



INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact factor: 4.295

(Volume 5, Issue 5)

Available online at: www.ijariit.com

IoT smart agriculture farming technology – IY TWIST perspective

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ABSTARCT

Smart agriculture is revolutionizing the entire farming industry. There has been a significant increase in agricultural yields during the 20th and 21st centuries. This can be attributed to the fact that farms are becoming automated with the use of adequate software and hardware. These are user-friendly as well as simple to use enabling easy monitoring for farmers. The latest technology is revolutionizing almost all fields that were traditional at one point in time, such as agriculture, nutrition, genetics, satellite imaging, and meteorology, to name a few. Crop yields have increased with advances in plant science. Efficient irrigation techniques are a must to ensure a quality yield from farming. The cost of end products should not be allowed to increase, as that will affect the morale of farmers adversely. The Food and Agricultural Organization of the UN (FAO) has estimated that there should be at least a 70% increase in food production by 2050.

Keywords— Precision, Farming, IoT, Technology

1. INTRODUCING THE SMART AGRICULTURE REVOLUTION

Smart agriculture is revolutionizing the entire farming industry. There has been a significant increase in agricultural yields during the 20th and 21st century. This can be attributed to the fact that farms are becoming automated with the use of adequate software and hardware. These are user-friendly as well as simple to use enabling easy monitoring for farmers. The latest technology is revolutionizing almost all fields that were traditional at one point in time, such as agriculture, nutrition, genetics, satellite imaging, and meteorology, to name a few. Crop yields have increased with advances in plant science. Efficient irrigation techniques are a must to ensure a quality yield from farming. The cost of end products should not be allowed to increase, as that will affect the morale of farmers adversely. The Food and Agricultural Organization of the UN (FAO) has estimated that there should be at least a 70% increase in food production by 2050. Agriculture is benefitted by the use of various automated machines, as shown by the milking industry. Various factors combine to ease the process of farming. These include soil chemistry, irrigation techniques, and disease management along with proper scientific expertise which helps analyze the data at hand. By incorporating intelligent sensors and IT, farmers can improve the yield of a particular crop and minimize waste; this will eventually increase the quality of farming. The major factors that should be under consideration by farmers for efficient agriculture business would be:

- Limited area of land that can be used for cultivations.
- Not enough water and a growing concern of drought.
- Climate changing patterns; both locally and globally.
- The way urbanization affects rural areas.

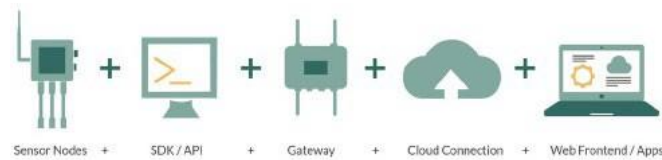
One controversial aspect of technological advances in agriculture is the development of Genetically Modified Foods (GMOs). GMOs can affect with pollination of natural crops and will cause various other issues in agriculture.

2. INTRODUCING THE CONCEPT OF SMART AGRICULTURE

Precision agriculture is the best way to convert a traditional farming process into the smart version. This technology is implemented by incorporating sensors into the farming field, which enables farmers to monitor various factors that are necessary for the process. For instance, from keeping an eye on environmental pollutants, and proper irrigation techniques to temperature management are a few factors that sensors are used for. This technology of precision agriculture uses machines that interact with a computer; earning the name of M2M, (Machine to machine) interactions. The basic pattern of an M2M interaction is as follows:

Computer and IT systems interact with sensors and other monitoring machines and devices, for gathering the information that gets converted into knowledge. Once the data is passed on to a computer, this is collected in one single area and analyzed thoroughly for any discrepancies or any other factors. For instance, some of the data collected include soil and crop behavior, the behavior of

animals in various environments, the status of the storage tank and other buildings that might be at a remote place on the farm. This whole process updates a farmer about what is going on in the field based on which decisions can be made to make sure all plants and animals are healthy, comfortable and satisfied with the environment. Thus, M2M helps a farmer to pre-plan the whole process of farming based on the data available from the previous stint. This allows the farmer to be watchful of potholes or warning signs, which eventually improves the yield of the crop. Precision agriculture facilitates the concept of Continuous Improvement. With data collected from a farm and insight gained from this information, farmers can ensure a constant cycle of yield improvement. Weather-related data which is gathered from external sources also play a key role while planning a time to plant farm crops. Also, some basic data about the crops do help farmers determine when to plant them for obtaining the maximum yield. As mentioned before, well-analyzed M2M data can help farmers to look for weak areas or factors, to improve them.



