use the simulator to practice their normal operation procedures and to practise infrequent evolutions and faulted conditions operators are carried out through simulators. Also the simulators can be utilized to validate the normal operating procedures, to conduct engineering studies and to train plant technical supporting personnel. The use of simulators has proven through the years to be one of the most effective and confident ways by training power plant operators. Using simulators, operators can learn how to operate the plant more efficiently.

The Figure (4) shows the flow chart of proposed system for training technical crew which is first prototype form of the proposed system and show all malfunctions of gas turbine power plant which may encounter the main part of power plant (compressor ,diffuser ,turbine ,combustor, generator).and monitor situation of the compressor specially axial shaft situation and the vanes& blade situation from the erosion and corrosion and surface roughness and pitting of the blade surface , and monitor situation of the diffuser specially the forward part and aft section situation from cracks and erosion , and monitor situation of the turbine row of stationary vanes from damage and crack and test row of rotating blades status from damage and crack and check turbine axial shaft situation from deterioration, and monitor situation of combustion from the crack or damage, and monitor generator situation from damage and crack. This prototype also includes a prediction system process of potential failure occurring which received information from several sensor which send the data to help the technical crew and gives idea about which station parts suffered from failure and causes the problem, and the prediction system helps the technical crew to predict the malfunctions which affected the gas turbine power plant and the prediction system has six sensor and detector.

The first sensor is the ambient temperature sensor which shows that if there are any increasing in ambient temperature of the gas turbine power plant system which will deteriorate all mechanical and electrical parts of the power plant system and needs to take the required action against this problem through the advice that receive from prediction system to help technical crew to solve the problem and protect the power plant from damage by checking the cooling system immediately.

The second sensor is snow and freezing rain sensor which shows that if there are any increasing in snow and freezing rain rate which will reduce the air flow from the inlet of the power plant due to particles of the snow and freezing rain which needs to take the direct action against this problem through the advice that receive from prediction system to help technical crew to solve the problem and protect the gas turbine power plant system by cleaning the filters or condensing the snow or freezing rain immediately. The third sensor is dust sensor which shows that if there are any increasing in dust rate which will reduce the air flow from the inlet of the power plant due to particles of the dust which may block the filters of the inlet of gas turbine power plant system which needs to take the direct action against this problem through the advice that receive from prediction system to help technical crew to solve the problem and protect the gas turbine power plant system by cleaning the inlet filter.

The fourth sensor is oil and industrial vapor sensor which shows that if there any increasing of oil and industrial vapor rate causes compressor blades erosion and corrosion and fouling and the axial flow compressor which causes loss in power plant output and efficiency due to particles of the oil and industrial vapor and needs to take the required action against this problem through the advice that receive from prediction system to help technical crew to solve the problem and protect the gas turbine power plant system from fouling by washing these affect part continuously .

The fifth sensor is smoke sensor which shows that if there is any increasing of smoke rate which affecting the air flow from the inlet of the power plant due to particles of the smoke and increasing of CO2 percentage which needs to take the required action against this problem through the advice that receive from prediction system to help technical crew to solve the problem and protect the gas turbine power plant system by cleaning the filters and decreasing of the CO2 immediately.

The sixth detector is critical life power plant parts which show that if there are any exceeding of critical life power plant parts will damage these parts and need to take the immediate action against this problem through the advice that receive from prediction system to help technical crew to solve the problem by count the power plant operating hours and compared with standard critical life of power plant parts to protect any exceeding critical life time of the part and change the parts that satisfying exceeding condition. The proposed system can classify the malfunctions in to three level the first level is small or generic level malfunction the second level is medium or special level malfunction the third level is big or remote level malfunction.

