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SMART CHICKEN INCUBATOR

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Abstract— *Egg Incubator is a closed apparatus for providing a controlled environment in all the possible ways for the immense care for the egg to hatch after the incubation period. For an egg to be hatched, incubation is main process to be properly facilitated. The major drawback is regular monitoring and maintaining the incubation system in commercial farms. It has become hard task to monitor and control temperature and humidity according to the incubation cycle from remote distance on regular basics. In this project, the smart monitoring system is designed for the small scale low cost incubation system .It enable us to monitor and control the incubator from any distance as the data obtained from the sensors is collected in the cloud and updated regularly .The result of analyzed data is uploaded into the website . This creates the efficient way to monitor the incubation system at any time or distance.*

Keywords: Sensor, Monitoring, IoT, Incubation Mechanism, Smart Incubator.

1.INTRODUCTION

Egg incubation is a technology that provides opportunity for farmers to produce chicks from egg without the consent of the mother hen, is also one of the ways of transforming eggs to chicks. The most important difference between natural and artificial incubation is the fact that the natural parent provides warmth by contact rather than surrounding the egg with warm air.

Over the years incubators have been refined and developed so they are almost completely automatic. Modern commercial incubators are heated by electricity, have automatic egg-turning devices, and are equipped with automatic controls to maintain the proper levels of heat, humidity, and air exchange. Both still-air and forced-draft incubators are used in hatcheries. However, all the new incubators are forced-draft; that is; they have fans to circulate the air. They are capable of maintaining more even temperature, humidity, and oxygen levels then still-air incubators.

Statement of Problem

1. Improper control of humidity and temperature in the incubator system.
2. Failure of regular monitoring of incubator.
3. The existing incubator was not properly designed with tilting mechanism.

Aims and Objectives

The aim is to re-design and modify the performance of an existing incubator.

The objectives of this project are:

i. To design and construct an incubator using a well lagged material, ensuring affordability compared to the imported type of incubator for every household
ii. To use a bi-directional dc motor, so as to produce regular turning of egg tray.
iii. To use sensors to measure temperature and humidity and upload the values in real time for monitoring.

Five major functions are involved in the incubation and hatching of poultry eggs.

- Temperature
- Humidity
- Ventilation (Oxygen and Carbon dioxide level and air velocity)
- Position of eggs
- Turning of eggs

Temperature
Temperature is the most critical environmental concern during incubation because the developing embryo can only withstand small fluctuations during the period. Embryo starts developing when the temperature exceeds the Physiological Zero. Physiological zero is the temperature below which embryonic growth isarrested and above which it is reinitiated. The physiological zero for chicken eggs is about75*F. The optimum temperature for chicken egg in the setter (for first 18 days) ranges from 99.5* to 99.75* F and in the Hatcher (last 3 days) is 98.5* F

Humidity
Incubation humidity determines the rate of moisture loss from eggs during incubation. In general, the humidity is recorded as relative humidity by comparing the temperatures recorded by wet-bulb and dry-bulb thermometers.

Recommended incubation relative humidity for the first 18 days ranging between 55 and 60% (in setter) and for the last 3 days ranging between 65 and 75%. Higher humidity during hatching period is given to avoid dehydration of chicks.Ventilation is important in incubators and hatchers because fresh oxygenated air is needed for the respiration (oxygen intake and carbon dioxide given off) of developing embryos from egg setting until chick removal from the incubator. The oxygen needs are small during the first few days compared to the latter stages of development. Oxygen content of the air at sea level is about 21%. Generally the oxygen content of the air in the setter remains at about 21%. For every 1% drop in oxygen there is 5% reduction in hatchability.

Carbon dioxide is a natural by-product of metabolic processes during embryonic development and is released through the shell. The tolerance level of CO2 for the first 4 days in the setter is 0.3%. CO2 levels above 0.5% in the setter reduce hatchability and completely lethal at 5.0%.

Since the normal oxygen and CO2 concentrations present in air seem to represent an optimum gaseous environment for incubating eggs, no special provision to control these gases is necessary other than to maintain adequate circulation of fresh air at the proper temperature and humidity.

