Design and development of water flow valve control system using Bluetooth module for smart farming

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ABSTRACT

Agriculture is very important to the overall economic development of a country, and irrigation plays a pivotal role in agricultural development. Electric valves are used to control the flow of various fluids such as water, gas, and oil, using an electric actuator to open and close the valve. Herein, a method for controlling multiple valves in smart agriculture using Bluetooth is presented. This proposed system focuses on automatically opening and closing multiple solenoid valves, which play an important role in agricultural activities. Depending on the environmental conditions, the valve can be controlled from a smartphone by sending messages to a Bluetooth module connected to an Arduino. These modeling and control techniques for smart irrigation and smart agriculture are presented in detail.

Keywords: - *Smart Farming, Bluetooth, Controller, Modeling, and Valve.*

1. Introduction

Smart farming, also known as precision agriculture, is an approach to agriculture that uses technology to optimize crop yields, reduce costs, and conserve resources [1]. India, being an agricultural country, has been exploring the potential of smart farming to improve the productivity and sustainability of its agriculture sector. One of the key technologies used in smart farming is the Internet of Things (IoT), which involves connecting sensors, devices, and machines to a network and collecting data in real time. This allows farmers to monitor and control various aspects of their farms, such as soil moisture, temperature, and humidity, and make informed decisions based on the data. Farmers are using IoT-enabled sensors to monitor soil moisture levels and water usage, and adjust irrigation accordingly [2]. This can help conserve water and reduce water usage. Drones and satellite imagery are being used to monitor crop growth and identify any issues, such as pests or diseases. This allows farmers to take timely action to prevent crop damage. IoT-enabled storage systems are being used to monitor the temperature and humidity levels in storage facilities, ensuring that crops are stored under optimal conditions and reducing wastage. Smart machines, such as autonomous tractors and harvesters, are being used to automate farming tasks and reduce labor costs [3]. Blockchain technology is being used to track the origin and movement of crops, ensuring transparency and traceability throughout the supply chain.

Overall, smart farming has the potential to transform agriculture in India by increasing efficiency, productivity, and sustainability. However, the adoption of these technologies is still in its early stages, and there are challenges to be addressed, such as high costs and lack of awareness among farmers. Agriculture is an important part of India's economy and will be for a long time to come. The annual growth rate of GDP increased from less than 6% to 7%. This is due to the rapid growth of non-agricultural areas. Deterioration of soil and climatic conditions leads to deterioration of groundwater. Water for irrigation has become scarce. Indian agriculture is classified into agroecological diversity based on soil, temperature, rainfall and cultivation system. Land tending, harvesting, threshing and irrigation are the most energy-intensive operations in agriculture. Where water is important. In the above operations, irrigation plays a productive role. Irrigation is defined as the artificial addition and systematic sharing of water for high-quality or high-quality agricultural production [4]. A water control valve is a device that regulates the flow and pressure of water in a piping system. It is commonly used in various applications such as residential, commercial, and industrial settings, where water flow and pressure need to be controlled. Water

control valves are designed to open and close based on specific instructions from the user or a control system. They can be manually operated or automated, depending on the application and requirements. In addition to regulating the flow and pressure of water, water control valves can also be used to prevent backflow, which is the reversal of water flow in a piping system. Backflow can occur when there is a drop in pressure or when there is a connection between a potable water supply and a non-potable source, such as a swimming pool or irrigation system. Water control valves can help prevent backflow by automatically closing when a drop in pressure is detected or by using check valves to prevent the reverse flow of water.

Successful farmers use a variety of methods to provide water to their crops. Irrigation is a method of artificially using water to overcome the lack of rainfall for crop growth. Irrigation is a basic need to increase yields. When rainfall decreases, farming cannot be done without irrigation. Today, irrigated agriculture is limited. It protects plants from drought and increases yields.