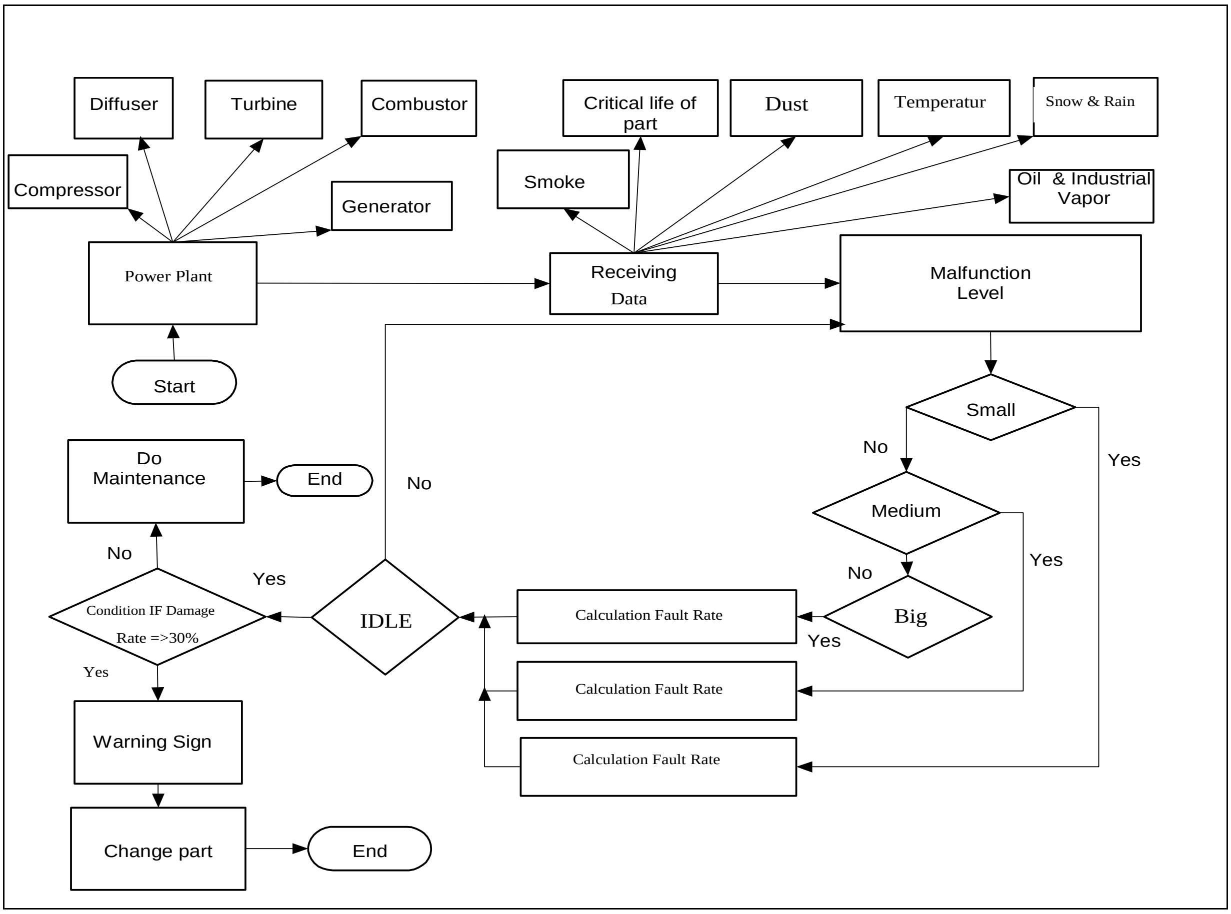

Figure (4) System Design Flow Chart of The Malfunctions

The proposed system will begin with the first level if the malfunction according to fault rate of power plant was small then the system will start processing by calculation and evaluating the malfunction. The system mechanism of processing is that malfunction of power plant must keep below (30%) which is (damage criteria level) if malfunction equal or exceed this level then must change the faulty part, and if malfunction didn't exceed damage criteria level then system will advice doing maintenance only of the part such as calibrated or clean etc**.**

If malfunction was not a small then the proposed system will continue and try medium malfunction level, if fault rate after calculated appeared equal or exceed of damage criteria level then must change the faulty part, and if calculated fault rate didn't exceed damage criteria level then system advice doing maintenance of the part.

If malfunction was not a small or medium malfunction the proposed system will continue and try Big malfunction level if fault rate after calculated appeared equal or exceed of damage criteria level then must change the faulty part, and if calculated fault rate didn't exceed damage criteria level then system advice doing maintenance of the part.

The Figure (5) shows the flow chart of proposed system for Evaluating of technical crew which is second prototype form of the proposed system which shows five evaluating level through set of questions the first level is Bad and second level is sufficient the third level is good and fourth is very good and sixth level excellent according to this evaluation result the proposed system gives the advice what is training level needs of each evaluated technician.