These are the information that is useful for analysis of M2M data:

- Being aware of weather patterns by going through forecast is a significant area that should be considered regarding the planning of the agriculture process.
- New scientific ways to enhance the yield of crops.
- Discomfort and diseases in plants and animals, with constant monitoring of symptoms.
- Agricultural laws, rules and regulations of a state as well as the country.

With M2M data in hand, farmers can approach fertilizer industries or those companies that produce agricultural pieces of equipment, to get customized items to improve the yield of a farm; as part of using the smart farm for better productivity.

2.1 Smart Agriculture

With the idea of getting constant data input, the implementation of smart agriculture is done differently, than the traditional process of farming. This can be incorporated into any type of farm to increase yield and productivity.

2.2 Large field arable farming

The vast area, in which the plants are grown, will need exhaustive measures to monitor the flora properly. This is where positioning technologies come in. The vehicles used in these kinds of farms are sophisticated with sensors on different parts of them, which can transmit data endlessly. These sensors, on the vehicles, come with elaborate data visualizations that are simple enough for a farmer to understand. Tracking technologies along with telematics avoids the vehicle going over the same area or patches. The sensors keep recording the vehicle condition, along with the correct location they are at and keep recording data in real-time and transmitting them to the monitoring station. With varying designs incorporated into farm machines, they can be used for each and every process of farming. Sensors planted on the field can transmit data regarding the soil quality and crop health. A large farm might have two different weather zones, which should be taken into account while planning to do agriculture.

2.3 Small to Medium-Sized Arable Farming

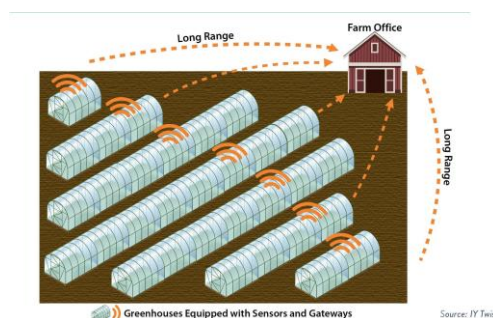
Mobile sensing technologies that are enabled spatially benefits these kinds of farms. The sensors used here monitor humidity in different soil layers, amount of nutrients, temperature, rainfall, and wind speed. With precision agriculture following the entire crop growth cycle from sowing to harvesting, farmers can ensure the right soil for agriculture business. Evapotranspiration is a major factor, as it determines the irrigation pattern needed by crops.

2.4 Livestock and animal monitoring

Sensors that are kept on animals help farmers monitor the behavior, comfortability and health of them. Monitoring of Oestrogen can determine if the animal is undergoing a heat cycle, an indication that they are ready for insemination. Vets and farmers can monitor the health of animals via rumen monitoring system, and in-vivo RFID, which records the acidity levels and temperature.

2.5 In-door Horticulture

Cultivation of flowers, vegetables and fruits can be done in greenhouses which can be monitored using customized sensors. Major indicators include temperature, humidity, and air quality, along with the presence of fungi such as oidium and mildew and solar radiation. With proper monitoring, farmers can track any diseases or infection by these fungi and can use appropriate measures to prevent them.



2.6 Benefits and return on investment in smart farming

The benefits of smart agricultural practices are as follows:

- Improves crop yields and reduces diseases during adverse situations.
- Farmers can limit the costs by smart use of fertilizers and pesticides.
- Reduces hard labor and brings in sophistication to farming.
- Everything can be planned including harvesting of the crops.
- It helps to optimize the post-harvest process of crops and supply into the foodservice industry.
- The qualitative savings include those of finances and the environment.
- Data can be used for making productive decisions that help improve the agricultural business for farmers.

3. THE NEEDS OF THE SMART AGRICULTURE COMMUNITY



4. SMART AGRICULTURAL TECHNIQUES, AN OVERVIEW

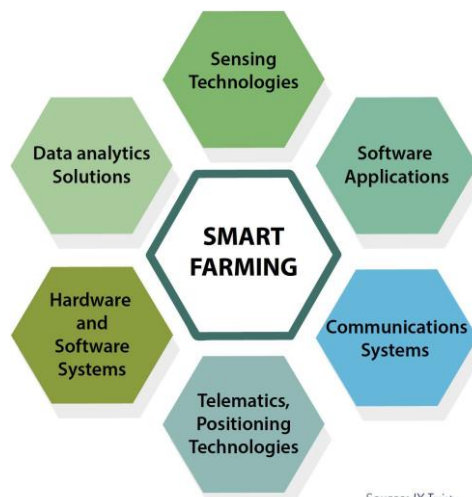
4.1 Sensing technologies and Data acquisition

As mentioned before, sensors are the eyes and ears of farms that monitor and send data to a computer. Acquiring data is the main goal and first step in any process, let alone agriculture and it can vary from a soil sample to harvesting criteria; this can determine the yield of a crop. Data will be diverse and many factors do contribute to this. Through the proper statistical analysis, farmers can decode the data and use it for their benefit. The places at which sensors are planted have to depend on these factors:

- The number of sensors that are needed at the site along with its positions.
- The frequency with which data is collected.
- The size of the collected data.
- Whether the sensors be run on solar power or battery.