Position of eggs
Artificially incubating eggs should be held with their large ends up. It is natural for the head of the chick to develop in the large end of the egg near the air cell, and for the developing embryo to orient itself so that the head is uppermost. When the eggs are incubated with the small end up, about 60% of the embryos will develop with the head near the small end. Thus, when the chick is ready to hatch, its beak cannot break into the air cell to initiate pulmonary respiration. Eggs positioned horizontally will incubate and hatch normally as long as they are turned frequently. Under normal circumstances eggs are set with large end up for the first 18 days (in setter) and in horizontal position for the last 3 days (in hatcher).

Turning
Birds, including chickens and quail, turn their eggs during nest incubation. Nature provides nesting birds with the instinct of turning eggs during incubation. Similarly eggs to be turned at least 8 times a day. Turning of eggs during incubation prevents the developing embryo adhering to the extra-embryonic membranes and reduces the possibility of embryo mortality. In large commercial incubators the eggs are turned automatically each hour i.e. 24 times a day. Most eggs are turned to a position of 45o from vertical, and then reversed in the opposite direction to 45o from vertical. Rotation less than 45o are not adequate to achieve high hatchability. Turning is not required in Hatcher.

2.CRITERIA

To meet this all criteria,the following things are provided in our incubator:

Light
The Light bulb of capacity 25W or 45W or 60W depending upon the size of the module.The purpose of the Light bulb is to ensure proper temperature inside the incubator.

Dc fan
The incubator contains dc fan to maintain humidity for proper hatching of chicken and also a tray of water is placed inside the incubator to maintain the humidity value.

Titing mechanism:
This mechanism is very important for hatching of egg, because in this mechanism eggs are properly arranged over the tray which is connected to the shaft where it is fixed with a dc motor which is provide different angle to the tray. The

tray has to be in different position of angle of 0’, 30’, 45’ which can prevent the attach of yoke with the shell .The tilting is taken 3 times per day for different angles. Since, the complete hatching period is 21 days .The tilting is taken for first 15 days. For remaining days tilting is not required. Generally, vibrator is not advisable, because which makes the egg collapsed.

EGG TURNING:

- Egg turning
- Egg position
- Ventilation

The associated effects of egg turning, egg position, and ventilation influence several processes, including gas exchange and heat transfer between the eggs and the external environment, egg water loss, adhesion of the embryo to the extra-embryonic membrane structures (corium, amnion and allantois), and nutrient availabEgg turning is a natural behavior of birds during incubation, and therefore, this practice was included in the artificial incubation process. Egg turning allows the diffusion of gases inside the eggs and between the eggs and the external environment. It is critical particularly during the first week of incubation, due to the long distance between the embryo and the shell, and to the high albumen density. During this period, the embryo depends on the diffusion of gases through the eggshell and the albumen to obtain O_2 and eliminate CO_2, because the embryo develops on the yolk surface and gases are exchanged directly by the embryonic cells. After the emergence of the circulatory system (~36 h of incubation) and the formation of the amniotic cavity and yolk vascularization, gases are exchanged through the vitelline vessels. The allantois begins to protrude out of the embryo body around days 3-4 of incubation, and continues to grow in size, surrounding the amniotic cavity, where the fetus develops. As both fetus and allantois grow, the allantois comes closer to the eggshell, reducing the distance traveled by the gases and allowing gas exchange via allantoic vessels by diffusion through the eggshell pores. Gas exchange through the allantoic arteries and veins begins on days 11-12 of incubation. By days 13-14 of incubation, fetal metabolic heat production increases, and egg turning aids the circulation of air in the inner surface of the egg (external shell membrane) and air chamber, and allows heat loss by conduction, convection, and evaporation. However, egg turning is also important to preventdehydration and incorrect embryo development. Moreover, egg turning moves nutrients, facilitating their absorption.

