Research Article
Development of Voice Controlled Automated Geyser Using Standalone Controlling System

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Abstract: The aim of this study is to present a system of controlled and automated heating using intelligent standalone controlling system and Interfaces (Embedded LabVIEW and Compact Reconfigurable Input/output FPGA Card-cRIO-9274). As Voice control is regarded as most convenient controlling option for human nature. The voice acquisition is made using microphone, the Microsoft SDK captures the voice and integrates it with the VI .The hardware consists of K-type thermocouple, Contact type level sensor for controlling process variables and NI-DAQ cards for signal acquisition.

Keywords: Embedded LabVIEW, FPGA card-cRIO-9274, Microsoft SDK, relay logic

INTRODUCTION

A geyser is being stated as a best example for any of the batch process. In today's industrial sector almost every manufacturing process in somewhat a derived form of batch process either it be a chemical mixing plant or a thermal power plant boiler or be a food processing plants. A batch process is a process control system which is an execution of series of processes in a controlled manner. Traditional systems consists of a systems require human interference to have supervisory on the processes in every stage. But the use of sensor feedback and rigorous programming has made it automated and safe. The manufacturing industries are one of the most accident prone zones in the world, for example a boiler in a power plant or a chemical mixing tank in a fertilizer industry. A slight failure of the sensor output or on-going program logic failure can cause huge damage to human and machine. Some of the advantage of using voice control is activation and emergency stop of a process can be done from the graphic user-interface, without going to hazardous environment. Generally we find it easier to give voice commands compared to any other which makes it more robust. The system can be built redundantly using an emergency stop button in case of failure of the voice system. But using a voice controlled system is more fool proof compared to system of set of analog buttons and wires. Using Microsoft SDK toolkit has helped us to insert a large no. of words as Voice commands (Rabiner and Juang, 1993).

Using Microsoft SDK toolkit we can use all the words in .net platform of a computer as every word has a set of proper pronunciation and SDK compares the input and check with the present commands if it recognises it goes forward. The voice acquisition is done

Fig. 1: Complete set up of geyser with valves heaters and sensor

with help of a simple microphone. The advantage of using an SDK toolkit it reduces the hassle of voice recognition through signal processing and taking its FFT results and comparing with different command signals which were carried out by Kathirvelan *et al*. (2012). Microsoft SDK toolkit on other hand provides an easy integration of voice commands with computer and also more robust for insertion of voice in a program.

With use of Microsoft SDK the voice commands basically gets converted into text format and that's being compared inside the LabVIEW program. This technique of string comparison is much better than signal processing of voice and making use of individuals voice pitch and formant. A robust and easier methodology has been used (Yuan and Fan, 2011).

In modern times lots of other wireless technologies are being designed such as remote sensing, zigbee, Bluetooth (Hu and Shen, 2007) etc. In this project we have tried to use a cheaper and easier technology to perform the same.

