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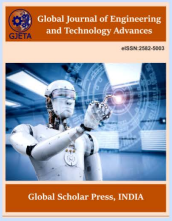

(RESEARCH ARTICLE)

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The design of an intelligent coffee machine

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Abstract

This paper presents the design, testing and implementation of a GSM-based embedded system installed on an off-shelf non-programmable coffee machine.

The intelligent system designed uses a water sensor, a coffee sensor and a Global System for Mobile (GSM) modem. An off-the-shelf coffee machine was adapted for this. The heart of the system is an Arduino Uno microcontroller acting as the intelligence in the machine processing and communicating messages.

Keywords: Arduino Uno; Embedded system; GSM; Wireless communication

1. Introduction

The twenty-first century has witnessed an explosion in the applications of the Global System for Mobile Communication (GSM).

GSM with SMS communication protocol with application in public transport was put forward in 2002[1], and in remote control of industrial applications and systems [2, 3]. Home security and automation have been researched by various researchers using GSM in combination with Wireless Application Protocol (WAP) [4].

GSM system is popular in such applications due to its remote control via text messages. For example, a home automation system incorporating speech recognition and GSM [5,6]; a ZigBee-GSM based home security system [7] further GSM applications have been applied in industrial applications like a biometric attendance system[8] and Interactive Control system [9].

Home automation has converted residences into intelligent and smart homes, including the remote monitoring, control and computerization of home security and several home appliances. This remote control is usually implemented by any one of the various wireless communication systems such as the Global System for Mobile Communication (GSM), Wi-Fi, Bluetooth, ZigBee wireless technology or Infrared wireless communication. The automation of home appliances is a crucial development toward making home chores comfortable and technologically manageable. This design incorporates artificial intelligence, automation and GSM communication ~~is~~ integrated into the coffee machine presented in this paper.

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Coffee machines on the market shelves can be classified into programmable coffee machines and non-programmable coffee machines. Unlike a non-programmable coffee machine, in addition to an ON/OFF switch and a thermostat, the programmable coffee machines enable the user to set alarms for the machine to prepare coffee and pre-select the type of coffee etc. This design of the intelligent coffee machine is based on the application of GSM technology with an embedded low-cost sensor network thus making it cost-effective.

This paper focuses on the design of an 'intelligent coffee machine' based on sensor network intelligence enabling communication between the machine and human.

2. Design of the Intelligent Coffee machine

Figure 1 illustrates the functional block diagram of the Coffee machine with the sensor network. The system is powered at 230V and incorporates an AC to DC step-down converter to provide a regulated DC output voltage of 10V for the operation of the intelligent system. The Arduino Uno microcontroller is the heart of the system, interfacing the different subsystems of the intelligent coffee machine and performing the control and processing function for the entire subsystem.

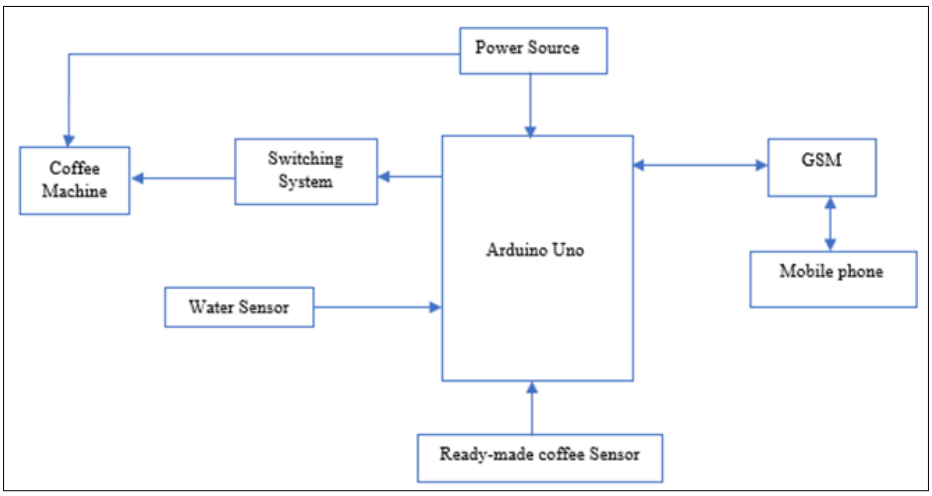


Figure 1 Functional Block diagram

The system design incorporates a water sensor for detecting the presence of water in the coffee machine and a sensor to confirm if coffee is ready for the user in the coffee pot.

The communication system uses Short Message System (SMS) to communicate with the GSM module which in turn transmits the messages to the microcontroller for commands actions. The GSM modem transmits messages back to the user as per the instructions sent and the decision made by the microcontroller. The switching system comprises a two-way switch and an Arduino one-channel relay that connects the coffee maker to the entire system.

