Wireless Sensor Network in Precision Agriculture: A Survey Report

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Wireless Sensor Network in Precision Agriculture: A Survey Report

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Abstract **–** This paper presents the importance of precision agriculture over the tradition agriculture that how farmers can get the exact details about their cultivation land while deploying the sensor and measure the various parameters of the land and then do the farming according to that parameters so they can earn more and through the deployment of sensor in land also helps the farmers in excellent crop yield. The wireless sensor system which is discussed in this paper tells about the various sensors used for measure the various parameters of land like moisture, temperature and soil salinity, which is the most important part of farming. Another thing is deployment and communication techniques through the hybrid network and the concept of microbial fuel cell membrane, in which anode and cathode is there and various bacterias will used to produce the current work as a acetate which will make the sensor node self powering. Bacteria's perform the reactions through the anode and cathode in the compartment and also added the various chemicals like methylene blue, neutral red, thionine produce which will accelerate the current for batteries used for sensor, which will expand the network lifespan.

Keywords - Precision Agriculture (PA), Microbial Fuel Cell (MFC), Wireless Sensor Network (WSN), Net of Things (NoT), Internet of Things (IoT), mote and VSI-PA.

I. INTRODUCTION

Wireless Sensor Network (WSN) is an advance expertise that is mounting consideration to the fashionable globe for its low-power wireless communiqué, low value performance, low power detector nodes and self-healing capability. This refined expertise drives materialization of detector applications and fast development in integration of digital electronic equipment that plays important roles in such space like cultivation environmental fortification, intelligent machines etc [1] [2].

Even once defrayal a great deal of cash and human resources by the governments of both central and state to enlargement the farming like subsidy on fertilizers, squat interest on farming loans, fixing pastoral branches of nationalized banks, a scarcity of soil testing labs is ascertained in most of the states of the country [3]. Because of that farmers don't have a bent to check the soil so as to extend crop yields. As a result, farmers stay unacquainted of atmospherically conditions like ratio (RH) of the air, Temperature and soil characteristics like soil kind, soil consistence and chemical levels etc [4].

Traditional agriculture is step by step turning into exactness agriculture. In close to future, greenhouse cultivation are the main methodology of crops production in whole world. Since most greenhouses square measure equipped with obsolete technology, farmers have to be obliged to air duty and putting your all into within the greenhouses. This project has focus to rework historically small-scale, manufacture based mostly sector into giant scale business that contribute to national economic process and property. Exactness Agriculture (PA) has the good thing about providing time period feedback on variety of various crops and environmental variables. As its name imply, PA is important in each the scale of the crop space it monitors furthermore as within the delivery amount of dampen and fertilizer. The info assortment, watching and materials application to the crops permits for higher yield and lower value, with less impact to the atmosphere. Every space receives solely what's needed for its explicit area and at the acceptable time and period [5].

In agriculture, the employment of Wireless sensing element Networks (WSNs) is extremely expeditiously used beneath the umbrella of exactness farming. the event of agriculture business starts with technologies farming machine like tractors, grain mix machine that must be economical and helpful to the farmers. Day by day with growing info and Communication Technologies (ICT), farmers will get edges to increase their crop gain. Through sensing element networks, agriculture field gets associated to the IoT that allows creating acquaintances amongst agronomists and farmers crops no matter their location. With the help of this approach that has period of time information concerning the lands and crops, helps farmers build right decisions. The new ideas inside the forthcoming technologies live Wireless sensing element Network, net of Things (NoT), and exactness Agriculture (PA) [6] [7]. The "Mote or sensing element Node" is employed as a collaboration and natural process of sensing, processing, communication and exploit. The huge strength of motes is that they type a network and co-operate consistent with various models and architectures, such networks are spoken as WSN [8].