METHODOLOGY

The system as shown in Fig. 1 is proposed in this study consists of a set of sensors that give a check to the level and temperature of the water simultaneously. Set
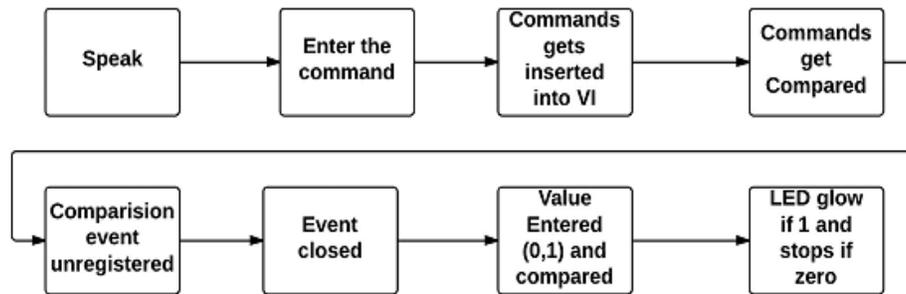
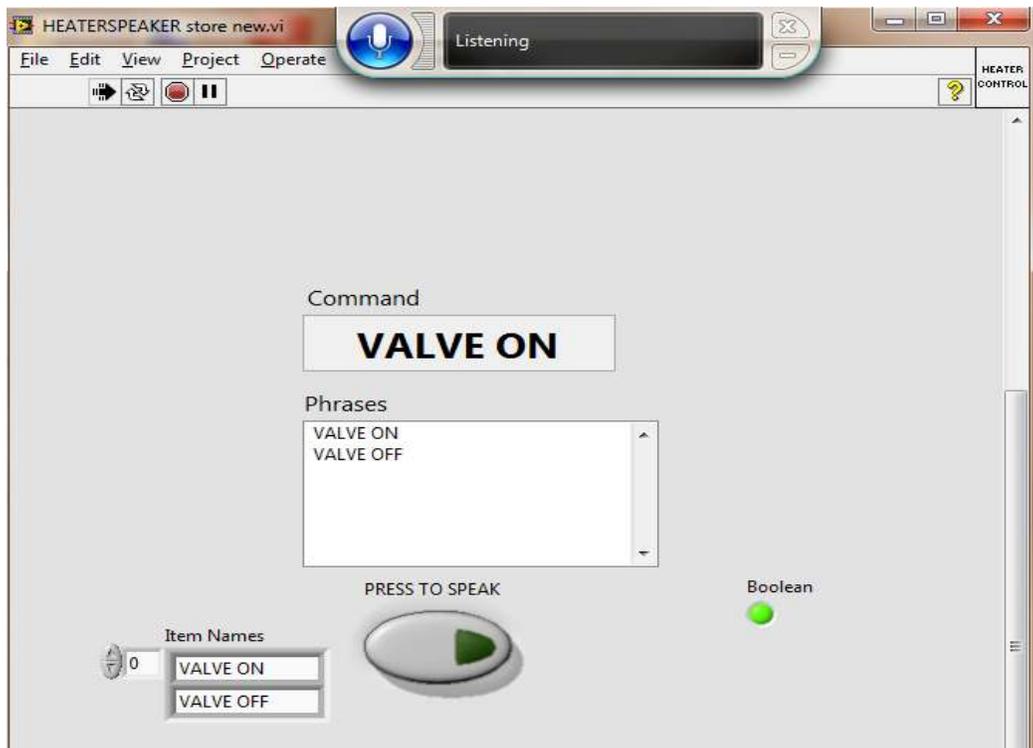Fig. 2: Process by which voice integration with VI is done

Fig. 3: Simulation of voice signal and comparison with output

of solenoid valves and an immersion heater are used as final control elements. The system is controlled by the embedded program inside the LabVIEW whose real time interfacing is done through NI-cRIO. A set of Data acquisition card has been used such as NI-9211 and NI-9215 for acquiring analog voltage signal and for temperature acquisition respectively. The voice commands are given by microphone and using Microsoft SDK it gets embedded into the LabVIEW program that controls the process. When the correct command is fetched the process will start and same for the stop.

The process by which the voice command is entered in the LabVIEW is shown in Fig. 2. In speech recognition VI the speech initialize sub VI is present which checks the input command given by microphone and the command we need for activation of the program. Basically, SDK can help you to convert a voice command to a text so we take on the text as a string input in the VI and compare it. And after the unregistering of events take place so that simultaneous process of next command can be done.

Figure 3 shows how the voice input gets processed into the LabVIEW using a simple microphone and its proper simulation demonstration has also been included.

The next part is we have to drive the geyser in an automated manner so as it just gets controlled by the Voice commands and without using any external switches. The process is systematically shown in underlying flowchart.