2. Literature Survey

Irrigation is the process of applying controlled amounts of water to crops to support their growth. Although irrigation has been widely used for thousands of years, there are still challenges associated with this practice. With the increasing demand for water for domestic, industrial, and other uses, water scarcity is becoming a major challenge in many regions. This can lead to conflicts between different users of water and make it difficult to sustain irrigation. Climate change is leading to changes in precipitation patterns and temperatures, which can affect the availability of water for irrigation. Changes in temperature can also affect crop growth and increase the risk of pests and diseases. Over time, irrigation can lead to the accumulation of salts in the soil, which can reduce crop yields and damage the soil structure. This can be a particular problem in regions where the water used for irrigation is high in salts. Irrigation often requires significant amounts of energy to pump water from a source to the crops. This can contribute to greenhouse gas emissions and increase the cost of irrigation. The quality of water used for irrigation can affect crop growth and yield. Water that is contaminated with pathogens, chemicals, or other pollutants can be harmful to crops and affect human health. Inadequate or poorly maintained irrigation infrastructure can lead to inefficient use of water, water losses, and reduced crop yields. This can be a particular problem in developing countries where investment in irrigation infrastructure is limited. Addressing these challenges requires a range of strategies, such as improving water management practices, promoting water-efficient technologies, investing in irrigation infrastructure, and developing crops that are more tolerant to water stress [5]–[7]. Valves are used to control the flow and pressure of various fluids, including water, gas, oil, and chemicals, in a wide range of applications. The materials used for valves depend on the type of fluid being transported, the temperature and pressure of the fluid, and the environment in which the valve will be used [8]–[10]. Various Cu-Ni alloy-based composites coatings can be used to protect base frame from corrosion [11]–[19].

As per Bernatin et al. [20], a novel approach to smart agriculture uses a method to connect smart sensor systems and smart irrigation systems by using wireless networks for communication. It also emphasizes key measurements of physical parameters. Autonomous or unmanned aerial vehicles for agriculture are proposed [21]. The development of unmanned aerial vehicles such as drones has had an impact on the calculation of crop biomass development and fertilization status through the use of lightweight powerful screenshot cameras.

As per Pivoto et al. [22], the project emphasizes on automating farming and making farming easy by using advanced technologies. PLC and SCADA enable the system to fully control the proposed project and form the front end of a user-friendly interface. As per Walter et al. [23], the novel deals with the monitoring and management of water storage and distribution using automated systems such as PLC and SCADA. can be enabled.

As per Wolfert et al. [24], this paper focuses on smart irrigation and preventing water waste in uncontrolled irrigation. New electric irrigation controllers increase irrigation efficiency, promote water conservation and reduce environmental impact. The main feature is to avoid water waste by using PLC based sprinkler irrigation system with different sensors and GSM controller.

3. Proposed System

The idea presented by this system is the automation of irrigation systems for agricultural activities through the principles of communication and electronics. The idea is implemented by using Bluetooth, relay, Arduino and mobile phone. There are two functional components in this article. They are valves/pumps. Arduino boards are programmed using the Arduino IDE software. The microcontroller (ATmega328) is the brain of the system. The pump and motor are coupled to the output pins. Overall activity is received to the user via mobile application. The 3D Model and wireframe sketch of water flow valve control system setup is shown in Figure 1.