II. LITERATURE SURVEY

A. Sensors Used in Precision Agriculture

Its major goal is to avoid wasting the crops from plant life and microorganism diseases like "eyespot", "Pseudomonas Syringae", "Phomalingam", "Leptosphaeria Maculans", "Alternaria-Dligst" and "Phytophthora". the atmosphere conditions like ratio and temperature area unit important elements to the unfold of unwellness. thus sensors area unit positioned in whole cultivate field to observe the microclimate

– the wet or temperature during a precise space, particularly once this is often} numerous from the weather or temperature within the neighborhood encompassing it can be closely monitored [9].

I. Soil Moisture

Acquaintance of wet content acts as an essential role in high yield of crop. An oversized extent of wet in soil would influence the usage of N (Nitrogen) of the roots. At the similar instance the O_2 (Oxygen) at the roots are going to be inadequate. Anytime of crop, totally different levels of wet are needed [10]. Soil wet is that the quotient of the number of wet gift within the entireness of soil. the number of wet contained by soil is never-say-die by Associate in Nursing alteration within the capacitance price and this additional have an effect on stuff constant of soil [11].

Calculation of Soil Moisture

Soil Moisture sensor is deploy at the distance downward of 1cm to 3 cm. To calculate the soil moisture of diverse types of soils, soaring frequency is use by mote. Following is the equation used to calculate the soil moisture [12].

$$C = \epsilon_r \frac{A}{D} \quad (1)$$

Where:-

C – Capacitance

A – Overlapping area of plates

ϵ_r- Dielectric Constant of the material within the plates.

D – Distance between the plates.

Below mentioned equation no. 2 is use to demonstrate the enlargement of potential among the plates.

$$C = \frac{q}{v} \quad (2)$$

Where:

C = Capacitance

Q = Charge on Plates

V = Voltage between plates [12]

Specifications of Moisture Sensors

Figure 1. Soil Moisture Sensor (UFM-M1) [12]

The above figure 1 show the mote named as UFM-M1, consists of 434MH, squat power wireless modules, with UGPA-434 omni bearing antenna. Outer radio broadcast range of the module is 400 to 500m. Its clout utilization is 10mW at 434*MHz* and current utilization is 17*mA* for in receipt of mode and 30*mA* for transmit mode. RF wireless modules used to have communication on 9.6*Kbps* with MCU. Whereas, 60 bytes of information package can be send to the transmitter module by MCU which is administrate by the Radio Frequency (RF) synchronizing protocol. Also, the module allow discretionary operational frequency (433.05 to 434MHz with 200Hz steps).

Microcontroller used in mote run by the 5V, the RF section runs by a 2.7 to 3.3V DC. The input electrical energy is passed from beginning to end runs by a 2.7 to 3.3 V DC. The input electrical energy is passed through 1N4004 diodes for defending alongside short circuit with LP2950 for RF module [12].

II. Soil Temperature

The soil temperature is one of the vital biological aspect with a slight vary of ambiance, topology, vegetation, soil sort and planting appearance. The soil temperature is familiarly allied to some procedure, such as, crop planting era, intensification of the plant and wintering shelter etcetera. The diverge of soil temperature unwaveringly affect soil nutrient incorporation and soil dampness contented. Thus, the examination of soil temperature in truthful time and divergence of soil temperature has a vital insinuation in the paddock of farming manufacture and in precise study [12].

Specification of Temperature Sensors

As shown in figure 2 the LM35 mote series is a meticulousness integrated-circuit temperature mote. Its resultant power is linearly next of kin to the Celsius (Centigrade) temperature. It is a crouch rate and petite in facet. Its execution temperature range is 55º to +150ºC [12].