Figure 4 shows the process happens in a sequence of events with help of different components. The process starts when "Valve On" command is said
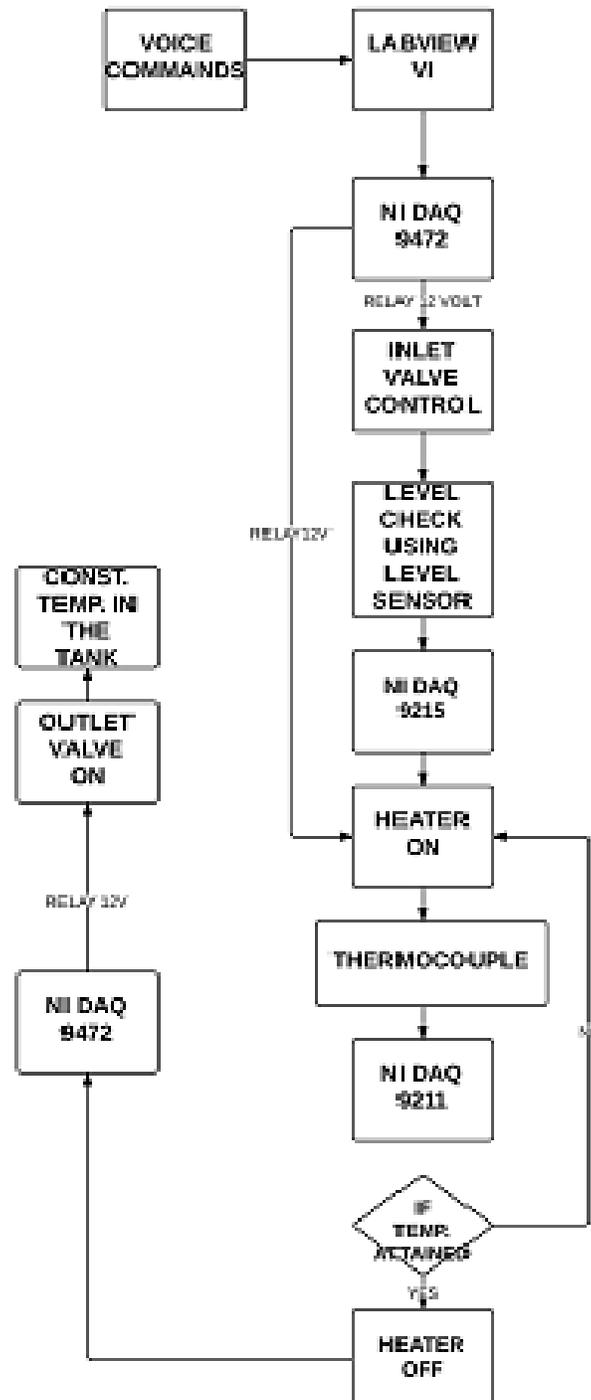
Fig. 4: Systematic flow chart of the process

and the first valve which is connected from the overhead tank starts working with help of the latch relay, which gets a ON bit from the NI-cRIO 9274 as shown in Fig. 5 which is a digital output device and acts as a standalone controller that gives output to the final control element.

