At this juncture based on our research, training pertaining to e-learning courses is relegated to effective teaching of a distance course. It does not directly relate to the security awareness (Alqurashi, 2019). For example, SACS questions each institution's ability to make training in technology available to faculty members teaching distance education courses. As universities continue to evolve toward hybrid and pure online teaching environments, security and privacy issues will need to be communicated and assessed. Therefore, we posit P6: Security training, education, and awareness programs will enhance the security and privacy of e-learning technologies (Els & Cilliers, 2018).

3.9 Risk Analysis

An effective risk analysis should integrate the security program objectives with a university's business objectives and requirements. The more the university and security objectives are in alignment, the more successful the two will be. The analysis will help a university draft a proper budget for a security program and its constituent security components. Once an organization knows how much its assets are worth and the possible threats they are exposed to, it can make intelligent decisions about how much money to spend protecting those assets (Tsai, Whitelock-Wainwright, & Gašević, 2020).

SACS guidelines state that an institution has an ethical responsibility to take reasonable steps to provide a healthy, safe, and secure environment for all campus constituents, as it will contribute toward more effective risk management. Risk management/analysis according to SACS can be carried out through a review of an institution's safety plan, crisis communications plan, and other health and safety procedures. However, once again, in the eLearning technology realm, specifics are lacking in terms of required guidelines.

4. DISCUSSION

It is undeniable that distance education has become an essential part of higher education. The framework included data evaluation, policies, legislations/regulations, architecture, integration, training, and risk analysis. The conceptual framework within this research relies on the premise that information privacy and security span all of the five components. Thus, we adopted (Meier et al., 2020) model because of its wholesome premise to protect the organization's various aspects. Said model diligently seeks the integration of privacy and security as fundamental feature into each of the five components.

The seven pillars aim to encompass and relay the essential importance of privacy and security in any information system. They acknowledge that their model has intentional redundancy because "...one's view of a component differs when considering how it relates to the business process, security governance, and/or privacy governance subsystems.

5. IMPLICATIONS, FUTURE RESEARCH, AND CONCLUSION

This research used a known security and privacy model and extended it to e-learning based on previous practices of similar modes. E-Learning has become a fixture in higher education; therefore, its security becomes an important matter that should be properly treated. We conveyed that a wholesome risk analysis should be conducted to identify vulnerabilities and challenges. Accordingly, policies and procedures are charted based on the findings to ensure compliance. In addition, an assessment of resources and training needs will be necessary as well. Accordingly, educating and preparing the stakeholders to counter these risks will become easier. An effective e-learning environment depends on stakeholders who understand the importance of security and behave responsibly within it.

This study also shows that privacy issues in some areas are not addressed comprehensively and clearly, nor are they informed to the practitioners. Higher education institutions need to train instructors and practitioners about privacy issues, particularly in an online learning environment. There should be "an urgent move to educate online behaviors in all school levels, and professional training.

Sharing knowledge publicly is becoming more and more important. However, it is equally important to respect and protect learners' privacy, especially in an online learning environment when privacy issues are more complex and nuanced compare with privacy issues in a physical learning environment. Some instructors may stop some good practices such as openly sharing knowledge among peers when such practice makes students feel that their privacy has been violated. It is a balance between respecting students' privacy and convincing students to step outside of their private zone to share knowledge openly with their peers.

Privacy is contextual, it is difficult to have a universal privacy policy that can be applied everywhere. Privacy concerns are context-based and may change over time within different groups of the community. New privacy issues need to be identified and some privacy contracts may need to be revised and tailored to a new group of the community or a new context.

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Faculty of Computational Sciences & Informatics - Academic City University College, Accra, Ghana
Society for Multidisciplinary & Advanced Research Techniques (SMART)
Trinity University, Lagos, Nigeria
SMART Scientific Projects & Research Consortium (SMART SPaRC)
Sekinah-Hope Foundation for Female STEM Education
Harmarth Global Educational Services
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Design and Construction of an Automatic Hydroponics Fodder Grow Machine

Mensah Michael & Mahami Wisdom
Faculty of Engineering
Academic City University College
Accra, Ghana
E-mails: michael.mensah@acity.edu.gh; wisdom.mahami@acity.edu.gh

ABSTRACT

Livestock is critical to the survival of people all around the world. The seasonal feed scarcity due to the rainfall patterns of the country and the rapid urbanization results to reduction of land for fodder production. Most smallholder dairy farmers in Ghana feed their dairy cattle on Napier grass and crop remains e.g. maize stovers, bean stalks, and banana leaves which are all poor-quality feeds. Sustainable fodder production technologies could be used as an alternative for producing fodder all the year round. Hydroponics fodder production is one of such technologies. The goal of the study is to design and construct an Automatic hydroponics fodder sprouting machine to aid in producing low cost fresh green nutritious fodder under a controlled environment to feed livestock such as cows, sheep, goats, pigs, chicken, ducks, turkey, and guinea fowls. The individual sub control systems were mathematically modelled and built using MATHLAB and SIMULINK. The physical system was built using a PID controller to monitor and control the growth parameters which were: Temperature, humidity, lighting, ventilation and irrigation

Keywords: Design, Construction, Automatic Hydroponics Fodder Grow Machine, SIMULINK

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1. BACKGROUND TO THE STUDY

Livestock is critical to the survival of people all around the world. The worth of the world's livestock is $1.4 trillion. In addition to providing income to approximately 500 million smallholder farmers in poor countries, the sector employs over 1.3 billion people each year [1]. Over the years, a global trend in cattle output has been noticed. Beef production has increased by more than 100%, while milk production per cow has increased by more than 30% [1].