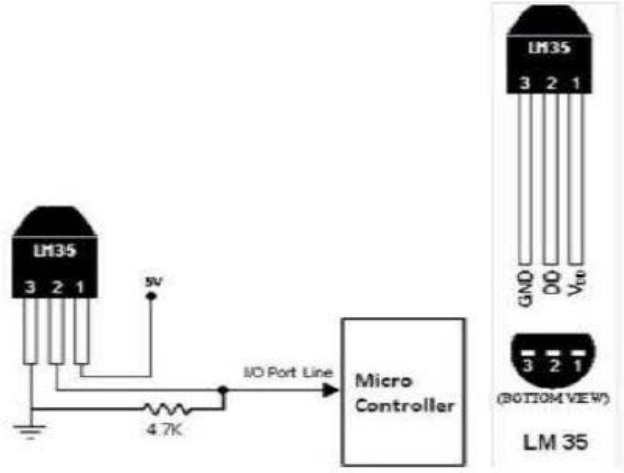

Figure 2 Temperature Measure Sensor [12]

III. Soil salinity

Soil salinity disgraces the entire farming by dipping harvest yield and deterioration soil class. Foremost upward hazard for the production of yield and sustainable farming can mainly most likely be the soil salinity. Salinity can be the reason of diminish in plant growth, decrease yield and in radical gear crop stoppage may be the result. Cultivation mainly depends on irrigation, such as, in scorched and semi scorched area, the upsurge of salt in soil profile is primarily controlled by evapotranspiration. Accumulation of salt on the facade of soil cans outcome in filth of soil quality and outcome in barren land [12].

Specification of Soil Salinity Sensor

The dimension of probes of sensor is 68 long X 3 mm diameters (Centre rod 60mm) with housing: 55x45x12 mm. The power consumption of sensor various from 4 to 6 V and works on frequency on 20MHz. Soil sensor probe output for permittivity, ranges from 1 to 80 with accuracy of. Its bulk electrical conductivity, ECb ranges from 0 to 300 with accuracy of $\pm$ 10 and sensor probe output temperature, ^{0}C ranges from -5 to 50 with accuracy of $\pm$ 5 ^{0}C [12] [13].

B. Deployment Technique of Sensors in Field

Herman Sahota, Ratnesh Kumar etl. told precision agriculture farm is alienated into customary four-sided figure Sensor fields (see in figure 3). Within the every grassland, motes are deployed in a rectilinear lattice farm, with the lattice range of 50m x50m, and at the deepness of 30cm. To preserve vigor, only adjacent motes are able to correspond directly with everyone. The satellite station at the comers of each yield has a broadcast range that can swathe all nodes in the yield area. The satellite stations do not execute any sensing maneuver, but they provide three purpose:

1) They gather the data from the sensor mote which is deploying in a yield area and relay the unruffled data to a base station.
2) They transmit routing and scheduling data to the sensors in the yield area.
3) They partake in the sensor localization procedure.

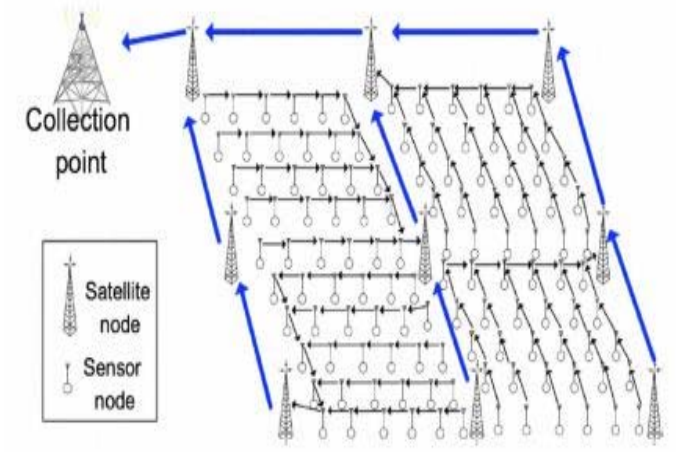

Figure 3. Network deployment model of sensor in field.

Due to the foremost point over, the steering is base on a two-level chain of command (field-level versus satellite-station level), which can abridge the routing and also accumulate vigor of the sensor mote. Moreover, the second summit also reduce the computational involvedness and hence vigor utilization of the sensor mote. The above third point is relates with the future work which we have to do in future.