4.2 Modes of Connectivity

The data gathered by sensors as a part of remote monitoring are sent to the Farm Management Information System (FMIS). This is done through a variety of communication modes, the most preferred being wireless such as 2G to 4G. Data communication via satellite is another way, the sensors interact with FMIS. Low Power Wide Area Network (LPWAN), is the most cost-effective way of connectivity. The main use of LPWAN is done in the area of crop and pasture management. Along with WAN connectivity, mesh networks are used which combine several small connectivities.



Source: IY Twist

5. FARM MANAGEMENT INFORMATION SYSTEM (FMIS)

Farm Management Information System (FMIS) clubs together both internal and external data that is needed by a farm under a single server. This forms the crux of IoT, which allows information to integrate and give clarity on what happens in farmland. Farmers will learn more about the workings of an ecosystem with a multidimensional view of farming activities. The task of FMIS is to convert all the information it has into useful knowledge. FMIS must be customized according to the agricultural operation. All the important personnel related to both plant and animal farming along with software engineers help this technology of IoT to grow. This benefits the entire farming industry through the process of automation.

6. IY TWIST

It is a firm that focuses on intelligent automation of traditional practices such as farming and agriculture, among other fields. With a focus on creating and implementing innovative automation technologies that help in optimizing operations in various fields, IY Twist focuses on incorporating IoT into an area that was predominantly run through human effort and manual labor. Through this, they achieve their vision of making the world a smarter and easier place to live in. The gap between technology and mankind decreases drastically through the automation process, thereby bringing in clarity by streamlining the processes under one umbrella. The designs by IY Twist integrate both software and hardware for sensors that use wireless networks as a mode of connectivity. IY Twist provides services to various IoT systems that include the environment, urban monitoring, waste management, and smart farm applications to name a few. IY Logic is one another product, which is hardware provided by IY Twist. This is a sensor node that helps in advanced wireless connectivity which can be implemented as an IoT device in the agricultural field. This works in remote areas as it offers satellite signals, LoRaWan and cellular connectivity. It works in connection with cloud systems and hence, there will be an excellent data storage option. With minimal maintenance costs and the chance of easy scalability, IY Logic comes in a waterproof casket. This has provisions for the sensors to connect. IY Twist is designed such that, it can be connected with any type of device with varying modes of connectivity. Any type of cloud platform can be used for this software. With IY Logic, there is a scope of more software development using IY Twist, hence upgrading IoT technology for farming and agricultural business.

6.1 IY Twist Technologies and Smart Agriculture

There are so many steps that get considered while applying IY Twist, IY Logic and related sensors and FMIS. These steps mostly are related to sensors, data, and FMIS and how IY Logic hardware helps in acquiring the data and how IY Twist software provides a cloud platform for vast storage of these data. As mentioned before, the necessary steps include:

- Data Sensing
- Data Communication
- Data Processing

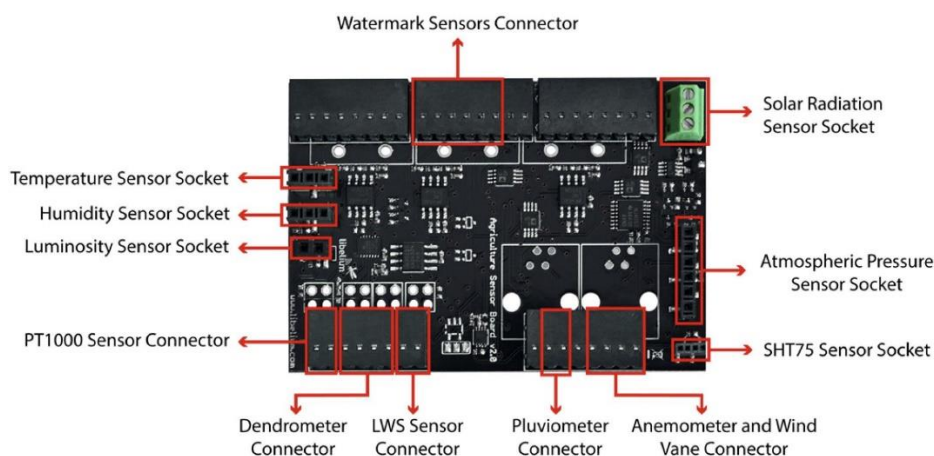
6.2 IY Logic - Hardware - Reforming Soil Sensing – Patent Technology

IY Twist offers a product known as IY Logic, which is a hardware component that contains sensors that reforms soil sensing technology. This hardware is commercially known as IY Logic Plug and Sense! Smart Agriculture. As mentioned, data collecting hardware is provided by IY Logic, whereas the software for its storage is provided by IY Twist.