Livestock is a valuable asset for the rural poor in developing countries, but it faces a serious problem in the form of limited seasonal feed supply. In Ghana and other Sub-Saharan African countries, pastures, agricultural wastes, and agro-industrial byproducts are common feed sources for livestock production. Seasonal scarcity, which has been frequently recognized as the most significant barrier to ruminant production in poor nations [2], is one of the most common concerns with these resources.

Feed resources are often available and of excellent quality during the wet season. Nonetheless, during the late dry season (March to May) and the beginning of the rainy season (late May/June), feed scarcity is a big issue. As a result, resolving the feed issue has the potential to significantly increase livestock productivity in West Africa. Despite continual declines in the extent of pasture and cultivable areas for crop production in Ghana, ruminants will continue to rely on food from natural pastures and crop leftovers. Livestock feed supply from natural pastures is characterized by seasonal fluctuations in total dry matter (DM) output and nutritional quality due to significant seasonal variations in plant growth.

In Ghana's Northern area, crop leftovers such as groundnut haulm, maize stover, millet straw, sorghum straw, cotton hay, rice straw, and others are important sources of feed for ruminant cattle [4],[5],[8]. Crop leftovers are the predominant feed supply for livestock in the region from November to March, which is crucial for both animal maintenance and production; but, from March to May, when feed is scarce, crop residues' contribution to animal nutrition falls. One of the key limitations to boosting ruminant production in developing countries has been recognized as a seasonal feed deficit [5]. As a result, livestock is malnourished and more susceptible to disease.

Hydroponic fodder is animal feed grown from seeds without soil, and with little water. A week after the seeds have sprouted, the nutritious seedlings will be up to 30 cm tall. They can be produced every day of the year, even in the dry season. Reduced availability of grazing land and scarcity of water to cultivate fodder makes it hard to produce green fodder throughout the year.

2. LITERATURE REVIEW

This section gives a review of hydroponics fodder production, the process of hydroponics fodder production, factors influencing the production of hydroponics fodder, types of hydroponics systems, and existing hydroponics systems, theoretical and conceptual framework, knowledge gap, and a summary of the literature review.

2.1 Overview of Project Work

2.1.1 Hydroponics fodder production

According to Sneath and McIntosh [10], hydroponics fodder is forage produced by growing plants in water or nutrient solution without soil. Hydroponics technology can be used to grow a variety of fodder crops such as barley, oats, wheat, sorghum, alfalfa, cowpeas, and maize. The type of seeds to be used is determined by geographical and agro-climatic conditions, as well as seed availability [11]. Because it is less expensive, uses less water, and is widely available, barley is regarded as the best choice for producing hydroponic fodder [2]. Young tender grass grown from cereal grain, primarily barley, is used as hydroponic fodder. It essentially replaces grains such as dairy meal, pig feeds, and poultry feed concentrates. Hydroponic fodder is widely regarded as the best livestock feed on a global scale

Hydroponics systems for fodder production range from high-tech greenhouses to low-cost systems and the choice are determined by the farmer's financial capabilities [9]. Low-cost systems can be built with locally available materials such as wood, bamboo, steel, and polythene, which significantly reduces the cost of a hydroponics system [9].

2.1.2 Why Hydroponic Fodder Systems

Efficiency

The efficiency of fodder production is greatly increased by providing the optimal environment. Water waste is reduced in hydroponic systems because it is applied directly to the roots and is frequently recycled and reused. However, because bacteria and fungi proliferate during recycling and the growth cycle, the water should be clean. As a result, it is recommended that water be filtered using infrared technology before recycling [12]. It has been reported that 1.5-2 litres are required to produce 1 kg of green fodder hydroponically, compared to 73, 85, and 160 litres for barley, alfalfa, and sorghum, respectively, under field conditions. Under hydroponic systems, this equates to only 2-5 percent of the water used in traditional fodder production [13]. This is especially important in areas where there is chronic water scarcity or where irrigation infrastructure does not exist.

Space

Hydroponic systems require far less space and time than conventional systems, making them ideal for city dwellers with limited yard space. The plant root systems of hydroponic fodder are much smaller than those of conventionally grown fodder, allowing for a greater number of plants per unit of space. It is also simple to start a hydroponic system indoors, where several racks with multiple tiers (vertical farming) are used to minimize land requirements, resulting in land preservation. Crop rotation is unnecessary in hydroponics; the same fodder species can be grown all year. Using hydroponics technology, approximately 600-1000 kg of maize fodder can be produced daily in a 7-8-day growth cycle in a 45-50 m2 area, compared to one acre in a traditional farming setting [9],[14]. Another study discovered that only one square meter of space is required to produce fodder for two cows per day, and milk yield increased by 13%.[15].

Pesticides, insecticides, and herbicides: Herbicides, fungicides, and/or insecticides must be used in traditional outdoor farming for optimum production. Because hydroponic fodder is grown in a controlled environment without soil, it is not susceptible to soil-borne diseases, pests, or fungi, reducing the use of pesticides, insecticides, and herbicides. An outbreak of pests or infections in hydroponically grown fodder can be quickly controlled by spraying the crops with appropriate pesticides or fungicides. Irrigation should be done with fresh and clean water because water-borne plant diseases spread quickly.