The routing compute routes over sensor mote in the field such that the diverse satellite station take turn in congregation information, so that vigor utilization is unbiased. Additionally the routing policy has the gain of withstand failure and achieve a certain stage of resilience, without adding up any additional procedures for this purpose.

Ours is a hybrid network, combine the features from together, ad-hoc and communications network. Also note that the network replica is scalable due to the cause that the vigor utilization is a linear utility of the integer of nodes. The parameters values used by the authors are mentioned below in the Table 1.

Table 1. Parameter Values used

Various Parameters	Values
Bitrate	1.2kbps
Transmitting current drawn	15.0 mA
Receiving current drawn	19.8 mA
Drowsy current drawn	10.0 mA
Ping current drawn	33.5 mA
Data Packet	8 bytes
Ack packet	4 bytes
Sync packet	12 bytes
Ping pulse duration	1 ms
SMAC initial listen period before transmitting sleep schedule	$2\Delta + T_{synch\ packet}$
SMAC Listening Time period	$2(T_{data} + T_{ack})$
SMAC sleeping Time period	$3\ (T_{data} + T_{ack})$
Frequency of Clock	22 KHZ
PDMAC maximum drowsy duration	$4\Delta + T_{ping}$
Packet error rate	02

C. Sensor Node Selection Algorithm

Yousef Hamouda and Mohammed Msallam describe the working of VSI-PA model in precision agriculture. The irrigation scheme is use in favor of precision agriculture purpose. At every time stair (f), the top soil dampness and top

soil hotness for every quarter (α_i) is measured and denote as $\mathcal{M}_{ai}(f)$ and $T_{ai}(f)$ respectively. Mainly research into precision agriculture, the method for cultivation using VSI-PA system triggers the valves, pumps, and supplementary actuators precise the cultivating factor surpasses predefined threshold significance. Then, the VSI-PA structure triggers the farming process. When $\mathcal{M}_{ai}(f)$ of a_i achieve the predefined threshold significance, which is base on yield necessities (e.g. size, age and type). Thus, the dirt dampness should be monitor sporadically. However, soil dampness is deliberate in discrete epoch for each region discretely. At each time step (f), the adjacent sensor mote set $(S_s(a_i, f)$ to the region a_i center with vigor echelon larger than predefined threshold significance E_{th} is elected to sense the soil dampness and hotness. The Euclidean Distance (ED) is use to compute the detachment among the sensor mote and the region center according to the relation [15]:

$$d_{ij} = \sqrt{[L_{s\,ij} - L_{a\,i}]^{T}[L_{s\,ij} - L_{a\,i}]} \quad (3)$$

The standard interpretation of the elected ''$n_s(a_i,f)$" sensors of a_i are recorded as the current $\mathcal{M}_{ai}(f)$ and $T_{ai}(f)$ according to the following relations:-

$$M_{ai}(f) = \frac{\sum_{j=1}^{n_s(a_i,k)} M_{s_{ij}}(f)}{n_s(a_i,k)} \quad (4)$$

$$T_{ai}(f) = \frac{\sum_{j=1}^{n_s(a_i,f)} T_{s_{ij}}(fk)}{n_s(a_i,f)} \quad (5)$$

Where $M_{s_{ij}}(f)$ and $T_{s_{ij}}(f)$ are the soil dampness and hotness reading of sensor S_{ij} in region a_i.