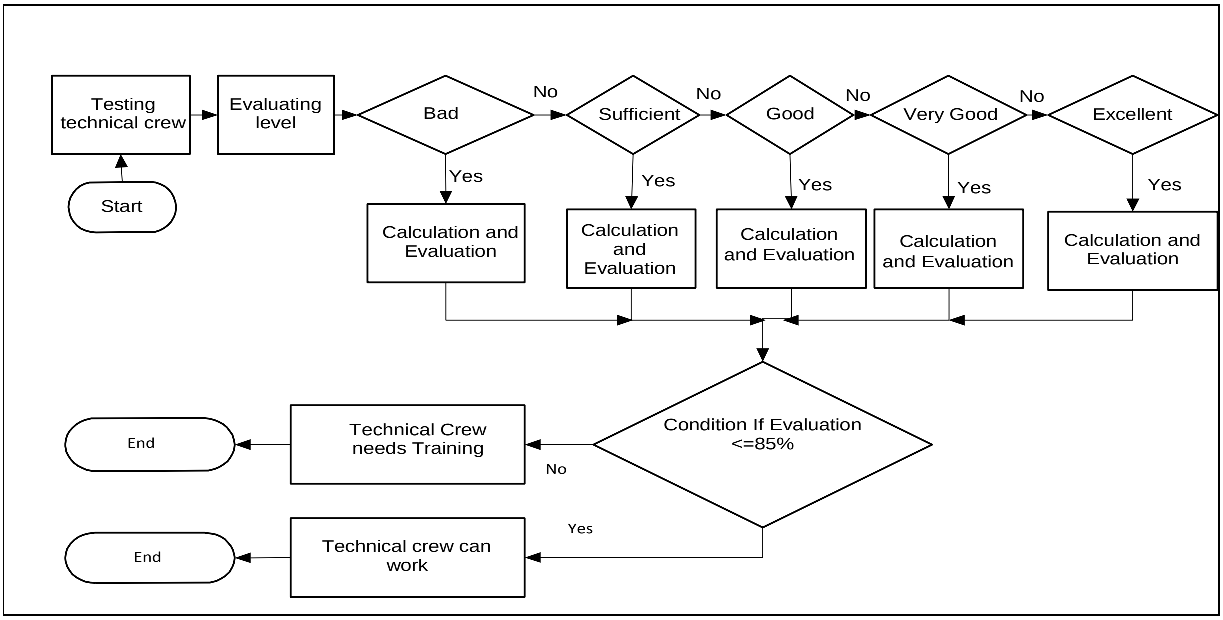

Figure (5) Evaluating Test Flow Chart

The Figure (6) shows the flow chart of the proposed system for power plant part testing procedure which is third prototype form of the proposed system which shows eleven testing step and gives the advice according to test procedure if the technical crew completed testing process successfully the power plant will be in save mode then the proposed system will give permission to technical crew to start up the power plant station, if the technical crew didn't completed testing process then the power plant will not be in save mode and proposed system will didn't gives the permission to start up power plant station and gives warning alarm show that which part need it to test.