Egg turning is not as simple as it may seem. Egg turning frequency, axis of setting, angle, and plane of rotation influence *in-ovo* development, which may affect hatchability and chick quality demonstrated that chicken hens turned eggs approximately 96 times daily during natural incubation. and showed that eggs turned 24 times per day (every hour) presented higher hatchability compared with eggs turned less frequently. Years later, observed that high egg-turning frequency (96 times/day or turning every 15 minutes) improves *in-ovo* development and hatchability. However, turning every 15 minutes is operationally difficult and increases equipment maintenance costs, and therefore, it is not applied in commercial settings.

The effect of egg turning rate on *in-ovo* development is also related to the tilt angle of the eggs. According to, normal embryo development requires eggs to be rotated 90 degrees every hour. This is achieved by horizontally tilting the eggs (horizontal setters) or the trays (vertical setters) over a 45º angle from side to side This is the angle that best fits the operational conditions of commercial setters, according and however, recommends that eggs should be horizontally turned 24 times daily at 20°-45° angles. In commercial hatcheries, broiler breeder eggs are turned 45º ± 5º per hour until day 18 of incubation. Eggs are submitted to circular movements because the chorioallantoic membrane may break, causing embryonic mortality . Chicks hatched from eggs that turned at 45˚ angle were heavier and presented lighter dry residual yolk. Egg-turning failures may reduce the formation of embryonic fluids, as well as the formation and growth of embryonic annexes, hindering embryonic and fetal development.

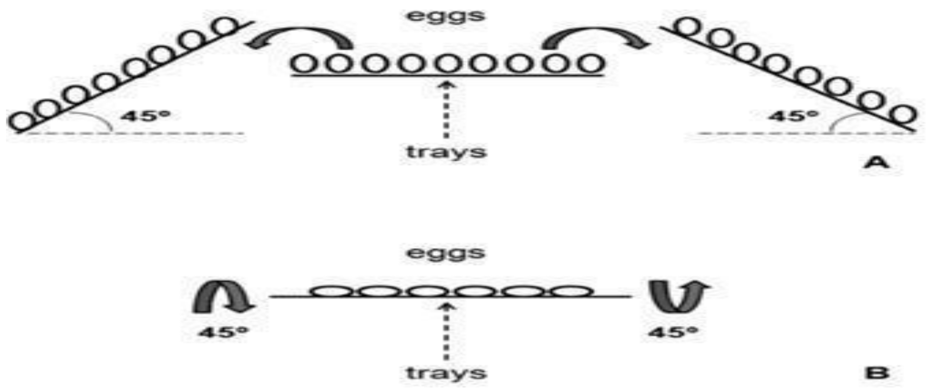
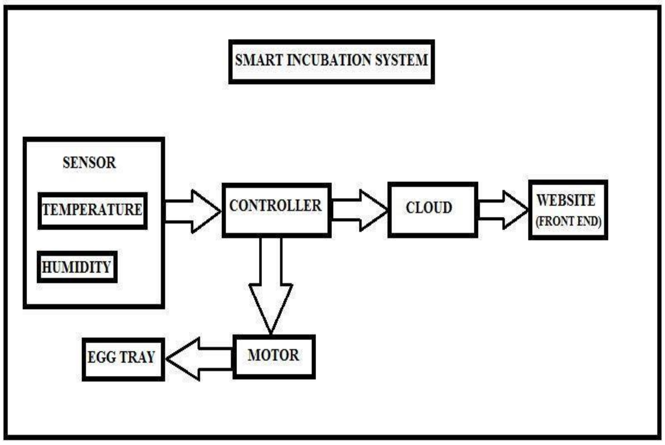


Figure 1.3 Egg turning in vertical (A) and horizontal (B) incubatorsSimilar to natural conditions, eggs incubated in horizontal setters are set in a horizontal position. However, differences in egg size (jumbo, extra-large, medium, small) and egg shape (pointed, normal, or round) may change its position, impairing *in-ovo* development. The position of the eggs in the setter is critical for the formation of the airchamber, which irregular position and size may prevent internal piping and result in *in-ovo* mortality when the chicks do not perform direct eggshell piping. In addition, the correct position of the egg in the setter allows adequate gas exchange through the shell during incubation In vertical setters, eggs should be set with the large end up, i.e., where the air chamber is located, thereby allowing gas exchange between the egg and the environment. According, up to 4% of eggs are set in the wrong position, *i.e.* with the large end down, resulting in embryonic oxygen deficit and delayed metabolism. Wrong positioning of the eggs at setting may be related to slightly more rounded shape of the eggs, impairing the formation of the air chamber, and consequently, internal piping.