Fodder yield

By bringing nutrients directly to the plants rather than developing large root systems to seek food, fodder production can be increased by up to 25%. Plants mature more quickly and evenly in a hydroponic system than in a conventional soil-based system. In 7-8 days, one kilogram of un-sprouted seed yields 8-10 kilograms of green forage [9],[10],[12],[16]. The fresh yield of hydroponic maize fodder is 5-6 times greater than that of traditional farm production, and it is more nutritious [18].

Feed Consistency

One of the major challenges that many beef producers face is the variability/inconsistency of plant species within their pasture, which is primarily due to seasonal fluctuations. Feeding hydroponic fodder ensures the quality and quantity of fodder consumed. This feed consistency can lead to better-tasting end products of consistent quality, which is one of the primary goals of beef producers. Similarly, consistency in feed can improve the quality of swine and poultry meat and products. Hydroponic fodder production has the potential to significantly improve the quality of animal products [19].

Fodder Quality

On a DM basis, the crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and Ca content increased in the hydroponic green forage, but organic matter (OM) and non-fibrous carbohydrates (NFC) content decreased [20],[21],[22],[23]. Hydroponic fodder is high in vitamins A, E, and C, as well as thiamin, riboflavin, niacin, biotin, free folic acid, and anti-oxidants like -carotene [24],[25],[9]. According to [21],[26],[27],[28], as well as [18], it was discovered that hydroponic fodder is also a rich source of bioactive enzymes, with the highest activity in sprouts occurring between germination and 7 days of age [29]. The fatty acid concentration had a significant positive relationship with the growth period. Linoleic, linolenic, and stearic acid concentrations increased linearly with sprouting time [30]. Aside from assisting in the elimination of anti-nutritional factors such as phytate in grains, hydroponic fodders are high in chlorophyll and contain a grass juice factor that improves livestock performance [9]. The crop is free from antibiotics, hormones, pesticides, or herbicides [18].

Reduced Carbon Footprints

Since fertilizers are rarely used, hydroponics is more environmentally friendly than traditional agriculture. This drastically reduces greenhouse gas emissions [17]. Run-off from traditional farming can degrade the environment [18]. Hydroponic systems help to reduce fuel consumption for transportation of products from distant agricultural farms, as well as carbon emissions.

2.1.3 Major disadvantages of hydroponics fodder production

Total dry matter loss: Several studies reported that sprouting resulted in a 7-47 percent loss in DM from the original seed after sprouting for 6-7 days of growth, primarily due to respiration during the sprouting process [10],[21],[30],[31]. Seed soaking activates enzymes that convert starch stored in the endosperm to simple sugar, which produces energy and emits carbon dioxide and water, resulting in DM loss with a shift from starch in the seed to fiber and pectin in the roots and green shoots.

Nutrient availability: According to [10] it was discovered that sprouted barley fodder was 3.4 times more expensive per kg of DM than the original barley grains. Similarly, ME (cents/MJ), CP ($/kg DM), and FCR (feed cost/kg live weight gain) were 3.7, 2.2, and 2.5 times higher using hydroponic fodders than the original grains, respectively [10], confirming Appleman's (1962) finding that hydroponic oat and barley grass maybe 2.1 and 3.8 times higher in terms of food energy than rolled oats and bar. Decades of research and farmer experience show that the costs of producing hydroponic fodder are 2 to 5 times those of the original grain [32].

2.1.4 Economics of Hydroponics Fodder production

Traditional fodder production necessitates a significant investment inland, as well as agricultural machinery, equipment, and infrastructure for pre-and post-harvesting, including handling, transportation, and fodder conservation. Labour, fuel, lubricants, fertilizers, insecticides, pesticides, and weedicides are also required. Hydroponic fodder production, on the other hand, requires only seed and water as production inputs, with minimal labor inputs. Hydroponics reduces post-harvest losses by requiring no fuel for harvesting and post-harvesting processes. Furthermore, hydroponic systems take only 7-8 days to develop from seed to fodder, whereas traditional systems take 45-60 days. However, the initial investment required to set up hi-tech, sophisticated, automated commercial hydroponic fodder production systems with environmental control, as well as operational costs, is significantly higher than traditional soil-based fodder production farming. Such hydroponic systems necessitate far more specialized equipment and technical knowledge than is required in traditional farming. Mould is very likely, and thus prevention or treatment may necessitate additional investment. As a result, even if there are benefits to feeding hydroponic fodder, the costs usually outweigh the benefits.

2.1.5 Techniques for the Production of Hydroponics Fodder

HGF cultivation can be high-tech, fully automatic, or a low-cost, effective structure based on the seed germinating and growing for 7 to 8 days using only water until they reach a height of 20 to 30 cm. In an automatic system, forgers or drip irrigators are installed in chambers. To keep the seeds moist, the relative humidity is kept between 80 and 85 percent, and forgers spray a fine mist of water on the trays. However, for Ghanaian farmers, low-cost, sustainable systems that meet local input needs are required. According to the availability of raw materials in local areas, both scientists and ordinary farmers have modified the method of hydroponics fodder production.

2.1.6 Construction of a Hydroponics Fodder System

The temperature and humidity must be properly controlled to grow high-quality fodder. The fodder grows easily in semi-controlled environmental conditions with temperatures ranging from 15 to 32 degrees Celsius and relative humidity levels ranging from 80 to 85 percent. Also, controlled lighting is required to grow fodder, so you must construct a small shed net or a low-cost lighting system.

2.1.7 Hydroponic Fodder Production Process

For hydroponic fodder production, only use high-quality seeds; damaged or sick seeds will not germinate or grow properly. Maize, pulses, wheat, and horse gram seeds can be used to manufacture hydroponic fodder, but pearl millet and sorghum seeds should not be used since the sprouting leaves contain a toxin that can injure your cattle. Farmers frequently utilize maize seeds to make hydroponic fodder. In cold areas, wheat and oats seeds are excellent for hydroponic fodder production, whereas in hot climates, maize seeds are suitable.