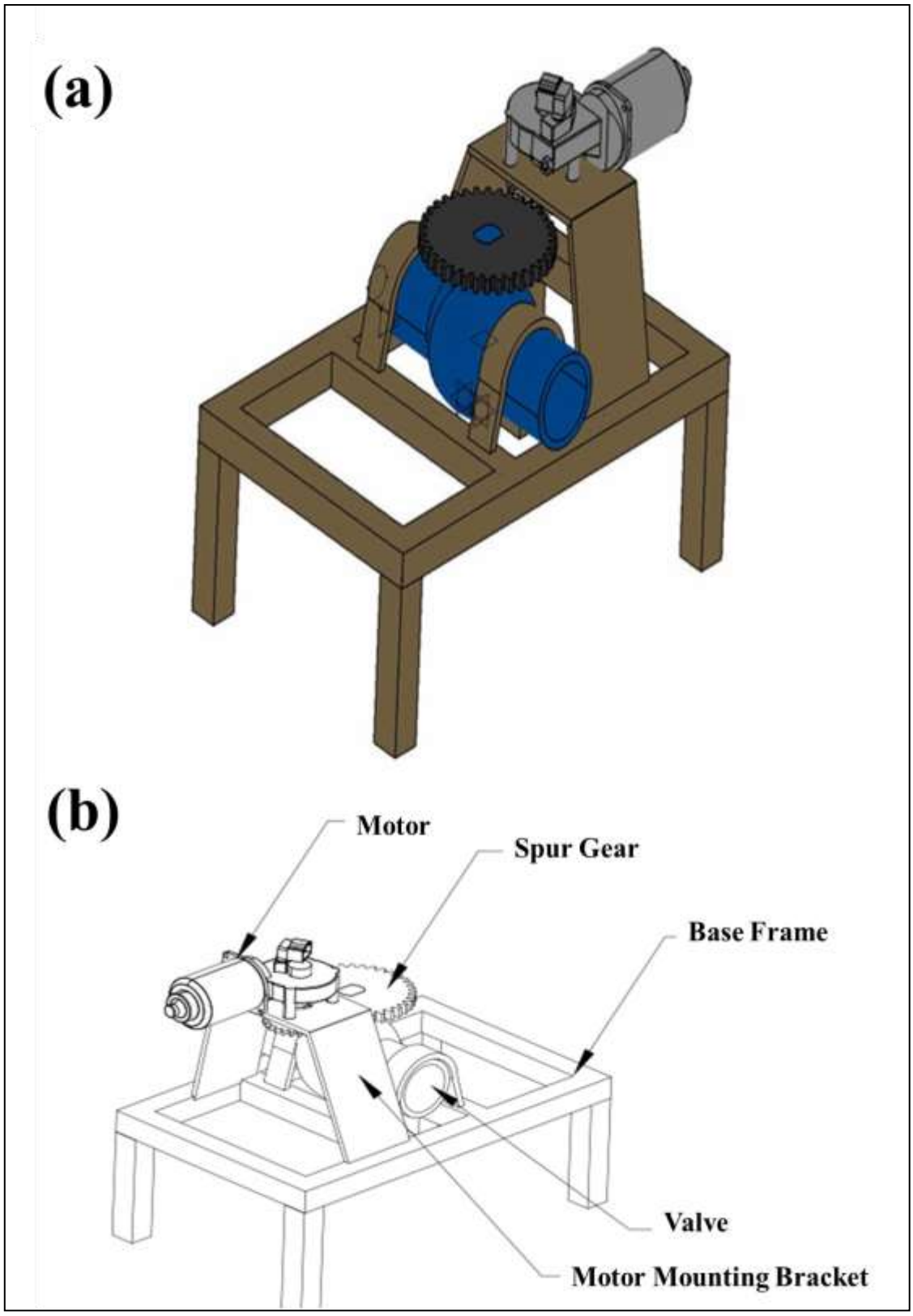

Fig 1: (a) 3D Model and (b) Wire Frame Sketch of water flow valve control system setup.

4. Components used for implementation of the system

The ATmega328-based Arduino Uno is a microcontroller board. It has 6 analog inputs, a 16MHz ceramic resonator, 14 digital I/P and O/P pins, 6 of which may be used as PWM outputs, a USB connection, a power jack, an ICSP connector, and a reset button. It comes with everything needed to operate the microcontroller; all you need to do is connect a USB cable, AC-DC converter, or batteries to your computer to power it. The initial release of the Arduino software was referred to as "uno" since "one" is an Italian word. The boards, together with the Arduino and IDE version 1.0, served as the standard for all subsequent generations of the Arduino. A boot loader that is pre-programmed into the onboard ATmega328 enables you to load fresh code without a third-party hardware programmer. The Uno varies from all prior boards in that it doesn't utilize the FTD-USB chip as the serial driver chip, even though it still uses the old STK500 protocol for communication.