In next part a set level is to be filled in the tank which is to be synchronised with the tank shown in the GUI because the speed of the flow is not being controlled so time based synchronisation is done. The level sensing is detected through a contact type level sensor which gives its input to NI-DAQ 9215 which is an analog input device as shown in Fig. 6. As soon as the water reaches fixed level the first solenoid valve shutdown, water stops filling and a led glow to notify the user that level is reached and simultaneously heater
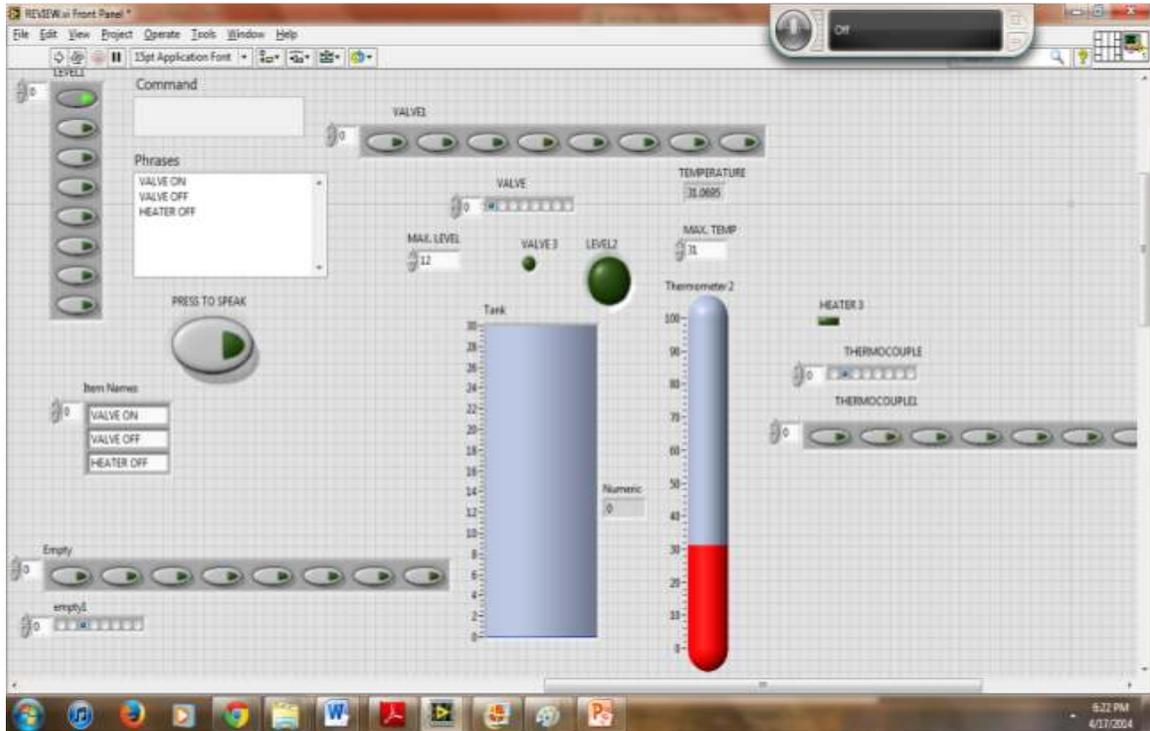
Fig. 5: Graphical user-interface of the geyser at the room temperature

Fig. 6: NI-cRIO for filling tank

Fig. 7: NI-cRIO when heater starts working and solenoid valve stops

Fig. 8: Heating of water

starts heating the water. It also gets ON bit from the standalone controller as shown in Fig. 7 as it is connected to the second port of the NI-cRIO which sends the bit to a latch relay which by passes a 220 volt supply from mains to the water heater as shown in Fig. 8.

As soon as the heater starts heating, the increasing temperature of water is displayed in the user interface directly as we have used NI-DAQ 9211 for the temperature data acquisition in which we have connected a K-type thermocouple (Sawhney and Sawhney, 1996) for the temperature measurement. In a NI-DAQ 9211 the DAQ consists of in built signal conditioning circuit which converts the voltage input to the temperature. As a process variable a required temperature has been set in the GUI as soon as the water temperature matches the required temperature the heater stops heating in automated manner and another LED glows just like the heater.

In final stage the shutdown of heater starts the emptying of water from the process tank as the solenoid valve switches on because of the NI-cRIO 9274 controller that gives the ON bit to the relay as shown in Fig. 9, which then passes the signal to the relay so that it can bypass 24v DC to switch on the solenoid valve. Now to stop the processes we have to give the voice command 'VALVE OFF' so that the amount we need gets out of the tank to the bottle where hot water is filled. This has been kept for our convenience so that extra water doesn't come out and optimization can be done. In another way a contact type level sensor is fixed in the top of the bottle and its input is given to the NI-DAQ 9215 so when the water is full to its brim the solenoid valves stops. And whole system stops as in Fig. 10.