2.1. Operational flow chart

The operational flow chart of the intelligent coffee machine is depicted in Figure 2. It can be observed intelligent information is communicated between the user and machine before the machine is switched on to prepare coffee.

Electronic components used in the implementation included SIM808 GPRS/GSM/GPS Shield, Arduino Uno and Arduino one-channel relay.

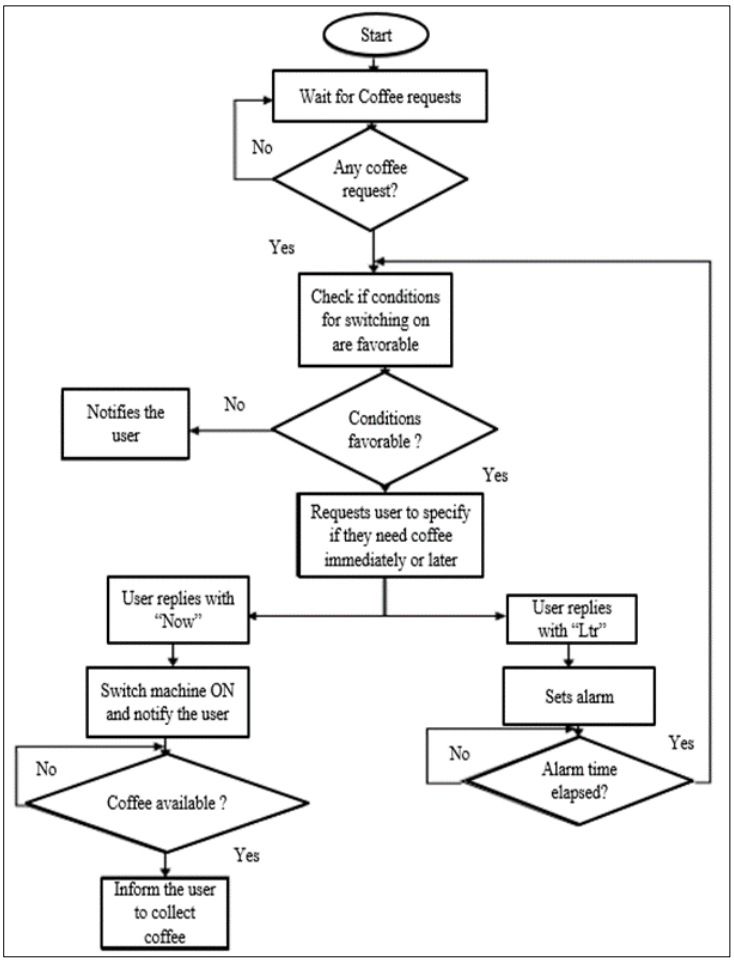
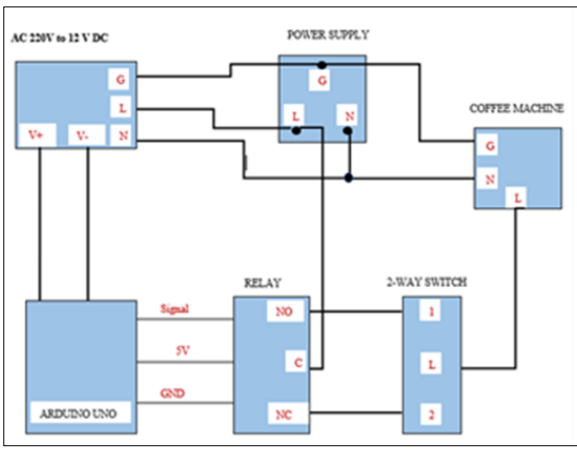


Figure 2 Operational Flow chart

2.2 Design of the sensor system

Figures 3, illustrates the Switching Unit and its operational truth table.



Relay State	Switch state	Machine State
OFF	OFF	**OFF**
ON	OFF	**ON**
OFF	ON	**ON**
ON	ON	**OFF**

Figure 3 Switching Unit and truth table

Water sensor circuit: A simple transistor-based water detector circuit was designed to check for the presence of water in the water chamber of the coffee machine. The absence of water prevents the machine from switching ON, hence protecting the water tank from getting damaged by excessive heat. Once the water level reaches the level at which the

wires are mounted on the coffee machine chamber, the positive side of the power gets connected to the base of the transistor through the water.

2.2. Coffee Detector circuit

An LDR and a laser emitter were, mounted appropriately to determine if the coffee is ready. The opacity of the coffee is effectively used in the coffee detection. When the is ready coffee, the LDR will not receive light from the emitter as the laser light will not penetrate through the dark coffee, however, the light emanating from the laser will easily penetrate through an empty transparent coffee pot. Figure 4 illustrates the circuit for the detection of coffee its presence/absence.