5. Design and Analysis

The flow chart in Figure 2 shows how the static check on the base frame layout is conducted in stable works software. By connecting all of the components included in the basic body design, the assembled drawing of the base frame design is first created. The experiment on the bottom body structure is then launched using the static test function. The foundation frame's material is then selected from a list supplied in the stable works software database. Depending on the specifications of the fabric being used, some material specifications may need to be changed. Then, the lower body's furnishings are used.

The program includes fixtures like fixed geometry, fixed hinges, and rollers and sliders. The weight is then transferred to the basic frame form. The cost of the load is principally determined by the combined base frame weight and the weight of the driving force, accelerated via the preferred safety feature. The creation of mesh follows that. Meshing is a method of dividing the layout's geometry into finite components, which are tiny and simple to construct. The accuracy of the data gleaned from the test will rise with finer aspects. After the meshing is complete, the test is launched, and the test's outcome is obtained.

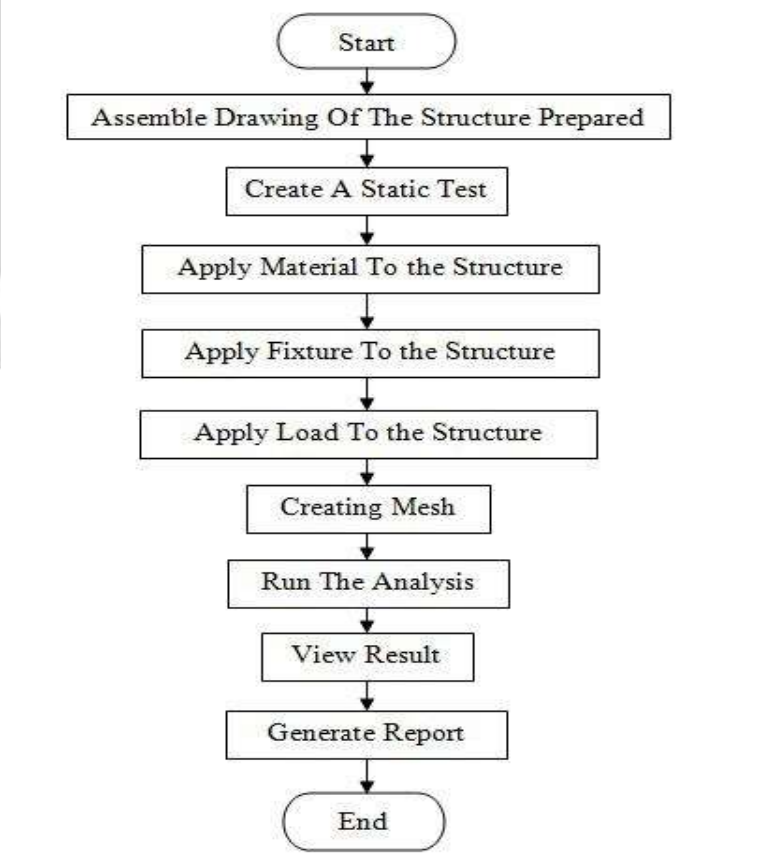

Fig 2: Flow chart of software workflow.

6. Methodology

To determine the most important factors for the FE analysis of axial ball bearings, parameter research is conducted. Mesh density, contact stiffness, osculation, load level, geometric nonlinearity, and material nonlinearity are the variables that are assessed. The FE software ANSYS is used to carry out the research. Finite element analysis' accuracy is affected by a number of variables, including the type of element used, the boundary condition, how the loads are applied, etc. The FE model is therefore nothing more than an approximation of reality. Physical testing can be used to investigate the parameters. However, it will need more money, time, and resources, therefore FE analysis is a better option, at least for parameter assessment.

The Arduino's port pins are each linked to a distinct application (Figure 3). The relevant application will react to the electrical signal generated on the port pins based on that signal. There are two sorts of electrical signals: signal low and signal high. If the signal is weak, the procedure of turning off will be carried out. If the signal is strong, the process of turning on will be complete.