2.1.8 Yield and Chemical Composition of Hydroponics Green Fodder

It appears to be a mat made up of roots, seeds, and plants. Hydroponic green fodders contain more protein, fat (ether extract), and soluble carbohydrates (nitrogen-free extract) than conventional green fodders, but less fiber, total ash, and acid-insoluble ash.

Table 1: Chemical compositions of conventional green fodder vs. hydroponics green fodder .

Nutrient	Convectional Green Fodder (%)	Hydroponics Green Fodder (%)
Protein	10.67	13.57
Ether Extract	2.27	3.49
Crude Fiber	25.92	14.07
Nitrogen Free Extract	51.78	66.72
Total Ash	9.36	3.84
Acid Insoluble Ash	1.40	0.33

2.2 Existing hydroponics Fodder systems

- Hydroponics Africa in Kenya Uses locally available materials to control the temperature and humidity of a room to grow fodder. The temperature and humidity inside the hydroponic fodder system are controlled using only a hydro-net and a hydro-cloth, to ensure higher growth and the best nutritional value possible. Patented photo-chemically treated trays are used to grow fodder. There is no need for electricity in the growing process since no electrical device is used. However, the system requires a lot of manual labor work in watering and monitoring temperature and humidity values which is labor-intensive.
- FodderTech is a company that specializes in the design, manufacture, and distribution of sprouting systems. This one-of-a-kind machine grows seeds to feed in 7 days. Sprouting commercial quantities of sprouts indoors enables livestock owners to grow green feed all year. These systems are bulky and very expensive. The cost involved to ship one of these machines to Ghana may cost a hundred thousand dollars.

- The Indian Institute of Technology, Kharagpur created a low-cost hydroponic system in a room with two brick walls and double-glazed glass windows on the other two sides (North-South), allowing sunlight to pass through but preventing a rise in temperature inside the hydroponic system. Bamboos were used to construct shelf racks [22],[33]. Due to dwindling available land, intensive labor, and pesticide requirements, and an insufficient supply of water in India's southern states, Tamil Nadu Veterinary and Animal Sciences University developed a hydroponic system at the University Research Center. Madhavaram Milk Colony Farm This is a low-cost mobile system that produces 40 kg of hydroponic fodder per day. The system is priced at 48000.0 Indian National Rupees (INR) [34] The ICAR research complex in Goa and Govind milk and milk products in Satara District, Maharashtra, India, aided in the development of low-cost on-farm hydroponic systems.
- In Malawi, Hydroponic fodder was grown in a simple greenhouse with wooden frame shelving on which seed trays were stacked [15]. According to [34], the rack could be made of wood, steel, or polyvinyl chloride (PVC) pipes, but they have also used an existing building wall to construct a lean-to-shade net greenhouse, which reduced construction costs. Controlling or adjusting humidity and air circulation in low-cost hydroponic production units is difficult, especially during the dry, hot summer months.
- In Tanzania, to ensure that the fodder grows well and has a high nutritional value, the temperature and humidity inside the hydroponic fodder systems are only controlled with a hydro-net and a hydro-cloth [17]. Using manual or automatic micro-sprinklers or a knapsack sprayer, freshwater is irrigated with hydroponic fodder at regular intervals. The external climatic conditions have a greater influence on the internal environment of the greenhouse in low-cost hydroponic systems. As a result, the season and climatic conditions of the locality/region determine the types of fodder grown hydroponically. The seeds germinate in 24 hours and grow to a height of 20-30 cm in 7-8 days, at which point they are ready for harvesting and feeding.

2.3 Review of Proposed System

All of the studies reviewed show that there are many techniques for hydroponics fodder growing, and the majority of these design techniques are labor-intensive manual operation, and shipping some of the available machines from abroad will cost hundreds and thousands of dollars. All of the hydroponics systems available in Africa are manually operated, which means that important parameters such as temperature, humidity, and lighting cannot be precisely controlled, resulting in poor yield. Precision sensors are used in this proposed system to accurately monitor and control the temperature, humidity, lighting, ventilation, and watering. The materials used in this system are low-cost, making it affordable to all farmers, and the operation is straightforward. This system is also distinguished by its solar power system, which makes it singular from all other hydroponics systems on the market. The power system of this one-of-a-kind machine allows it to be used in areas where there is no electricity.

