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Energy optimization by harmonizing the Greenhouse parameters

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Abstract – *Greenhouse management system offers to increase the productivity of crop by controlling various parameters. As technology develops, there is so many enhancements done in greenhouse system. But the growth of crop, dependable on environmental and other factors like used method, labor etc. Emerging embedded system with wired/wireless system, real time monitoring can be possible. Considering smart grid point of view, energy saving becomes important. Now a day, energy saving also becomes important aspect in every field. This paper represents a method of controlling greenhouse environment with the help of ARM processor & GSM module, energy saving aspect , suggested crop pattern and relevant equation of energy optimization in greenhouse field.*

Keyword*- Greenhouse monitoring & controlling; real time monitoring; energy optimization; crop pattern*

I. INTRODUCTION

Mostly the world & people are dependent on agriculture & their productivity. Because there is a lot of fluctuation in atmosphere, people cannot predict that deviation & not obtain enough productivity. So there is requirement of technology in that direction which provide to fulfill the criteria for crop to develop& corresponding atmospheric parameter condition. Greenhouse also helpful in nursery for orchid breeding, vegetables, fruits, and transplants.

[12] Idea of growing plants in environmentally controlled areas has existed since roman times. In the 13thcentury, greenhouses were built in Italy. They were originally called giardinibotanici(botanical gardens).Then, in 1450, sangayorok written description of greenhouses which was designed to regulate the temperature and humidity requirements of plants & crops. As the time passed, every country adopts the greenhouse system with some enhancement. With the help of greenhouse, it may enable to grown a selected crop through the year. Therefore, greenhouse monitoring & controlling become essential this days.

Due to development in agriculture field, there are many ways to monitor & control the various parameters like temperature, humidity, soil moisture, light intensity. System can be wired or wireless. In the wired system, power source is wire. This system more reliable but complex to handle. When in wireless sensor network, power source of node is battery but it has also a drawback relative to battery which is of limited capacity. To overcome this drawback AODTPC (adaptive on demand transmission control protocol) protocol with kalman estimator is used. [5]

In WSN, there are also many ways to monitor the greenhouse. Bhaviskar et al [13] adopted ZigBee protocol in which they divided system into two part PCN (portable controller node) system & SAN (sensor & actuator node) system. PCN system consist laptop/PC &Xbee transceiver. A GUI application provides real time monitoring & controlling of various parameters & remote control. SAN system consist sensor node & actuator node. At sensor node, it senses various parameters and transmits to PCN system. At actuator node, it performs the switching operation.

Liu et al. [8] proposes design of greenhouse dividing in two frameworks. First part consist several sensor nodes which were used to measure different parameter. In that, sink node install inside the greenhouse to collect the data [10] & transferred to remote PC. Second part consist GSM module & management software. Authors analyzed the result of sensors & RSSI (received signal strength) value. Ling et al. [6] proposed a monitoring system with ZigBee module [1] which is interfacing with microprocessor C8051F. They also provided the flow chart of network address searching & mode of transmission. Yeh et al. [3] build a mobile nursery for orchid breeding using ARM9 processor interfacing with PC based server. They were showing standard deviation improvement for temperature & humidity. Another advancement in controlling tool is that Hanggoro et al. [2] demonstrate design of greenhouse monitoring & controlling using Android mobile application. They were concentrated in humidity level of greenhouse using Ardunio UNO processor interfacing with Android mobile application.

Sahu [4] monitor & control the greenhouse using microcontroller AT89C51 & shown the result analysis of transducer readings. Sometimes robot also placed in farm to monitor the farming status with the help of sensors. [9] [11].

There are many type of processors which are used as a controlling part. In this system, ARM7 is used and as a remote administration GSM SIM900 module used. Here, Energy optimization concept also included which means kind of energy management process of monitoring, controlling & conserving energy at a suitable place.The term energy optimization include yield of crop and energy consumption. For energy saving, 20 crops data are considered. With respect to, it design a flow of suggested crop which may lead to energy optimization aspect.

This paper organized as follows: section II describes system overview with hardware and software, section III includes research work and section IV includes future scope.