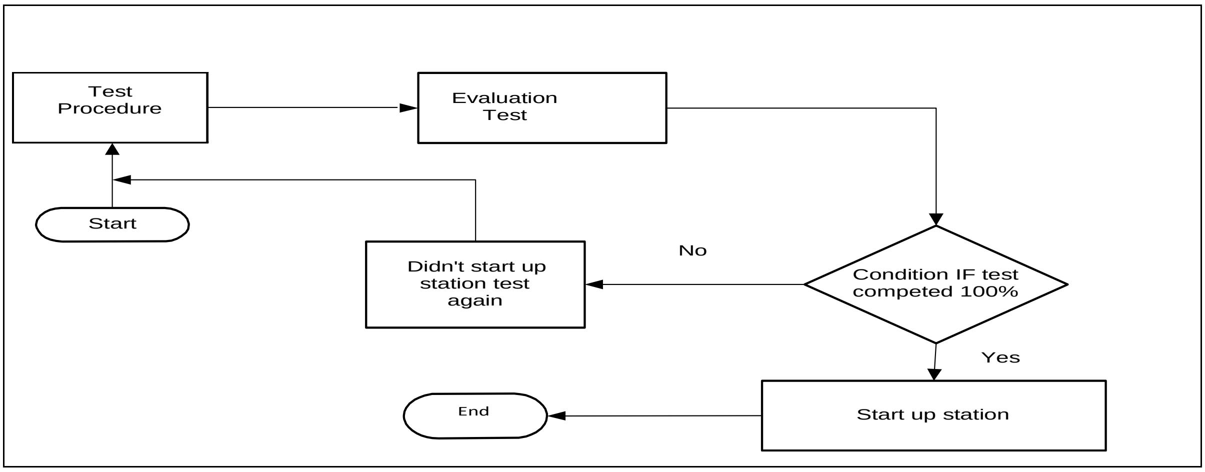

Figure (6) Power Plant Part Test Procedure Flow Chart

The Figure (7) shows flow chart of proposed system for fault diagnosing of gas turbine power plant which is fourth prototype of proposed system and has (21) checking icon. The system mechanism of processing is that the affected part of power plant must keep below (30%) which is fault criteria level.

If receiving data value from power plant exceeding this level the proposed system will gives warning alarm and advice to change the faulty part and proposed system will shows the fault level. If receiving data value didn't exceed the fault criteria level then the proposed system shows that the power plant status is good.