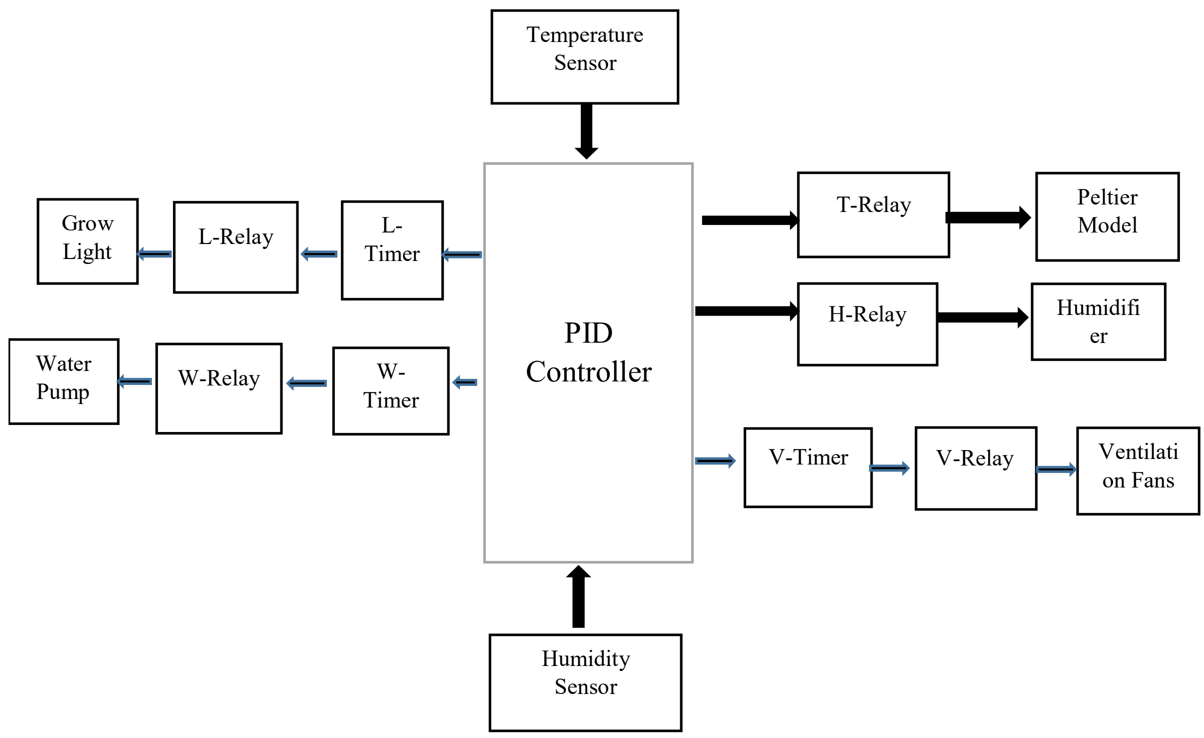

Fig 1: Block Diagram of Proposed System

2.4 Technical/Component Review

2.4.1 Temperature Sensor

A temperature sensor is a type of electronic device that measures the temperature of its surroundings and converts the measured data into electronic data to record monitor, or signal temperature changes. Temperature sensors come in a variety of shapes and sizes. Some temperature sensors require direct contact with the physical object being monitored (contact temperature sensors), whereas others measure an object's temperature indirectly (non-contact temperature sensors) [36].

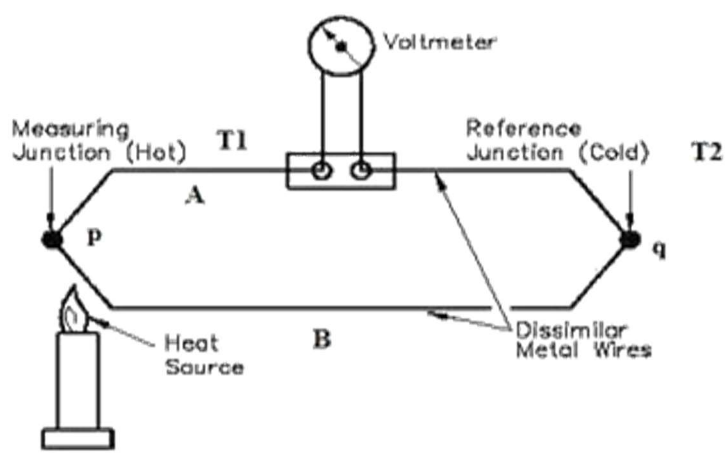

Figure 2. Diagram of a Thermocouple.

Infrared (IR) sensors are commonly used in on-contact temperature sensors. They detect the infrared energy emitted by an object and send a signal to a calibrated electronic circuit, which determines the temperature of the object.

Thermocouples and thermistors are two types of contact temperature sensors. A thermocouple is made up of two conductors, each of which is made of a different metal, that are joined at one end to form a junction. When the junction is heated, a voltage is generated that is proportional to the temperature input. This is due to a phenomenon known as the thermoelectric effect. Thermocouples are generally inexpensive due to their simple design and materials. A thermistor is another type of contact temperature sensor. The resistance of thermistors decreases as temperature rises. Thermistors are classified into two types: Negative Temperature Coefficient (NTC) and Positive Temperature Coefficient (PTC) (PTC). Thermistors, which are made of ceramics or polymers, are more precise than thermocouples (capable of measuring within 0.05-1.5 degrees Celsius). Resistance Temperature Detectors (RTD) are the most precise and expensive type of temperature sensor. They are essentially the metal counterpart of thermistors.[36]. Temperature sensors are found in automobiles, medical devices, computers, cooking appliances, and other machinery.

2.4.2 Humidity Sensor

A humidity sensor is an electronic device that measures the humidity in its surroundings and converts the results into an electrical signal [36]. Humidity sensors range in size and functionality; some are found in handheld devices (such as smartphones), while others are integrated into larger embedded systems (such as air quality monitoring systems). Humidity sensors are widely used in meteorology, medicine, automobiles, HVAC, and manufacturing. Humidity sensors are classified into two types based on how they calculate humidity: relative humidity (RH) sensors and absolute humidity (AH) sensors. The maximum amount of humidity for air at the same temperature is used to calculate relative humidity by comparing the live humidity reading at a given temperature to the maximum amount of humidity for air at the same temperature. To determine relative humidity, RH sensors must first measure temperature. Absolute humidity, on the other hand, is measured independently of temperature. The capacitive and resistive humidity sensors are the two most common RH sensors. Capacitive sensors use two electrodes to measure the capacitance (the ability of a thin metal strip to store an electric charge) of a thin metal strip placed between them. The capacitance of the metal increases or decreases at a rate that is proportional to the change in humidity in the sensor's environment. The difference in charge (voltage) caused by humidity increases is then amplified and sent to the embedded computer for processing. Resistive humidity sensors work on a different principle than capacitive humidity sensors. These sensors use a small polymer comb that expands and contracts in size as the humidity changes, affecting the system's ability to store charge.