D. Selection Sampling Interval

Unlike in precision agriculture scheme by means of a preset sampling interval, the projected VSI-PA system adaptively analyze the sampling interval to get better the vigor competence and preserve the soil dampness of the plants with enhanced crop yields. Each area is implicit to have diverse soil hotness variation. The erratic sampling interval at every time step is chosen according to the soil hotness. The sampling interval is concentrated when the hotness is lofty. This means that the tempo of soil dampness lessening is also lofty, and in turn, the soil dampness is precise in time before it drops appreciably under the threshold rate, and causes harm to the plants and decline of the crop yields. On the other side, the sampling hiatus is enlarged when the temperature is squat. This means that the tempo of soil dampness diminution is also squat, and successively. Taken as whole vigor utilization by the network is abridged, and life span of the network is enhanced. Therefore, the variable sampling hiatus $\Delta t_v(a_i, k)$ and the soil temperature $(T_{a_i}(f))$ of area (a_i) at time k are assumed to be limited into a range as $\Delta t_{min} \le \Delta t_v(a_i, k) \le \Delta t_{max}$ and $T_{min} \le T_{a_i}(k) \le T_{max}$ respectively. The variable sampling interval$(\Delta t_v(a_i, f))$ at a step (f) is implicit to be elected with respect to an inverse liner function of $T_{a_i}(k)$ with respect to the following equation [15]:

$$\Delta t_v(a_i, f) = \left(\frac{\Delta t_{min} - \Delta t_{max}}{T_{max} - T_{min}}\right)(T_{a_i}(f) - T_{max}) + \Delta t_{min} \quad (6)$$

According to Eq. (4), the smallest value of soil hotness T_{min}, the maximum value of sampling interval Δt_{max} and vice versa. The parameter T_{min}, T_{max}, Δt_{min} and Δt_{max} are elected according to crop and top soil type [15].

E. Communication Model of VSI-PA

Three types of sensor nodes are used in this architecture for communication which are named as NSN (Normal sensor Node), MSN Master Sensor node) and SSN (Sink Sensor Node). In the communication architecture every Normal Sensor Node (NSN) identify its Master Sensor Node (MSN), then it goes in the sleep mode and wait for its activation periodically which contains the data about the battery level and timestamp for the synchronization time. When the Master sensor Node (MSN) sends the group message to the NSNs, then these nodes wake up and start sensing the parameters of agriculture land such as soil temperature and soil moisture, after sensing the parameters they send the data to their respective MSN.

When the communication runs in the Master Sensor Nodes, first the Master Sensor Node identify the current Normal Sensor Node and after that it will also goes to the sleeping mode and waiting for its activation signal. Master Sensor Node periodically wakeup to receive the message from Normal Sensor Node, which contains the state of Normal Sensor Node and its synchronization time. Then the Master Sensor Node transmits the data to the Sink Sensor Node which it will receive from the Normal Sensor Node. [15].

F. Energy resources for Sensor Nodes

It's the elevated moment to stir to renewable sources to make certain the vigor sanctuary for prospect generation. Now Microbial Fuel Cell (MFC) is used to engender the energy from the bacterias. This machinery can utilize bacterium previously present in wastewater or in soil as catalysts to generate energy [16] [17].

Mechanism of Microbial Fuel Cell

Inorganic and Organic matters are oxidized to produce the energy, bacteria which will work as biocatalysts in Microbial Fuel cell (MFC) [18].

Electrons which are formed by adding the substrates and by bacteria they transport to the negative terminal (anode) and also go to the positive terminal (cathode) through freight. Numerous chemical resembling methylene blue, impartial red, thionine will utilize as the disinterested party to accelerate the cohort of current in MFC. Figure 4 construes that electrons

produce from the substrate assets which will transport to anode electrode with the help of bacteria which is placed in anode compartment. Protons are formed in the oxidation reaction and conceded to the cathode by proton swap membrane. The transport of electrons from anode compartment to cathode compartment is occurring by straight get in touch with or by movable electron shuttle. Finally, the electrons are participating with the electron acceptor and the protons in cathode compartment [19].

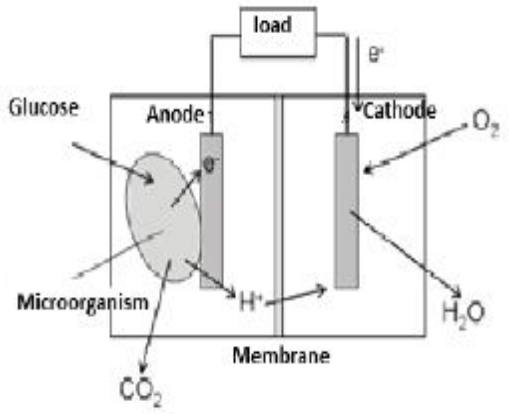

Figure 4. Mechanism of Microbial Fuel Cell [19].