II. SYSTEM OVERVIEW

2.1 .HARDWARE DESCRIPTION

To control & monitor inside the greenhouse environment ARM7 LPC2148 used which is the main part of the system. Other than this, temperature & humidity sensor, soil moisture sensor, light intensity sensor, co_2 sensor, water flow sensor is used. As mention, SIM 900 GSM module used for remote administration.As it message the crop name let's say 'tomato', it will set the environment condition of tomato inside the greenhouse. If the range of crop exceeds, message will be displayed on mobile. Figure 1 shows implementation platform related to hardware.

Figure 1.hardware

2.2 SOFTWARE DESCRIPTION

Software is design to control the parameter of greenhouse and relevant crops criteria like temperature, humidity, soil moisture, light intensity. Keilμvision8 is used for it.

2.3 Design Flowchart

Figure 2 shows a design flowchart in which process A, B, C, D & E shows for co2, light intensity, soil moisture, temperature & humidity respectively. When process start it enter crop name and check delay timers then procedure of checking all the 5 parameter will go on continuously.

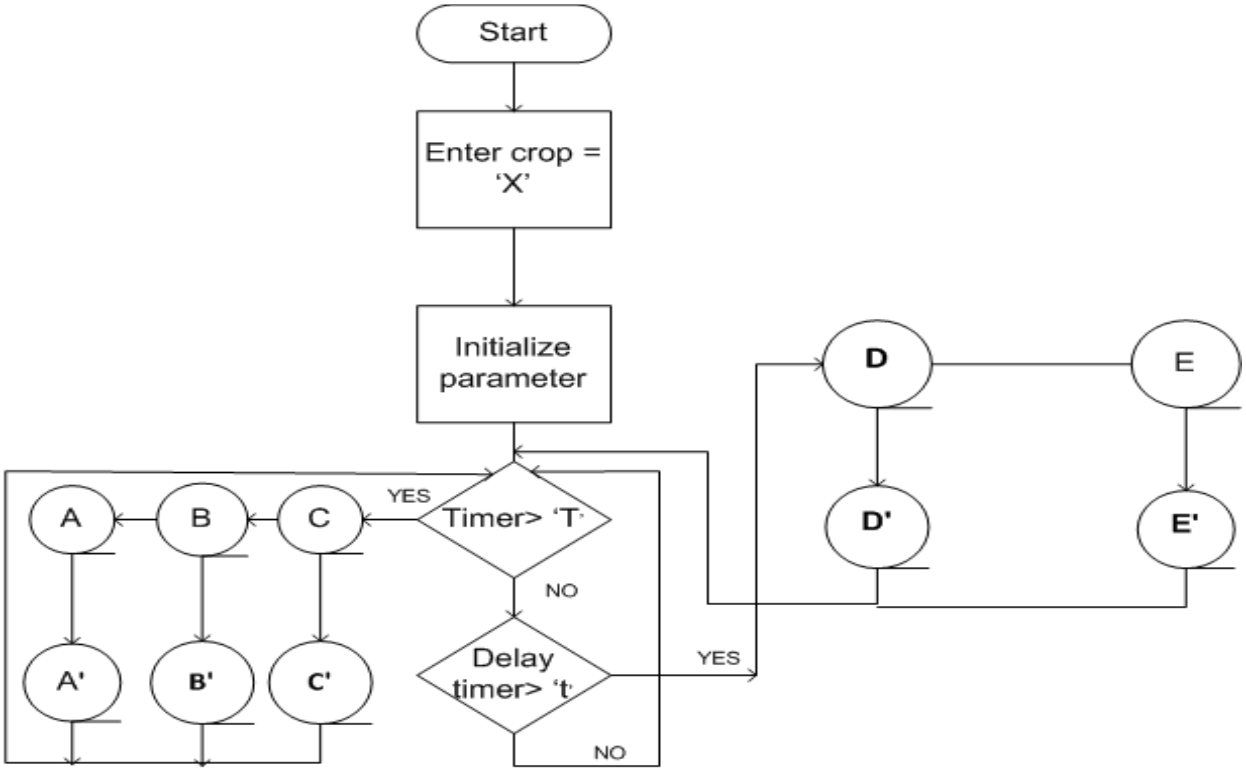


Figure 2 design flowchart

III. RESEARCH WORK

3.1 ENERGY OPTIMIZATION AND SURVEY

Energy optimization is related to energy management. In greenhouse, energy optimization includes some parameter like external and internal environment of greenhouse. By choosing appropriate pattern of crop with respect to environmental parameter, energy can be consumed. To show the accuracy of energy consumption, survey did on 3 city junagadh and porbandarby taking the their temperature, humidity, rainfall parameter over a last three year 2012, 2013, 2014[14][15].To do so, below survey might be helpful which leads to energy consumption equation.

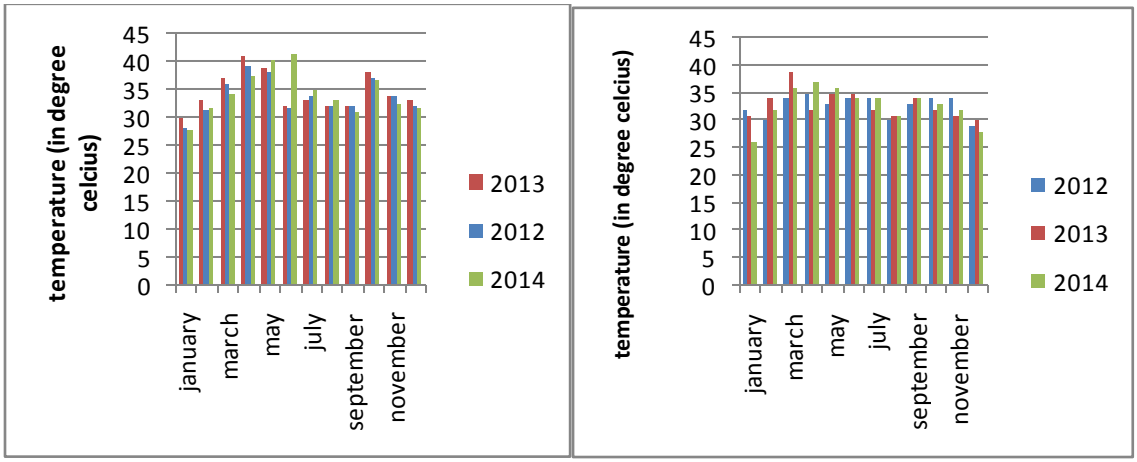


Figure 3 & 4month vs. temp graph (junagadh&porbandar respectively)

Figure 3 & 4 shows temperature of junagadh and porbandar city over a three year.