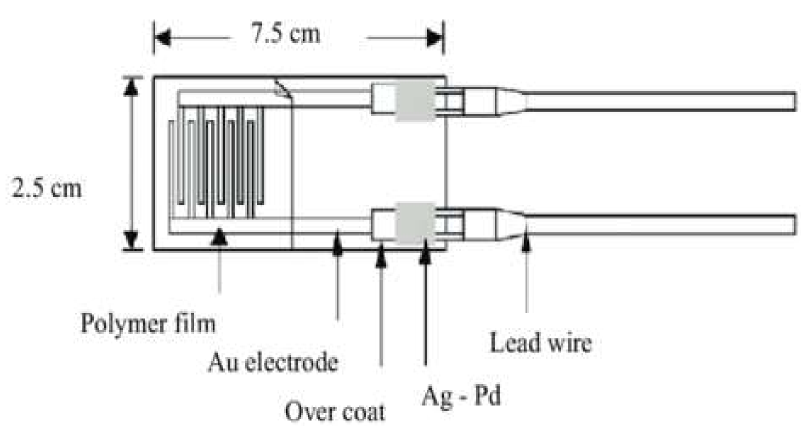

Figure 3: Schematic of a Resistive Humidity Sensor.

Absolute humidity is measured using thermal humidity sensors. Thermal humidity sensors, as opposed to RH sensors, use two probes, one to measure dry nitrogen and the other to measure the air in the surrounding environment. When humidity is collected on the exposed probe, the sensor detects the difference in thermal conductivity and calculates AH.

2.4.3 Ultrasonic Mist maker

A piezo atomizer disc/transducer (ceramic humidifier) in an ultrasonic mist maker/humidifier (also known as an ultrasonic atomizer) works by transposing high-frequency sound waves into mechanical energy that is transferred into a liquid, creating standing waves. The liquid is broken into a fine mist of uniform micron-sized droplets as it exits the atomizing surface of the disc, so the key component required for this little project is a specific (20-mm, 113-kHz) ultrasonic atomizer disc/transducer [37].

2.4.4 555 Timer

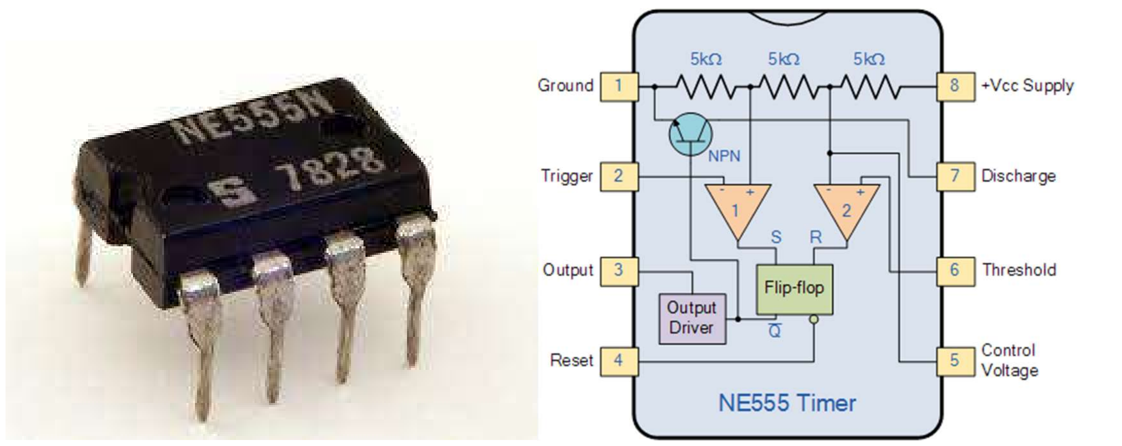

Figure 4: Pin layout Diagram of a 555-timer IC

The 555 Timer is a widely used integrated circuit (IC) that can generate a variety of output waveforms with the addition of an external RC network.

Pin configuration

Pin 1 is connected to the ground.
VCC: The positive supply voltage is connected to Pin 8. This voltage must be at least 4.5 volts and no more than 15 volts. It's common to power 555 circuits with four AA or AAA batteries (for a total of 6 V) or a single 9 V battery. Output: The output pin is Pin 3. The output is either low (very close to 0 V) or high (very close to the supply voltage placed on pin 8). The connections to the remaining five pins determine the exact shape of the output — that is, how long it is high and how long it is low. Pin 2 is the trigger, which acts like a starter's pistol to start the 555 timers. The trigger is an active low trigger, which means the timer begins when the voltage on pin 2 falls below one-third of the supply voltage. When the 555 is activated via Pin 2, the output on Pin 3 becomes high.