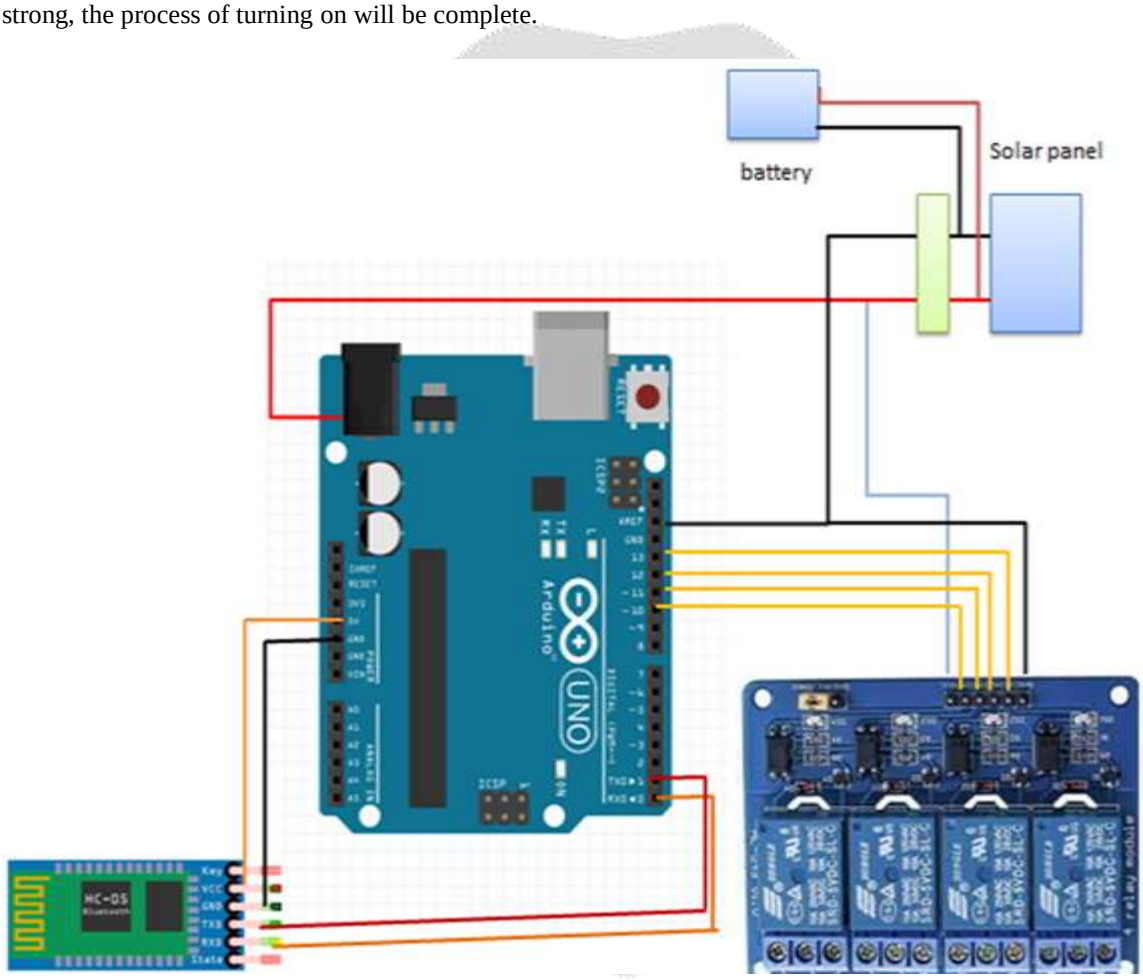

Fig 3: Arduino Connections for water flow valve control system setup.

7. Conclusion

Electric control involves using an electric actuator to position the valve. The actuator is connected to an electrical control system that provides the force required to move the valve. As a result, the key reason for the development of this project is to build the manpower and to growth the yield of crop. The proposed user-friendly farming is used for distance operation of valve automation. This in-flip create an awesome future for farmers. Overall, the design of an electric valve involves selecting appropriate materials and components, sizing the valve and actuator, and ensuring proper wiring and control system integration. The design must also meet or exceed performance specifications and safety requirements.

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