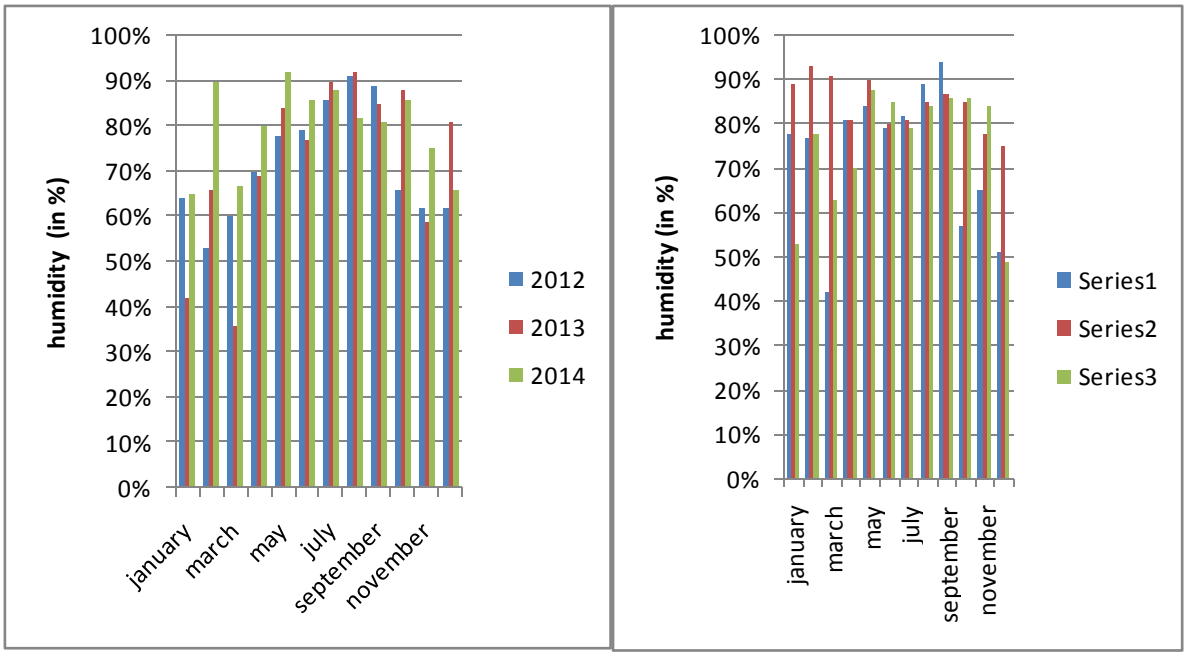


Figure 5&6month vs. Humidity graph (junagadh&porbandarrespectively)

Figure 5 & 6 shows a humidity range of junagadh&porbandar over a three year.

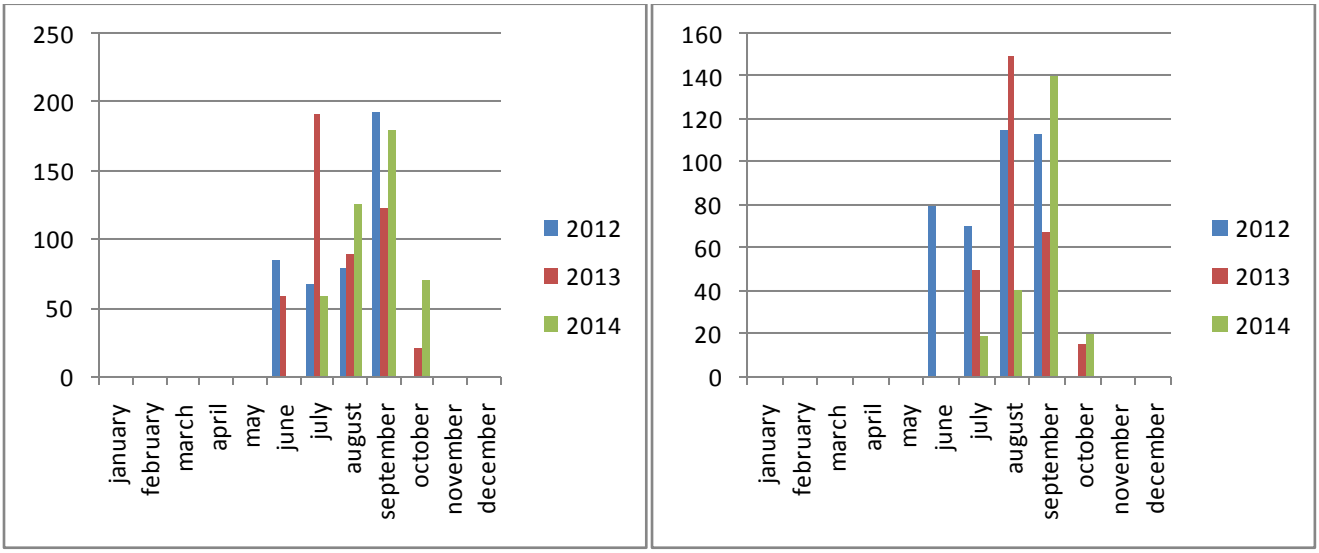


Fig 7&8month vs. rainfall graph (junagadh&porbandar)

Figure 7 & 8shows a rainfall graph of junagadh&porbandarcity over a 3 year

3.2 ENERGY CONSUMPTION EQUATION [16][17]

By referring above data if choose any crop randomly without considering external environment TEC(total energy consumption) is more compared to selecting a crop pattern environment. Using MATLAB it can be proved.