Discharge: Pin 7 is referred to as the discharge. This pin is used to discharge an external capacitor, which controls the timing interval in conjunction with a resistor. Pin 7 is typically connected to the supply voltage via a resistor and to the ground via a capacitor in most circuits. Threshold: Pin 6 is referred to as the threshold. This pin's function is to monitor the voltage across the capacitor discharged by pin 7. The timing cycle ends when this voltage reaches two-thirds of the supply voltage (Vcc), and the output on pin 3 goes low. Pin 5 serves as the control pin. This pin is typically connected to the ground in most 555 circuits, usually via a small 0.01 F capacitor. (The capacitor's purpose is to smooth out any fluctuations in the supply voltage that could interfere with the timer's operation.)

Reset: Pin 4 is the reset pin, and it can be used to restart the timing operation of the 555. Reset, as the trigger input, is an active low input. As a result, for the 555timer to function, pin 4 must be connected to the supply voltage. If Pin 4 is briefly grounded, the 555 timer's operation is halted and will not resume until Pin 2 is re-enabled.

2.4.5 Water Pump

The pump's operating principle is to convert mechanical energy to pressure. A rotating impeller accelerates a liquid, and as the area of the pump casing expands, the fluid velocity is converted to pressure. As a result, pressurized fluid escapes from the pump discharge. It transports water from one location to another or simply moves it around. There are two types of centrifugal and positive displacement pumps. Positive displacement pumps trap and move water. A hand water pump that traps and sprays water is one example. A centrifugal pump employs a rotating fan or similar device to increase water pressure and flow within a sealed casing before expelling it through a small opening. That is how sewage treatment pumps work. A centrifugal pump must be filled with water or immersed in it, whereas a positive displacement pump does not. 38]

Figure 5: Diagram Water Pump

2.4.6 Relay

In electronics, relays are the most commonly used switching device. The first important relay parameter is the Trigger Voltage, which is the voltage required to turn on the relay and change the contact from Common NC to Common NO. The other parameter is your Load Voltage and Current, which is the amount of voltage or current that the relay's NC, NO, or Common terminal can withstand.[39].

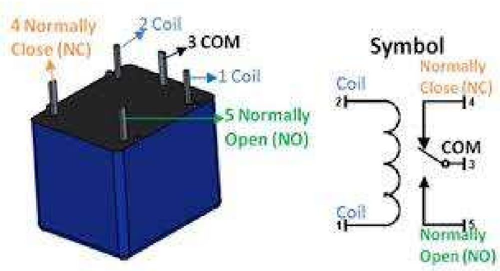

Figure 6: Schematic Diagram of 12V Relay

2.4.7 Exhaust Fans

Exhaust fans work by sucking hot or humid air out of a small, localized area and allowing fresh air to enter from somewhere else (such as a doorway or vent) to replace it. The warm air drawn out by an exhaust fan is then drawn through a ducting system and expelled outside. The amount of air that a fan can move is determined by its size and speed. A small fan may move the same amount of air as a large fan, but it must oscillate at a faster rate to do so - depending on how the fan is built, this may also make it noisier.[40]

Figure 7: 220V AC Ventilation Fan

2.4.8 LED grow lights

LED grow lights are luminaires that produce light for growing plants by utilizing LED chips in a modern and efficient manner. LED grow lights come in a variety of shapes and sizes, but as the most important units of LED grow lights, LED chips have the most influence on the light quality, i.e. spectrum (colors) and photon flux ("brightness") produced. Because LED grows light manufacturers can select which LEDs to use in their lamps, it is critical to understand which type of LED grow light is best suited to the specific application. The ability to match the light to the needs of plants is one of the advantages of LED grow lights over traditional lighting solutions.[41].

Figure 8: LED Grow Light

2.4.9 Water Sprinkles

A sprinkler irrigation system is a method of watering your farm that works similarly to normal rainfall. Pumping is used to move water through a network of pipes. It is then separated by sprinklers, resulting in tiny water drops that fall to the ground. Water is distributed over the entire soil surface by spray heads located at the terminals.[42]

Figure 9: Water Sprinkles

2.4.10 Digital Timer

A digital timer is a small electronic device that runs on batteries. This device's primary function is to count down minutes for precise timing. These timers are much more portable than traditional clocks. Digital timers range in complexity from simple to complex, portable, and include complete operating systems.

Figure 10: Digital Timer Relay

2.4.11 Power Inverter

An inverter's primary function is to convert direct current (DC) power to alternating current (AC). AC power can be supplied to homes and industries via the public utility; however, the alternating-power systems of the batteries can only store DC power. Furthermore, almost all household appliances and other electrical equipment can be powered by alternating current (AC).)

Figure 11: Power Inverter

2.4.12 Charge Controller

The charge controller regulates the amperage and voltage delivered to the loads, and any excess power is delivered to the battery system to ensure that the batteries do not overcharge. When there is no sunlight in the evening, battery.

Figure 12: Solar Charge Controller

2.4.13 Solar Batteries

Solar batteries are used to store solar energy (solar electricity) and then discharge it as needed. Rechargeable solar batteries are used to store excess electricity in off-grid PV systems. Wet cells are used in some solar battery banks, while sealed or gel cell batteries are used in others. The temperature, mounting, and ventilation requirements for each of these batteries vary.

Figure 13: Solar battery

2.4.14 Switch
A power switch regulates the flow of electricity to an electric device. The switch has an on and off position, which is typically represented by a 1 (on) and a 0 (off) (off).

Figure 14: Switch

2.4.15 Voltage Regulator
A voltage regulator is an integrated circuit (IC) that maintains a constant fixed output voltage regardless of load or input voltage changes. It can do this in a variety of ways depending on the topology of the circuit within, but for the sake of keeping this project simple, we will focus primarily on the linear regulator.