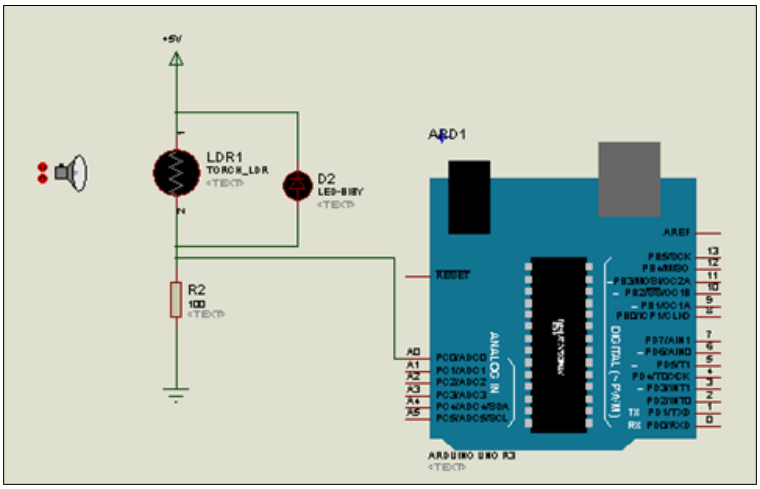


Figure 4 Coffee Detection Circuit

3. Testing of the Intelligent Coffee machine

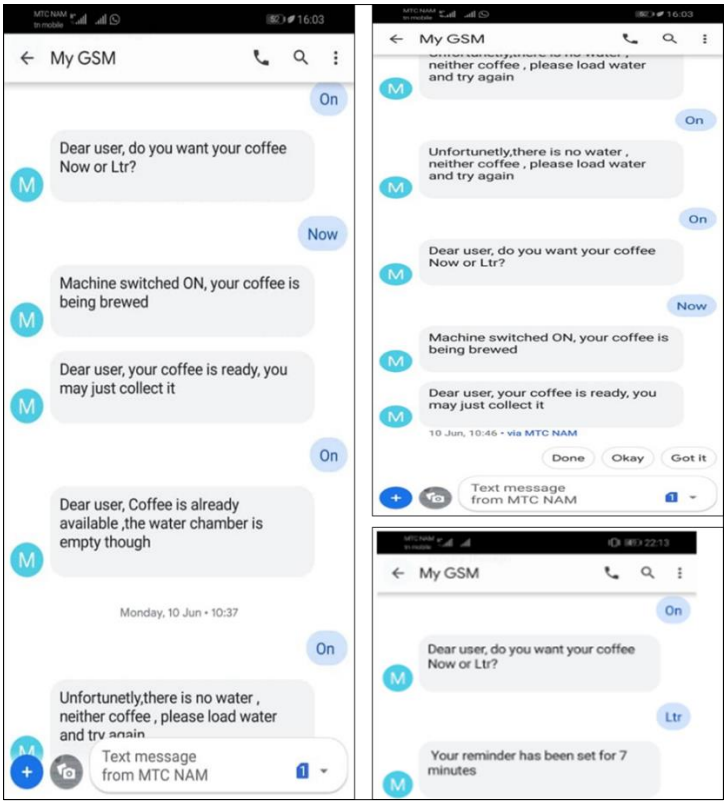


Figure 5 User-Machine interaction via SMS

The machine is programmed to understand the following commands:

- On -Switch the machine ON
- OFF- Switch the machine OFF
- Sta- Coffee state request
- Now- Switch on immediately
- Ltr -Set coffee making alarm

Illustrations of communication received during testing of the machine

Upon completion of components installation and circuit housing, the machine was tested remotely, and the intelligent coffee machine functioned according to specification. With GSM it is possible to communicate with the Artificially Intelligent Coffee machine.

The constraint in the use of the machine is noted to be the credit on the phone. The GSM SIM Card should have SMS credit to communicate with the owner.

4. Conclusion and Recommendations

In conclusion, the design and implementation of an Artificially Intelligent coffee machine is presented.

Detailed engineering design analysis of individual components involved in the system is crucial in optimizing the efficiency of the machine.

This design project aims at solving the problem of a lack of wirelessly controlled coffee makers in the market. This prototype design serves to prove the concept of automatic and remotely controlling home appliances, a step towards developing smart homes. This project was done to ensure that all the expected exit level outcomes such as problem solving, engineering design, independent learning abilities, and professional communication were achieved.

Note

This project was done under the guidance and supervision of Dr Francis in the year 2019 and presented at the at the final year Bachelor of Engineering, Namibia University of Science and Technology by Ms Julia Ndejene 2019.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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