TEC (practical) =

$$\sum_{i=1}^{12}(A_{HEATER}/B_{COOLING}) + \sum_{i=1}^{12} C_{BULB} + \sum_{i=1}^{12} D_{MOTOR}$$

Where,

$A_{HEATER} = (\Delta T \div T_{PRE}) \times V_R \times A$

$B_{COOLING} = (\Delta T \div T_{PRE}) \times V_R \times A$

$C_{BULB} = L_{REQ} \times L_{EFFI} \times A$

$D_{MOTOR} = T \times ER$

TEC (normal) =

$$\sum_{i=1}^{12}(A_{HEATER}/B_{COOLING}) + \sum_{i=1}^{12} C_{BULB} + \sum_{i=1}^{12} D_{MOTOR}$$

TEC (practical) <TEC (normal)

Here,

ΔT = Temperature gradient

T_{PRE} = External temperature

V_R = Ventilation rate

A = Area of greenhouse

L_{REQ} = Luminance require w.r.t external environment

L_{EFFI} = Luminance efficiency for respective component

ER = Energy required

If crop pattern choose in a proper way let's say in September 2012 at junagadh there is maximum external temperature is 34°c, if crop was chosen nearby range suppose ginger was selected which required maximum 30°c; humidity 70-80%; light intensity 55000 lux, then all the above parameters are as follows:

$B_{COOLING}$ = 725.78 watt

C_{BULB} = 77.42 watt

D_{MOTOR} = 746 watt

[by taking ventilation rate = 50; area = 232.25 m^2; l_{eff} =60 for florescent lamp;t = 1 hour ;ER=746 watt]

Therefore, TEC = 1549.20 watt

If crop selection is other than a pattern and it was chosen cabbage which required maximum temperature 18°c;humidity 60-80%;light intensity 50000, then the parameters are as follows:

$B_{COOLING}$ = 5080.46 watt

C_{BULB} = 77.42 watt

D_{MOTOR} = 746 watt [by taking above parameter]

Therefore, TEC (normal) = 5903.88 watt

Hence,

TEC (practical) <TEC (normal)

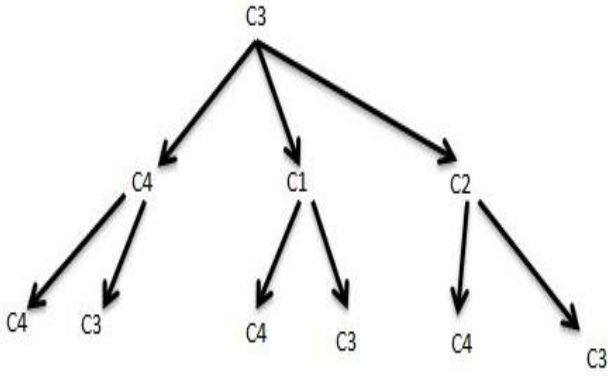
3.3 crop pattern

Here, crop pattern shows for 4 crops further expansion in the pattern can be possible.

Crop name	Temperature(^{0}C)	Moisture (%)	Light intensity(lux)
Rose(c1)	18-28	65-70	60000-70000
Tomato (c2)	15-27	60-65	50000-60000
Gerbera (c3)	14-24	60-65	50000-60000
Ginger (c4)	15-30	70-80	45000-55000

Table 1 crop detail

Table 1 shows 4 crop detail and relative to it if crop pattern planned in 2012 junagadh it was as following: if in winter it suggest Gerbera then in next season summer it suggest ginger, rose, tomato and in monsoon gerbera and ginger according to external environment.



IV Future Scope and Conclusion

By using embedded and wireless platform, it can be possible to build a system which can monitor and control the greenhouse. In this system, it can be possible to optimize the energy using appropriate crop pattern which include yield of crop and energy consumption. Crop pattern did for 20 crop and here, it shows for 4 crops, in future it can be expand.

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