3.BLOCK DIAGRAM



This mainly concerned with three parts.

1.Designing
2.Controlling
3.Monitering

Design Specification and Analysis
This chapter presents the design details for the incubator to be constructed

The Incubation Components
Frame/Chamber: Wood
Heating System: Bulb
Ventilation: Fan
Control System: Raspberry pi
Monitoring system: DHT22 sensor(both Temp and hum)
Turning System: Dc Motor

i. Determination of appropriate materials and dimension incubator box.

Frame: 55cm X 55cm X 55cm (lbh)
Tray: (15cm X 15 cm)

ii. Parameter of the temperature and humidity

When it comes to the design of an incubator, heat required and transferred are critical factors and are of major importance. Temperature and relative humidity in the incubator are dependent on the heat supplied and level of ventilation. Adequate heat supply and ventilation enhance air circulation and heat transfer [11]—[12].

Determination of Humidity
The humidity required for the incubation of poultry egg is require to be the mass of water vapor per unit volume over unit volume of air. It keeps the egg from losing too much or too little moisture during the incubation process. However, humidity depends on mass flow of air, temperature and speed of the fan, there to determine the humidity we have

$_vV = mvRvT$

Where;
H = Humidity
m_V= Molar mass of water
$_v$ = Energy density or heat density R_v = Gas constant T = temperature
V = volume

Determination of Heat Generation

Heat generated Q, is determine as MCΔT. Therefore heat required to raise the temperature of the incubator will be the heat required to raise the temperature of the air, eggs, glass, egg tray, water and wooden wall. Hence, we determine these heats below;
For heat generated in the incubator; $Q_I= M_I C_I \Delta T$ 3.4
Therefore, heat required to raise the temperature are listed below;
$Q_A= C_A \Delta T$ 3.5Eggs
$Q_e= C_e \Delta T$ 3.6
Water
$Q_W= C_W \Delta T$ 3.7
Plywood
$Q_P= C_P \Delta T$ 3.8
Where; Q = heat
C = specific heat capacity
ΔT = change in temperature
m = molar mass
Therefore, total heat required to raise the temperature of the incubator will be the summation of all the heat of the parameters listed above, given as;
$Q_I= Q_A + Q_e+ Q_T + Q_W + Q_P + Q_g$ 3.9

Selection of DC Electric Motor

Torque generated by electric motor
T_m =
I.e. T_m = 3.20
Where N = Speed in rpm
W_1 = Angular velocity of the driving pulley

Torque generated by the electric motor is given as; Where;
= 34.4 r.p.m
T_m = 27.76 Nm_2

Determination of Wood Strength to support the weight of Eggs

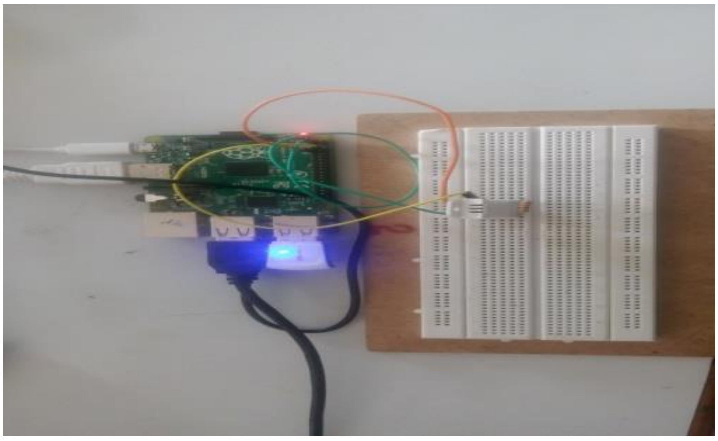
Taking into consideration of the loading due to the weight of the eggs;
Since they are uniformly distributed on the wood, therefore; Length of plywood =0.6m
Mass of plywood m_p =2.40714kg
Mass of an egg = 0.0689kg = weight of the egg So the mass or weight of 50 eggs will be W_e =0.0689 x 50
= 3.445kg
W_e = 3.445kg
Since the weight of the eggs is3.445, then the UDL will be the weight of the egg divided by the total span of the wood which is 0.6m
UDL= = x 9.81 = 0.05632kN/m
For a UDL: R_A = R_B =
= =0.01689KN/m
So the shear forces at point A and B will be
S_A =- = -0.01689KN
S_B = = 0.01689KN
So the bending moment at mid-point will be M_C M_C = = = 2.5344 x10_{-3}KNm

