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# A New Approach to Natural Language Programming For Process Control

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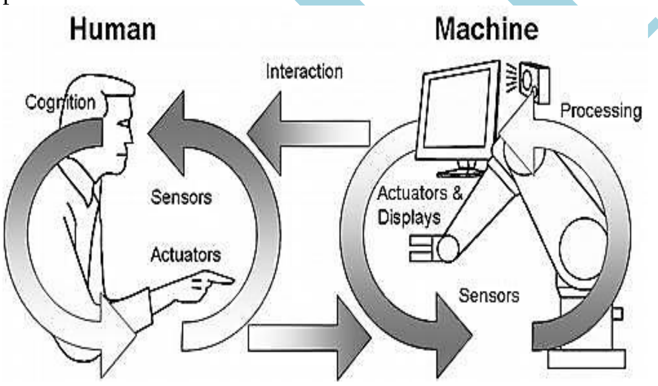
*Abstract-* **This paper addresses the opportunities and challenges involved in applying modern approach. A model to realize a natural language interface for process control is described. The interface accepts natural language input and it is translated to a form that can activate concerned process controller to start up motorized valve while monitoring associated sensors .The interface can be reconfigured to suit changes in process without altering program thus eliminating the tiring task of reprogramming.**

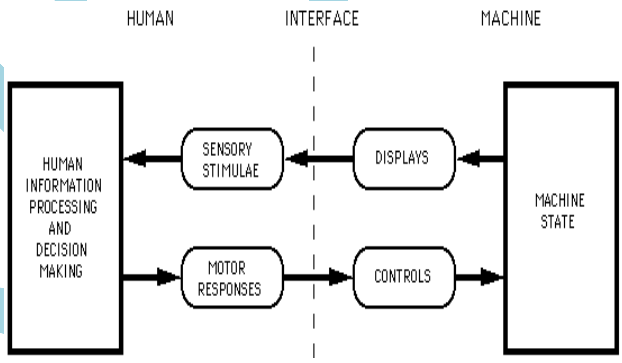
## 1. INTRODUCTION

The field of natural language programming is trending and creating more interest on electrical, electronics and computer science. Monitoring and controlling a process has been an integral part of any industry. Every process control system consists of process and relevant control equipment. Modern process control systems are controlled by computers. Parameters of such as temperature, Pressure etc are monitored using set of relevant sensors which are interfaced to Computers. Based on information acquired from sensory inputs computer does job of running a program. Using programming language chosen strategy for control of a process as to be initially coded in accordance with requirements and fed to computers. This is no insignificant task and demands that programmer have clear picture of process and its related hardware.




The problem becomes more complicated when alterations are to be incorporated into an existing process. In such case it may happen that entire software has to be reconstructed to suit new environment-a task that will consume several precious skilled man hours. We present a method to tackle this problem by using direct natural language control of set of motors and related sensors comprising a process .This not only saves time but also facilitates direct interaction by the users who understands little about programming language .While sensors provide feedback on the state of controller's action ,actuators execute actual task.

**MAN- MACHINE INTERFACE FOR PROCESS CONTROL**




Rapid growth of intelligent techniques using artificial intelligence, fuzzy logic, neural networks etcetera has paved a way towards the development of more sophisticated means of controlling a process .Many intelligent approaches to develop man-machine interface for process control have been attempted .Maini et al' described design of man-machine interface for plant operation. While Hancke et al' outline the new trends in design of man-machine system for process control that includes knowledge based system, aspects of visualization and the change in scenario of modern control rooms with reference to the personnel involved their training etcetera. Pruvot et al' emphasize need of man machine interface for control centers to act quickly and without obstacle of complex manipulations. Fuzzy logic has also been integrated into such systems provide adaptive and flexible control of processes. The stages of understanding a process, learning a programming language and then coding its control algorithms have always been a hard task for personnel involved in process control operation .Though first aspect is unavoidable, learning a programming language and then coding an existing program to implement modification in the control or process methodology may be avoided by providing natural language interface for control process. This enables human personnel to directly issue commands in natural language for activating a process. Further any modification to be made can be realized merely by effecting relevant changes in the knowledge base and requirement base. This paper deals with model to design such a man-machine natural language interface are controlling a process comprising of sensors and actuators using prolog. Interface allows use of natural language to program or issue commands to a process. Use of natural language in contrast with conventional programming language allows better readability, quicker program generation and consequently fast training of personnel handling the process.