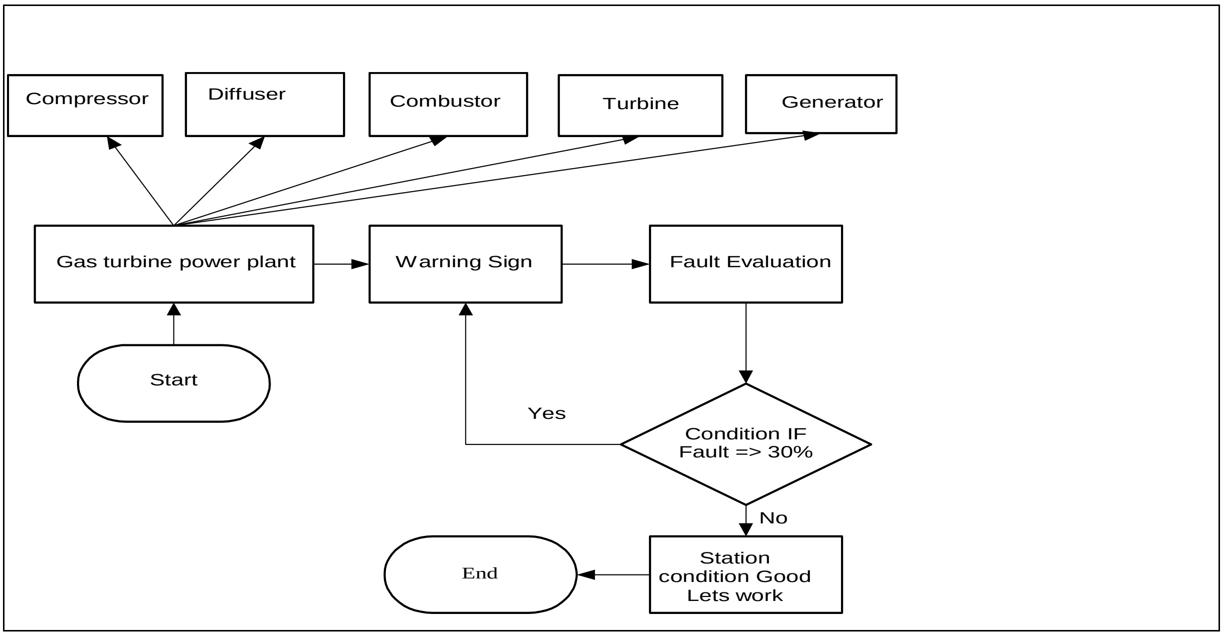

Figure (7) Fault Diagnosing of Gas Turbine Power Plant Flow Chart

10. System Implementation:

To implement a proposed system successfully, a large number of inter-related tasks need to be carried out in an appropriate sequence .the system implementation is the realization of technical specification of an application, or execution of a plan, idea, model, design, specification, standard, algorithm, or policy. And the purpose of the implementation process is to design and create (or fabricate) a system element conforming to that element's design properties and/or requirements. The element is constructed employing appropriate technologies and industry practices The success of any software solution is directly related to achieving a successful system implementation To satisfy expectations, an implementation that is well thought out, well planned, and meticulously executed is imperative, we apply the expertise and experience in the system implementation to realize the develop a strategy that identifies areas of responsibility and appropriate timelines related to gathering data, entering that data, and determining the optimum time to complete basic training, evaluation, power plant testing part, fault diagnosing and monitor and remote control of power plant. So the Training users or technical crew on gas turbine power plant malfunction level and evaluating technical crew level and testing procedure of power plant and fault diagnosing and monitoring with remote control of power plant effectively is key for a successful system implementation. The lack of appropriate training and support can be important reasons for poor user acceptance and adoption. As with any technology implementation, careful consideration should be given to the basic skills of users as this will guide the training program that you need to develop. So to prepare an efficient technical crew work effectively in the gas turbine power plant must train it in the training center before send to filed by this way we will reduce the error of the technical crew as minimum as possible and also significantly reduce the training cost of technical crew which will trained in power plant training center. And the proposed system contains several prototype forms we explain it below in details

1-Training of Technical Crew Prototype Form:

The Figure (8) shows training of technical crew prototype form which includes set of Icons used to train the technical crew. The proposed system collects all malfunctions of the power plant and classified in to three level which are (small malfunction, medium malfunction and big malfunction), by choosing any malfunction icon the proposed system will shows the picture of the malfunction and explain the malfunction and gives the level of this malfunction, if the trainees need more details the system can display a video about malfunction type. and the trainees can see a simulation of gas turbine of power plant operation through how gas turbine work icon .in same time the system has ability to predict malfunction and gives the solution by choosing prediction and solution icon through prediction device which has set of sensor and detector supported on power plant and send the data information wireless to prediction device. The trainees can end the training process after finish training through main form icon and can exit out of form to the main form to choose another process.

