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Synergy and Agro Physics of Biosensors and IOT in Smart Agriculture

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Abstract:
Physics in Agriculture technology has modified itself over the last century to new heights with the development of electronics and Internet technology. Modern agriculture has grown exponentially as IOT have become the key element in smart farming to help the farmers to take critical decision regarding crop production and management. In recent times different types of biosensors technologies are used for micro to nano scales in modern agriculture. Starting from first step of soil management to last step of crop harvesting to food processing and marketing technology puts immense presence in every point. Biosensors play a huge and significant role in modern agriculture and now with the advent of 4^{th} generation high speed internet technology the use of IOT (Internet of things) in synergy with different types of bio sensors has changed the way of modern farming. In this article the synergy of different technology has been discussed which is transforming the world of agro technology.

Key words: Agro Physics,Biosensors, IoT, Sensors

1. Introduction:

Smart agriculture [1] comprises of application of biosensor technology [2] & IOT [3] to increase the productivity or yield. The application of IOT and biosensors are also used to market the products of the farmers at a satisfactory price. IoT is a network of different objects which can have an artificial intelligence of interacting with each other through high speed internet [4]. The world has moved immensely towards digital technology [5]. In the last 5 years wireless internet network (Based on IOT), & with the development of different types of Biosensors agriculture in modern times has become smarter and smarter day by day. IOT and innovative sensor technology can help the farmers in several different ways to monitor, protect and manage their agro resources from remote distance and without his physical presence [6] there by cutting down input labour cost significantly.

In this article the synergy of Biosensors with IOT is illustrated along with future prospects and different challenges are also discussed. In this short review paper several application methods of Biosensor and IOT are proposed and elaborated starting from Soil preparation, Irrigation, Pest control; Weather monitoring, Yield health check [7-8] etc.

2. Literature Survey:

In article [9] it has been described that, in existing Agricultural system there is a combination of the results of previous history and present conditions created by communities, governments, individuals. These conclusions are normally based on training, tradition, predictable profit, personal choice and resources without any interventions of IOT devices etc. The author in reference [10] describes that, on the basis of market demand and profit the best crop which is to be grown is decided, but till now we have been using old existing system without automation which is not hundred percent effective. India is a lower middle income country with huge population different kinds of crops has to be grown throughout all seasons. India has several varieties of weather, soil and demography. Crops of both moderate and tropical climate are found in India. India is one among the few rare countries which has such variability as specified in [11]. In [12] the authors have developed a system which can sense the soil moisture, humidity, temperature of a agricultural field and transfer the data over a long range area but not much use of Biosensor or IOT.From this we understood that we can collect the data of the different parameters of the agricultural land and assembling of various data collecting sensors with the main microcontroller. We can predict the suitable amount irrigation and fertilizer application for particular land by using different sensors and IOT devices which will gather the data of different conditions like temperature, Humidity, light intensity, soil moisture etc [13].

In this papers authors mainly proposes the concepts of IOT into the Agricultural system for swift management of farming and allied activities. The methods mentioned in works of different authors are complex and are unable to be act in a simple sustainable way. Therefore our paper puts forward the plausible simple low cost solutions to the existing methods.

3. Propose different Application of Sensors and IOT in Agriculture:

3.1. Land Preparation: Before the sowing of seeds the land has to be tilled and should be freed from any disease causing bacteria, microbes or contamination. To know the status of soil contamination, biosensors and IOT can be used. By studying the soil condition using biosensor farmers can treat or recreate their lands for sowing seeds [14]. The deficiency of micro or macro level nutrients can be determined, analysed and then micro and macro nutrients can be added in the required proportion to the land under preparation for cultivation.

3.2. Irrigation: The block diagram of IOT based irrigation to the farmers who risk their health during the physical handling of pesticides.[15-16] system is shown in figure 1. It consists of moisture sensor which can be inserted into the soil or on the leaves. The information collected by the biosensors from the soil or the leaves about the level of moisture/water in the leaves or Soils are then transmitted to the processor unit for analysis which through relay and cloud network can switch the water pump on or start the sprinklers in the field and thereby irrigating the field without any human intervention. This will certainly reduce down the number manual labour and thereby decrease the input cost irrigation and moreover over irrigation can be avoided and precise water necessity could be met which is very important in recent times as the world is going through a severe water scarcity phase.

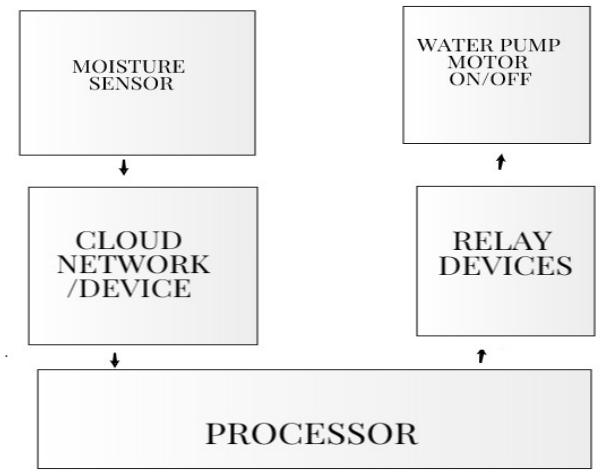


Figure1. Shows the schematic block diagram of sensor based IOT platform for irrigation.