## VISUALIZATION OF PROCESS AND ASSOCIATED HARDWARE

A computer controlled process is visualized here as an assemblage of motor controlled valves with their related set of sensors which in turn are interfaced to computer either directly through i/o ports or via analog to digital converters. The sensors would be responsible for sensing parameters such as pressure in a pipeline or the temperature in a boiler. The control strategy may define the problem of control in terms of opening or closing a valve or a set of values based on the values reported by the sensors associated with them. Diverse possibilities can arise while formulating a control scheme. For instance a particular point in the process may have two sensors mounted. The control scheme selected may require the valves V1 and V2 to be turned clockwise by a certain angle subject to following conditions-

- The first sensors a report of value between say 100 and 200 units,
- The second senses any of the discrete values 12, 14 or 18.

This control strategy may be fairly simple for an efficient programmer to implement using some conventional higher level language. Any change made in the above rule for control will force the programmer to make alterations in program, recompile and implement it. But in case the process hardware is upgraded to sense a couple of more sensors and actuate more valves, the programming effort would naturally be much higher. Best method is to formulate a general reconfigurable code' that can activate a number of motorized valves with their associated sensors.

## THE NATURAL LANGUAGE INTERFACE

It is clear that every natural language command issued to the process should inherently carry the following information.-

**NAME OF THE PROCESS:**

A process name helps identify one out of several process controllers in case a number of processes are being controlled distributedly. It may also be possible that a large process control system is visualized as a set of several subsystems. In this case the subsystem controller name would have to be specified. The process name is however not mandatory when only a single process is being controlled.

**GENERAL METHADOLOGY:**

This should not be confused with the process name. By process we mean the action defining the process such as LOAD, RELEASE etcetera. These and their synonyms may be coined by the process engineer as desired. The process identifies the action to be taken and allows the system to understand which set of valves are to be activated and which set of associated sensors are to be monitored. It thus acts as a pointer to a fact in the knowledge base that contains all relevant information about the components of the process.

**A QUANTITY:**

This specifies by how much amount the motor connected to the valve is to be rotated.

**A DIRECTION:**

This is again an optional an optional feature as some of the processes explicitly define the direction in which a motor should rotate.

**A MODE:**

This gives an idea of the speed of the motor involved in the control action and is a fuzzy linguistic variable. If not specified a default can be forced. The interface works on the assumption that the strategy of a process realized using the assembly of S1 sensors and M1 motors, comprise of a set of IF THEN rules such as-"IF VK belongs to the set [a, b] THEN rotate M1 by amount D degrees clockwise". Where VK is the sensor associated to motor M1 and the closed interval [a, b] comprises of possible sensor-reported values that can cause actuation of the motor by D degrees. Such rules formulated by the process engineer comprising the control strategy of a process are stored in a reconfigurable knowledge base. This 'a priori' knowledge allows for interpretation of typed natural language commands issued by the user to execute an action. Thus a natural language command-"P1 SHOULD LOAD THE HOPPER SLOWLY WITH TEN UNITS"
Would be translated as-
"P1 LOAD HOPPER SLOWLY TEN"
Where P1 is the name given to a controller of a process, "LOAD" is the job to be done and the cardinal "TEN" relates to the amount of material to be loaded or to be more specific-the angle through which a motorized valve should rotate to load the hopper with ten units of some material. The description of the job "LOAD" viz., the motor(s) to be activated, the relevant sensors and their port addresses exist in the 'a priori' knowledge- Base against the controller name P1. The fuzziness involved in "SLOWLY" is also resolved using the relevant sensor inputs.

## THE KNOWDLEDGE BASE

We have used a parser check for the grammar and to extract these parameters from the natural language input using the 'a priori' knowledge base of the process being controlled. This knowledge base contains the grammar and the lexicon needed by the parser in addition to all information regarding each process in the form of the motorized valves to be activated, their relevant port addresses, sensors and range of values over which control is to be effected. It also contains the fuzzy rules and regions associated with each sensor. This knowledge base is accessible to the user who in turn can easily add, delete or modify the parameters during process upgradation. The structure of a typical fact in the knowledge base coded in prolog is shown below-
Process_info(process_name, process, direction,mode, valve_info,sensor_info).
Where the valve_info and sensor_info are organized as a list of lists to facilitate modifications.

**ADVANTAGES**

Highly expressive

Permits variety of access points
Highly flexible.
Highly representative of reality.
Requires no training to use.
Easy to represent new and complex concepts.
No indexing necessary.

**APPLICATION**:

Spelling correction, grammar checking…
Better search engines
Information extraction
Psychotherapy;
New interfaces

- ✓ Speech recognition(text to speech)
- ✓ Dialogue systems (USS Enterprise onboard computer)
- ✓ Machine translation(Babel fish)

## II. CONCLUSION

The use of a natural language front-end for process control will allow greater flexibility while changing over to a new control strategy –both from the point of view of the end –user and the process engineer. While on the one hand, the interface will allow quicker training of personnel, it will also provide for easy manipulation of its knowledge base due to its reconfigurable feature. Thus the same front –end can be used for a variety of processes with necessary alterations in its knowledge base.

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