Design of incubator module

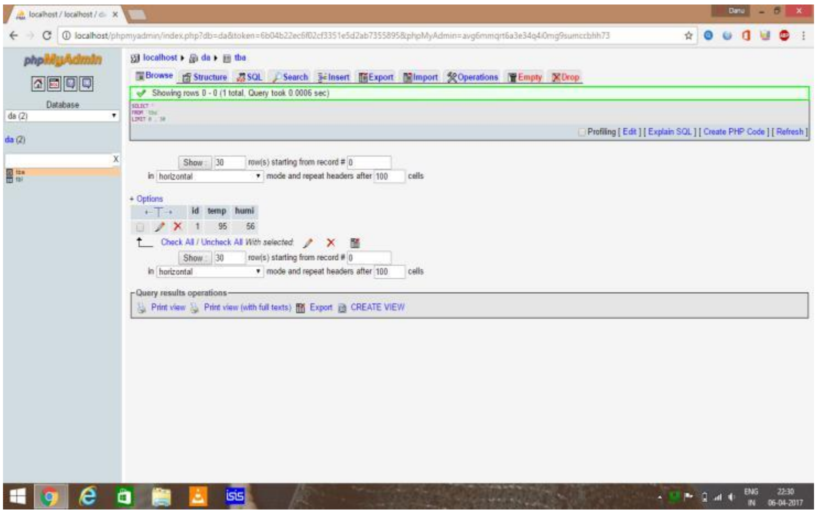
Monitoring:

Monitering the temperature and humidity inside the incubator through web.

Step 1: Interfacing DHT22 sensor with the controller and download the library files of sensor and write its coding using python.

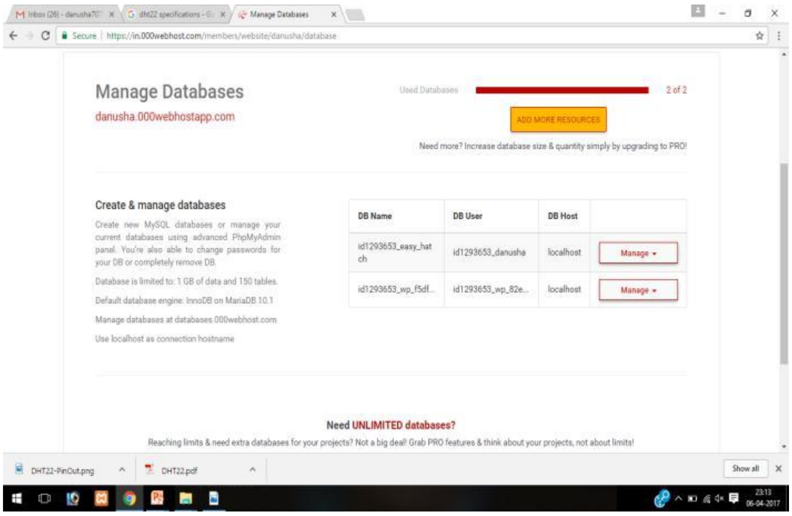


Step2: First of all, using local server (wampserver), create backend database by writing appropriate coding using php.