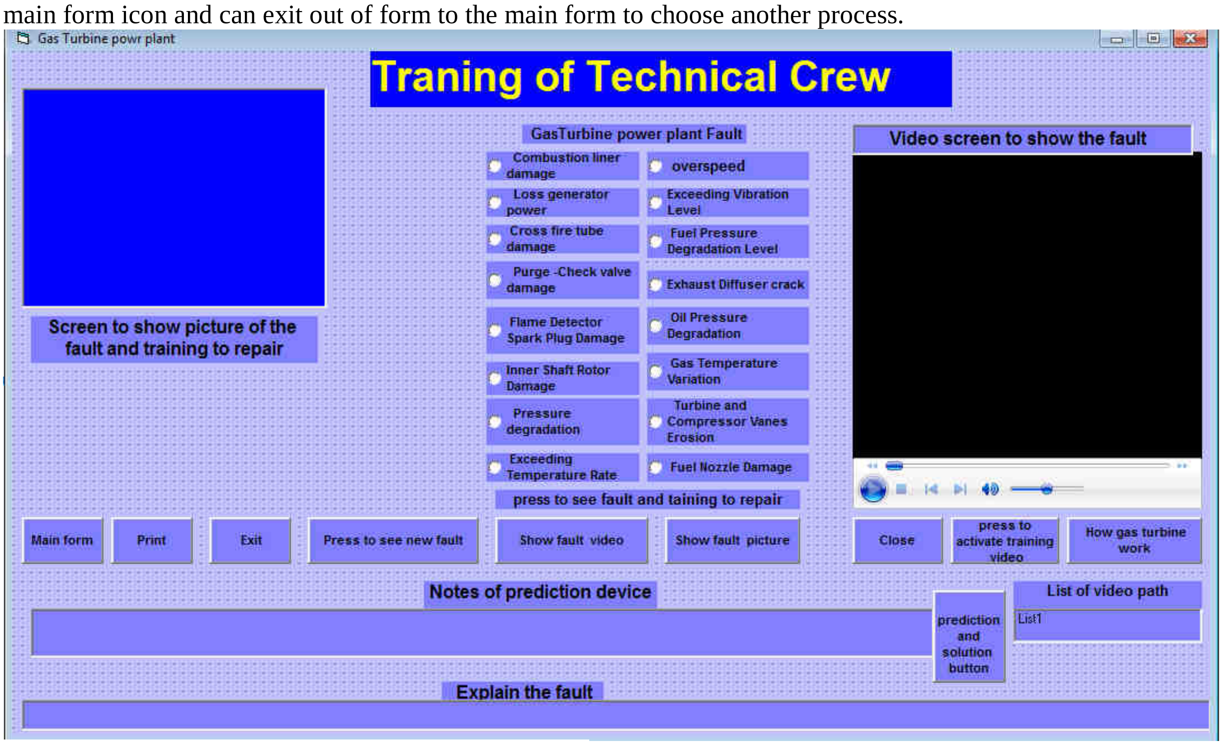

Figure (8) Training of Technical Crew Prototype Form

2. Evaluating Forms of Gas Turbine Power Plant Prototype Form:

The Figure (9) shows Evaluating Forms of Gas Turbine Power Plant Prototype Form which includes set of icons which use to evaluate the technical crew level, which classify the evaluation level in to five level (bad, sufficient, good, very good and excellent) . The proposed system gives the advice about each evaluated crew according to evaluation; the proposed system gives permission to excellent evaluated level to work directly in power plant which doesn't need training course but other level sure needs training courses to work in power plant. By this way the system can recognize between the groups of technical crew levels and gives the correct advice. The technical crew can end the evaluation form of gas turbine power plant process through main form icon and exit out of the evaluation form to the main form of the proposed system to choose another processing.

3. Routine Test Procedure of Gas Turbine Power Plant Prototype Form:

The Figure (10) Shows the Routine Test Procedure of Gas Turbine Power Plant Prototype Form which includes set of icons which used to test the all part sections of power plant through group of testing step then shows the status of the station if the technical crew didn't complete the test procedure successfully the proposed system didn't give permission to start up the power plant and in same time gives warning alarm and the proposed system gives percentage degree rate of tester by this way the system will help the technical crew or trainees to complete test the part of power plant and don't forget any section. If the trainees completed routine testing procedure successfully the power plant will be in save mode and the proposed system gives the permission to start up the power plant through receiving advice and message from the system, by this way the proposed system will protect the power plant completely from damage. The technical crew can end the routine test of gas turbine power plant form through main form icon and exit out of the routine test procedure form to main form of proposed system to choose another processing.

4. Fault Diagnosing of Gas Turbine Power Plant and Solution Prototype Form:

The Figure (11) shows the Fault Diagnosing of Gas Turbine Power Plant and Solution Prototype Form which contain set of the icons which use to fault diagnosing of power plant section through group of diagnosing icon. By choosing any diagnosing icon the proposed system will directly receive the value of fault rate of chosen icon, and if fault rate exceed fault criteria level of power plant section then the system will gives warning alarm and needs to change the part, and if the value of fault rate didn't exceed the fault criteria level then the proposed system shows that the power plant is in save mode by this way the system can diagnose the all power plant section fault and gives the correct solution .and the technical crew can end the fault diagnosing of power plant form through main form icon and exit out of the fault diagnosing of power plant form of proposed system to main form to choose another processing.