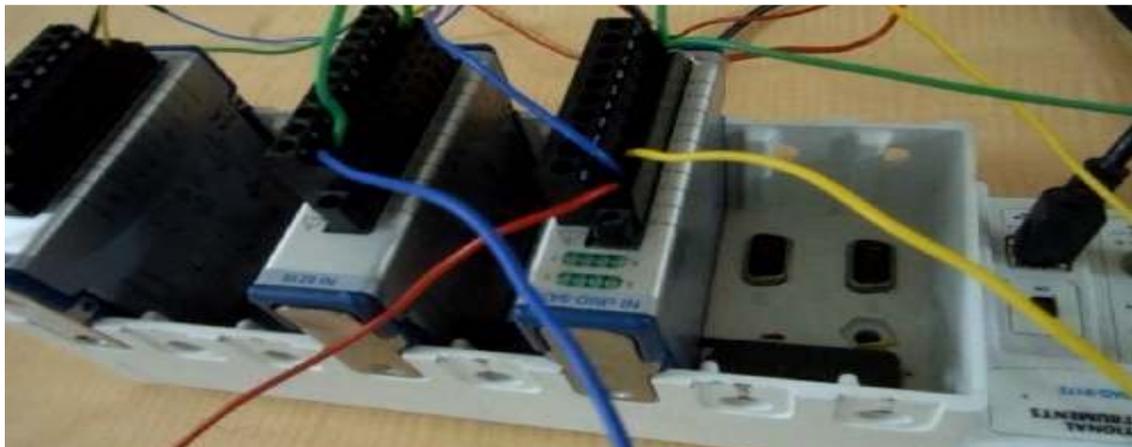Fig. 9: Heater shutdown and solenoid valve empties the tank

Fig. 10: Process stops and heated water comes out of the process tank

RESULTS AND DISCUSSION

The proposed structure of system has been shown in above pictures in a sequential manner as described in the flowchart earlier. The main areas of application of this technology can be food processing industries, chemical industries, boilers in power plants and other manufacturing industries where field condition are very harsh. This can be developed further so as to use this in the above mentioned fields. As we are using NI-cRIO 9274 which is having provision for connecting with many real world signals at a time so we can have many other features.

In this study we have used contact type level sensor for measurement of level and a k-type thermocouple for sensing. We have tested it on a smaller phase and in very limited resources successfully. So if we can add a level sensor that can measure continuous level such as a capacitive level sensor or a ultrasonic level sensor that gets easily interfaced with the LabVIEW and gives correct output would be very beneficiary. Also if we control the flow speed of the water inlet using a flow meter of any kind.

By making this changes the process will be more robust and risk free as its design is done so as to minimize human loss in harsh condition.

Also we can add some more voice commands for emergency stopping the heater and also any other output device we have like we have now for our valves to stop. This can make the system less vulnerable to accidents. And the system should be made more compact so to make it more useful in industrial as well as in day to day human life as a home appliance.

CONCLUSION

The Voice controlled automated geyser using a stand-alone controller has been designed successfully. The voice input through a simple microphone is given which then uses the Microsoft SDK to recognise the word and helps to converts the speech to text which is further compared inside the LabVIEW program as a string. After the process gets initiated the solenoid valve gets on and water starts filling in tank and at a certain fixed level the increase in water flow will stop, if any emergency situation is there to stop the water valve 'VALVE OFF' command will work. After that heating starts and a temperature is set the thermocouple will measure the temperature if the temperature reaches the point we have set the heater will stop and the water inside the tank starts evacuating to a hot water bottle and after receiving a certain amount of water to stop the outlet valve we can say 'VALVE OFF" else another contact type level sensor will take care of it when the tank is full to the top. We were unable to have a continuous level sensor but a supervisory controlling at step level was good enough for home usage but for application in hazardous areas continuous level monitoring is a must. We are also planning to reduce the dimension of the setup and cost involved.

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