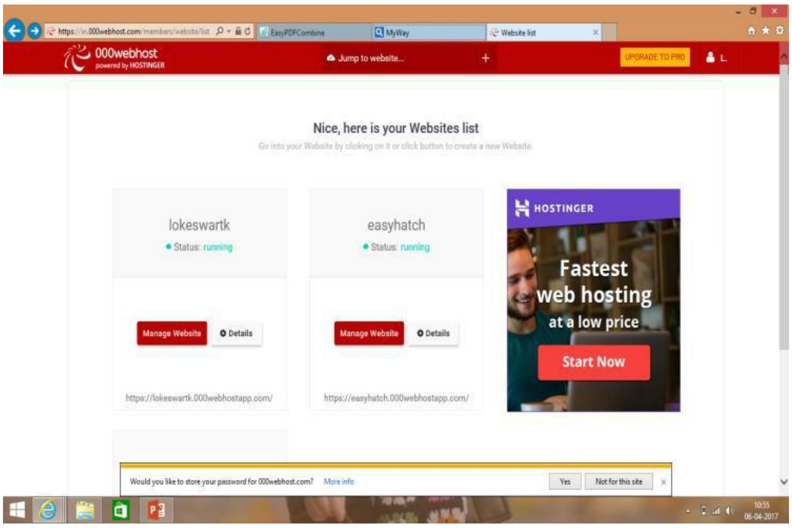


Step3: Create front end using HTML and bootstrap.

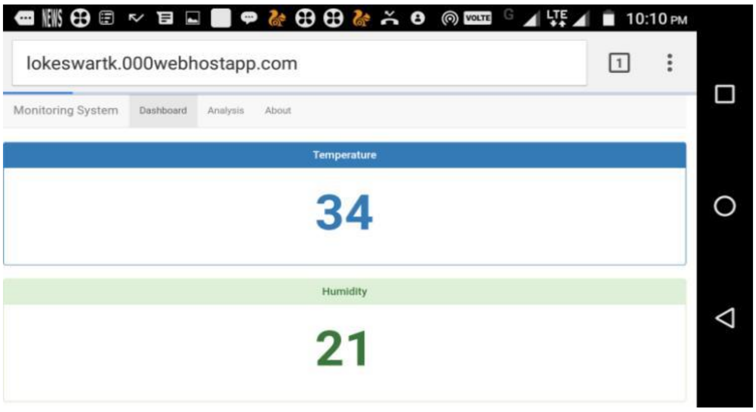
Step4:Upload all file in filezilla



Step5:creat domain for website



Step 6: On successful completion of all process ,we can monitor the temperature and humidity anywhere at anytime.



Testing
After designing the incubator is subjected to testing process by taking complete analysis of parameters like temperature, humidity. This may be done by keeping bulb at different position inside the incubator.

4.ANALYSIS OF TEMPERATURE AND HUMIDITY

DAY 1:

TIME	TEMPERATURE	HUMIDITY
9.00pm	31.45	45.7
9.25pm	34.56	44
10.45pm	35.40	37.10
11.25pm	38.30	27.2
12.00am	40.2	25
2.00am	39	25.2

DAY 2:

TIME	TEMPERATURE	HUMIDITY
7.00am	33.70	39
7.45am	34.50	39
8.35am	35.40	37.10
9.46am	38.30	28.70
10.00am	38.70	27.20