3.3. Pest management and minimisation of chemical application. Pests are the cause of one of the major problem faced by farmer, agriculturist all over the world. The study of pest pattern by the biosensors in the crop field and analysing the nature of the pest correct variety of insecticide or pesticide can be applied. IOT can intervene in the process of manual spreading of pesticides by just instructing the machine to spread pesticides over the crop field. This will bring in a huge benefit to the farmers.

3.4 Weather monitoring: Climate change [17] is creating a lot of havoc in the agro sector in the recent times. Taking local weather conditions data on the field at real times can help farmers to predict the necessary steps of early harvesting and fruit fly activities over the farm land. Figure 2 shows the monitoring of heat map of North East India over the fields which is changing over the years IOT enabled devices can be used to overcome or negate the change in the heat wave pattern, generation of green house gases etc [18]. This can be archived by changing the plantation pattern or by cultivating climate change resilient crop variety in the region which is showing shift of pattern with time.

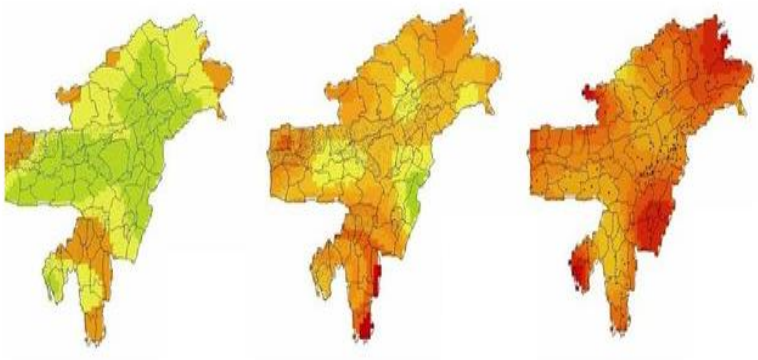


Fig 2. Changing Heat map of north east India, showing requirement of fast action (downtoearth.org.in).

3.5 Yield health checking: The yield of crop can be checked and compared with the projected output and identifying the deficits, quick measures can be taken to get good marketable quality produce. e.g. Per hector production of Brinjal (eggplant) is estimated to be 20 to 25 tons but due to deficiency of fertilizer or irrigation problem the estimated yield reduces to 7 to 10 which is 30-60% less than the estimated value[19] , this can be analysed by sensors and IOT and remedial measures can be taken quickly.

4. Drawbacks of existing different methods:

Existing techniques are mainly designed by the western countries and are of high cost and higher complexity. India is a low middle income country; the internet connectivity mainly in rural India is very poor therefore the existing methods cannot be applied due to high cost and low connectivity in village areas of our country. Another thing is that rural people are not highly educated but so many agro technologies are not user friendly rather needs highly qualified manpower so the new methods have to be user friendly particularly helpful to the rural population.

Finally the proposed method are of low maintenance in comparison to the old IOT aggregation with smart agriculture as high maintenance will increase the expenditures of agricultural inputs which will add up to the cost of the crop.

5. Challenges in the Synergy and probable solution:

5.1. Cost of Investment: High cost of investment is one of the prime hindrances in the implementation of IOT and sensor technology in the agricultural farmlands. Low power consumption devices and high performance Bio sensors and other hardware and software are required which are a little bit expensive at the recent times. This problem can be solved by multilevel co operations and also by the support of the policy makers.

5.2. Data connectivity: Network connectivity in India especially in rural India is one of the most vital problem to be addressed . In order to have IOT based smart agriculture sector seamless connectivity and reliability with maximum coverage all across the country is required, most of the agricultural farm lands in India are located in the far remote corners of the country where the internet connectivity is not at satisfactory level till date. So a major infrastructure in the field of data communication and Storage is required to be building across the villages of the country.

5.3. Mass education: Education to every nooks and corner of the country is one of the biggest components in smart agriculture. Most of the people associated with farming are marginal poor, uneducated farmers. They are not at all aware of the development of technologies and smart computing. Education about this big data transformation and new innovative method of smart agriculture and efficient use of cloud platform with profound efficiency will help the farmers to rip all the benefits of smart agro technology.

5.4. Powerful app Development: For flawless, immaculate data connectivity in 4^{th} generation mobile communication technology and highly developed mobile technology demands development of good powerful apps. These apps are the inter link and foundation for all the analysis of the data that the devices or instruments provide.

6. Conclusion:

The paper discusses the most plausible synergy of biosensor based technology and IOT platform to be used in modern agriculture system. Using developed Bio- sensor technology in synergy with IOT to feed the 7 billion world population is definitely a revolutionary idea and need of the hour. The smart farmers can grasp the opportunity provided by IOT and biosensors to strengthen sustainable food production for growing population demand. IOT and bio sensor technology has simplified the lives of several farmers and others associated with the agriculture sector to successfully collect meaningful data and take remedial actions in quick times without big erosion in their budget.

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