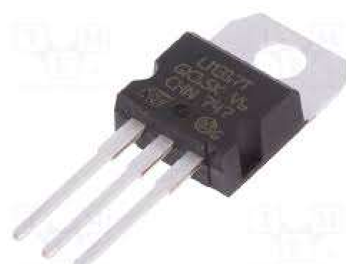

Figure 15: 12V Voltage Regulator

2.4.16 Stepdown Transformer
A Step-Down Transformer converts a high primary voltage to a low secondary voltage. The primary winding of a coil in a Step-Down Transformer has more turns than the secondary winding.

Figure 16: Stepdown Transformer

2.4.17 Thermoelectric Module

The Peltier effect governs the operation of thermoelectric coolers. By transmitting heat between two electrical junctions, the effect causes a temperature differential. To generate an electric current, a voltage is supplied across linked conductors. Heat is evacuated from one junction and cooling occurs when current travels through the junctions of the two conductors. At the other end of the circuit, heat is deposited. Thermoelectric coolers in fig 2.17 act as a solid-state heat pump.

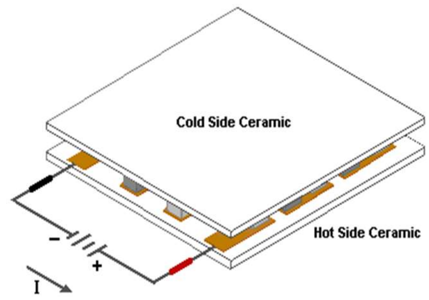

Figure 17: Thermoelectric Peltier Module

2.4.18 Heat sink

A heat sink is a component that helps to transfer heat away from a hot device. It achieves this by increasing the device's operating surface area and the amount of low-temperature fluid that flows through it.

Figure 18: Heat Sink

2.4.19 Steel Insulated Boards

Insulated panels are commonly utilized in typical industrial and warehouse constructions, as well as retail, distribution, leisure, commercial, chill, and cold stores, hospitals, schools, and apartments/single dwelling spaces.

Figure 19: Steel Insulated Board

3. PROBLEM STATEMENT

The main challenge of livestock production such as poultry, sheep, goat, and cows among others in Ghana and West Africa at large is the high cost, quality, and shortage of feed. Livestock production is a significant part of the country's agriculture, accounting for 14% of total GDP. Agriculture is also a significant source of revenue for the country's farmers [7]. Its socioeconomic significance in alleviating rural poverty cannot be overstated. Around 75% of the cattle produced in Ghana is produced in the three northern regions [7]. The country's rainfall pattern has a serious impact on livestock feed availability. Farmers are unable to feed their livestock green grass during the dry season, causing them to lose weight and become malnourished, resulting in poor milk and meat quality.

4. OBJECTIVES OF STUDY

Project Goal
The goal of the study is to design and construct an Automatic hydroponics fodder sprouting machine to aid in producing low cost fresh green nutritious fodder under a controlled environment to feed livestock such as cows, sheep, goats, pigs, chicken, ducks, turkey, and guinea fowls.

General Objectives
To design and develop a hydroponics fodder grow machine

Specific Objectives
- Installation of a temperature and humidity controller to properly maintain the required conditions for plant growth.
- Installation of Peltier cooling model to serve as air conditioning for the grow box.
- Use of forgers to provide the required humidity for plant growth.
- Use of insulated steel plates to maintain the indoor temperature and humidity.
- Use of a water pump for watering the fodder.
- Installation of grow lights to provide the needed lighting for plant growth.
- Use of ventilation fans to improve air circulation.

3.1 Research Questions
Many questions must be answered to design and build a hydroponics fodder grow box that can be widely used by many users and applied in a variety of contexts. Some of these inquiries are as follows:
- What are the agricultural climate factors and how do they influence the growth of fodder?
- What sensor technologies apply to this project?
- Which are the existing automatic fodder grow systems and why automation?
- What hardware and software are needed for this project?
- Which other problem in agriculture could be solved using this technology?
- How are module integration and design specifications achieved?
- How important is hydroponics fodder growth important in livestock production?
- How is cost controlled in this project?

3.2 Justification of the study
The main advantages of the proposed design in comparison with previous works are;
- This system will have the ability to monitor agricultural climate parameters (temperature, relative humidity, light intensity, ventilation).
- The systems will be able to use less water to grow more fodder than the traditional farming system
- The system will be free from pest and disease infections

- The system will be free from insecticides and weedicides
- The system can be used in any area since it could easily be powered by solar
- The system covers less space
- is relatively cheap and easy to build.

3.3 Work Scope

This project aims to create indoor hydroponics grow machines that can be used to cultivate crops such as microgreens, cabbage, lettuce, vegetables that do not grow higher than one foot, and fodder to feed livestock.

3.4 Significance of Project

- To produce low-cost nutritious feed for livestock production.
- To provide green fodder for livestock during the dry season.
- To minimize overgrazing and its consequences.
- To improve egg-laying in poultry production
- To boost livestock production in Ghana.
- To Analysis the feasibility of Hydroponics fodder production in the sustainability of agriculture in Ghana and Africa at large.
- To preserve some important medicinal plants that are on verge of extinction due to climate change.

4. CONCLUDING REMARKS

The population of the world is increasing at an increasing rate. The current food systems are almost at a steady state hence will be incapable of sustaining the growing population. The spraying of chemical insecticides, pesticides, and weedicides is destroying the fertility of the land drastically, industrialization and urbanization are taking off most of the available land and livestock production is greatly affected by the seasonal availability of feed. Hydroponics fodder growth technology is a game-changer for livestock production all over the world.

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