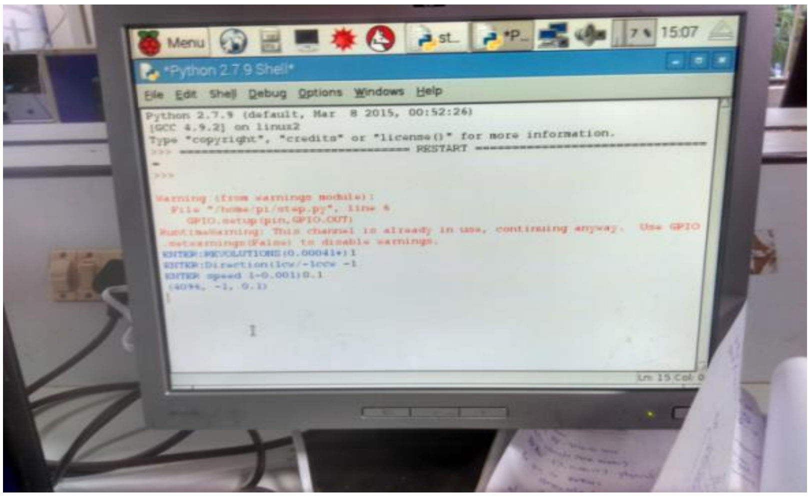
DAY :3

TIME	TEMPERATURE	HUMIDITY
2.00pm	31	41.2
2.25pm	32.6	35.80
4.00pm	35.5	37.2
4.35pm	38.20	29.20
5.25pm	38.30	28.70
5.46pm	38.45	27.20

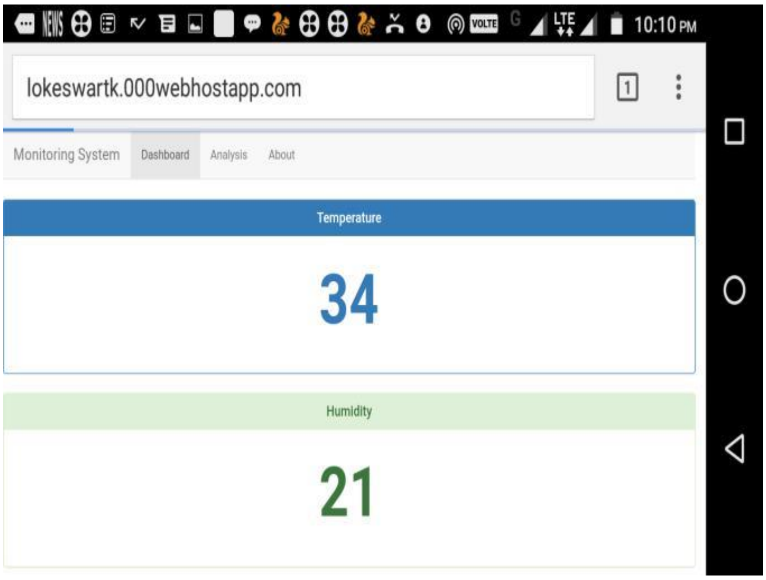
Overall Analysis:

TEMPERATURE(*C)	HUMIDITY(%)
30.56	42.00
31.20	46.70
33.10	37.48
34.50	39.00
35.40	37.10

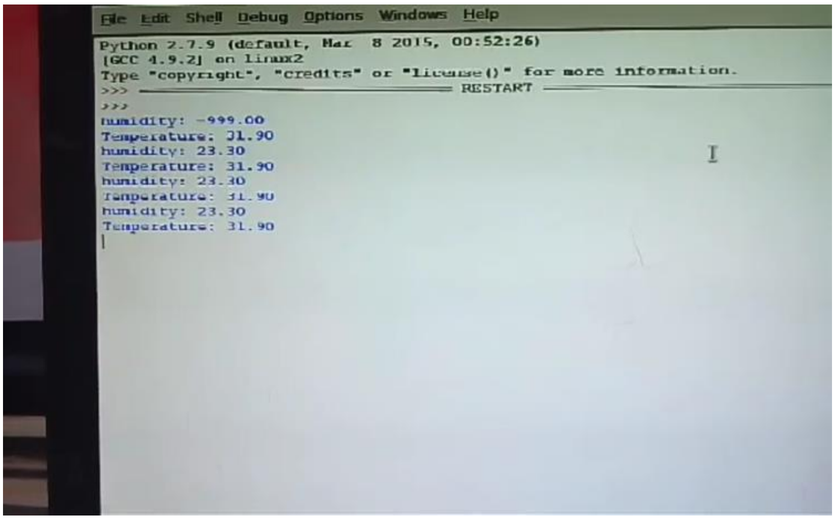
5.RESULTS:



Output of Dc motor



Output displayed in website



Output of DHT22 sensor

6.CONCLUSION

By the above results obtained, its on comparing with Proposed system with preexisting system,the drawbacks In monitoring and controlling process is much reduced Also cost of design incubator is much reduced.

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