Voltage generation in MFC

$$\Delta G_r = \Delta \boldsymbol{G_r^o} + RTln(\sqcap) \quad (7)$$

where ΔG_r $(\boldsymbol{j})$ is the Gibbs gratis vigor for the particular situation, $\Delta \boldsymbol{G_r^o}$ $(\boldsymbol{j})$ is the Gibbs gratis vigor underneath in customary circumstances habitually describe as 298.15 K, 1 bar pressure, and 1 M concentration for the species, R (8.31447 $Jmol^{-1}K^{-1}$) is the universal gas constant, T (K) is the absolute temperature, and Π (unitless) is the reaction quotient compute as the behavior of the products separated by those of the reactants.

For MFC computation, it is more expedient to calculate the retort in requisites on the whole cell electromotive force (emf), E_{emf} (V), distinct as the potential distinction among the cathode and anode. This is associated to the work, W (J), generated by the cell [20].

$$W = E_{emf} Q = -\Delta G_r \quad (8)$$

where Q) nF is the charge transport in the retort, articulated in Coulomb (C), which is resolute by the integer of electrons swap in the rejoinder, n is the amount of electrons per rejoinder mol, and F is Faraday's constant (9.64853 x 10^4 C/mol). Merging of these two equations we have

$$E_{emf} = -\frac{\Delta G_r}{nF} \quad (9)$$

If all reactions are computed at standard conditions, $\Pi = 1$, then

$$E_{emf}^o = -\frac{\Delta G_r^o}{nF} \quad (10)$$

Where E_{emf} (V) is the customary cell electromotive force. We can therefore employ the mentioned above equations to articulate, on the whole reaction in requisites of the potentials as

$$E_{emf} = E_{emf}^o - \frac{RT}{nF}\ln(\Pi) \quad (11)$$

From the equation 5 we can get the actual value of emf for reaction.

For standard electrode potential if acetate is oxidized by bacteria at the anode we write the reaction as

$$2HCO_3^- + 9H^+ 8e^- \rightarrow CH_3COO^- + 4H_2O \quad (12)$$

For sucrose oxidation at anode, we therefore have,

$$E_{an} = E_{cat}^o - \left(\frac{RT}{2F}\right)\ln[(CH_3COO^-)^2 / (CH_3CH_3)] \quad (13)$$

For cathode potential E_{cat} if we deem the crate where Permanganate is exercise as the electron acceptor for the rejoinder, we can write

$$E_{cat} = E_{cat}^o - \left(\frac{RT}{5F}\right)\ln[(Mn^{2+}) + (MnO^{4-})(H^+)^8 \quad (14).$$

The computation of EMF Cell is mentioned below:

$E_{emf} = E_{cat} - E_{an}$ [20] [21].

III. CONCLUSION

In this paper author discuss the three things, first thing is that the author discuss the various sensors which is used in the precision agriculture to measures the various parameters like LM35 and UFM-M1 sensors which will measure the temperature and pressure respectively.

Second thing author explain the algorithm on which network hierarchy and communication model is based which is used in precision agriculture in which author conclude the packet size of data, bitrate and energy consumption in transmitting and receiving the signals of data packet through the VSI-PA system.

Third and the last thing which author discussed the concept of MFC (Microbial Fuel cell) which will convert the soil energy into electrical energy through microbes with the help of some acetates, which is the efficient energy resource for supplying of power to the sensors used in precision agriculture.

IV. FUTURE SCOPE

The energy generated from this MFC is very less so in future the new finding will be there so that our network life span get increases while continuous operation in precision agriculture, which will brings a lot of changes in the field of farming.

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