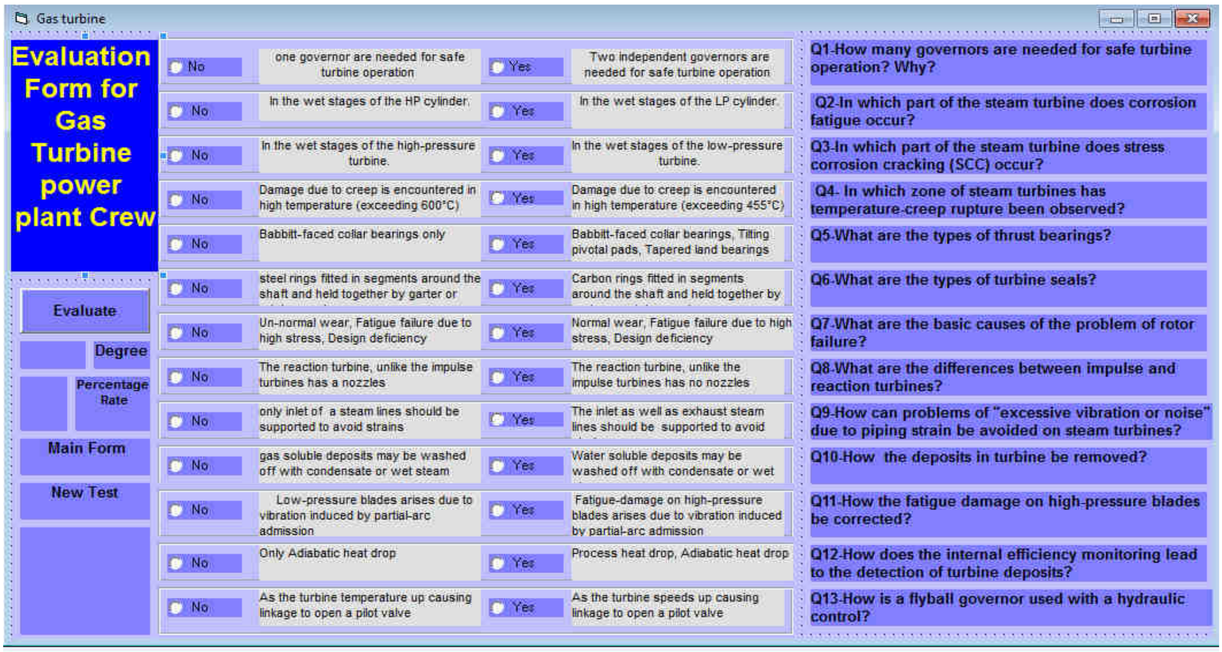

Figure (9) Evaluating Forms of Gas Turbine Power Plant Prototype Form

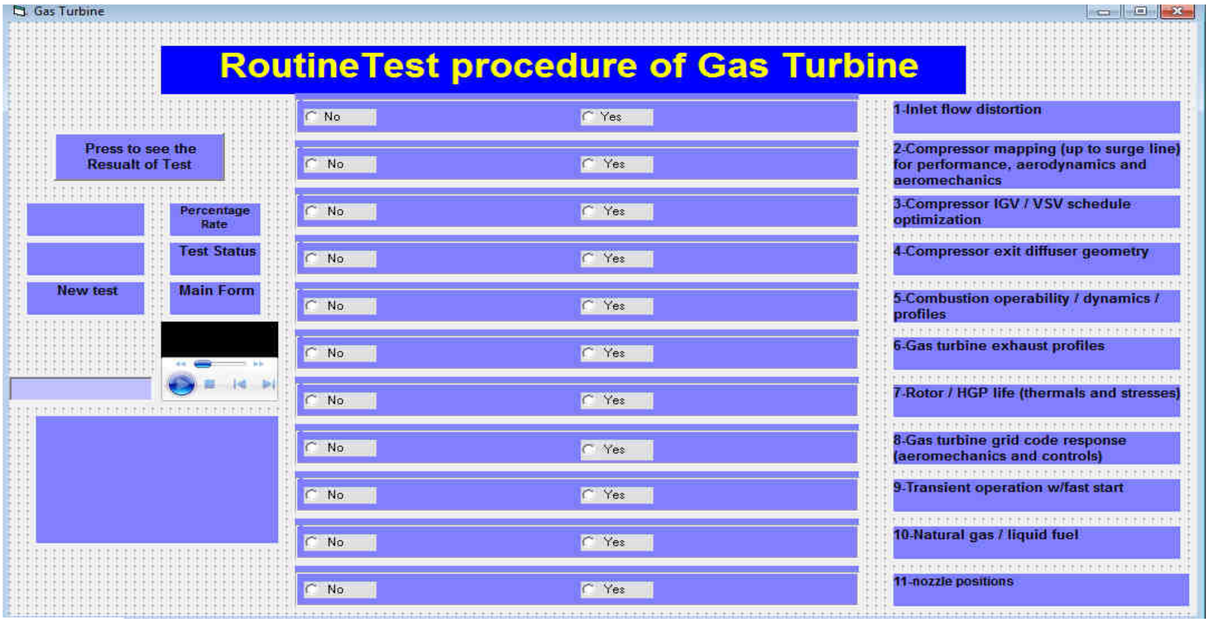

Figure (10) Routine Procedure Test of Gas Turbine Power Plant Prototype Form

Figure (11) Fault Diagnosing of Gas Turbine Power Plant and Solution Prototype Form

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