6.3 Data Collection

This phase consists of three components which include sensors, devices, and gateways. Sensors are the components that are planted on agricultural fields in different areas or patches of farmland. They differ with the kind of data they are collecting, time intervals at which they are collected and the power source they run. The necessary data that gets collected varies from plant growth analysis to observation of weather patterns. So, the right configuration of sensors is essential for collecting apt data from various applications. These are the necessary data that gets collected: The temperature of the soil, air, along with humidity

- Solar radiation
- Luminosity
- Direction and speed of wind along with rainfall and atmospheric pressure
- Leaf wetness
- Measurement of fruit and trunk diameter using dendrometer



Source: IY Twist

6.4 Circuit board of IY Logic or IY Twist Agriculture

This circuit board consists of a plethora of sensors that collect data and transmit to FMIS. These sensors include:

- Watermark Sensors Connector (Topmost panel)
- Solar Radiation Sensor Socket (Top Right Panel)
- Atmospheric Pressure Sensor Socket (Middle Right Panel)
- SHT75 Sensor Socket (Bottom Right Panel)
- Anemometer and Wind vane connector, Pluviometer Connector, LWS Sensor Connector and Dendrometer Connector (All at the bottom panel)
- Temperature Sensor Socket, Humidity Sensor Socket, Luminosity Sensor Socket and PT1000 Sensor Connector (All panels along the left side)

IY Logic known as IY Logic Sense Smart Agriculture, deals with irrigation systems, greenhouses and precision or decision agriculture. With the aid of technology, this hardware can control the sugar content in grapes which are cultivated for making good quality wine. This also helps with regulating conditions in a greenhouse. Selective irrigation can be done using the soil moisture sensor, which has three levels of depth when planted in dry soil zone. Prevention of contamination is done via the monitoring data from humidity and temperature sensor sockets. For monitoring irrigation systems, and to detect any kind of leakage to water sources such as nearby ponds or lakes, IY Twist has developed a Plug and Sense! Application model. This is also useful for giving out data that helps farmers to clean the water source, thus making it portable water. It is very easy to install these sensor probes and the IY Twist team can incorporate new sensing capabilities to enhance the quality of them. It is very easy to maintain well too.

6.5 Data Communication

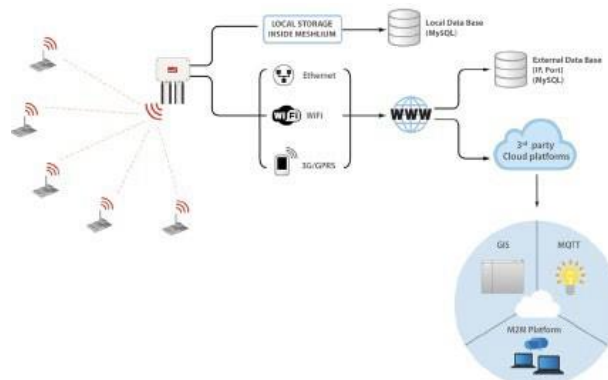
With enough data collected, it is now time to know more about communication, storage, and processing of the same. For this, IY Twist uses Meshlium Hardware. The distance for transmitting data could be between 100 meters to 100 km. The data collected is stored in two ways. The first way would be to store locally within Meshlium which in turn is kept in MySQL local database. In another way, the data is stored in 3rd party cloud platforms that get transported to GIS and MQTT, which are a part of the M2M platform.



6.6 Data Storage and Processing

The Meshlium that's used for the first type of storage is hardware. This is a multi-protocol router. The main purpose of this router is to be a gateway for sensor networks. It would be in-built with six different radio interfaces, which include:

- Wi-Fi 2.4 GHz
- Wi-Fi 5GHz
- 3G/GPRS
- Bluetooth
- XBee
- LoRaWAN



6.7 IY Twist provides a readymade Smart Agricultural Solution

Launched in March 2016, IY Twist provides IoT solutions in implementing smart agriculture or farming practices. The applications include software, hardware and cloud platform connections. Introducing IoT to the farming community is the idea behind this venture, as agriculture is the most needed process that's on a slight decline. Food is an essential item and agriculture makes that happen!

7. SMART AGRICULTURE PROJECTS UNDERTOOK BY IY TWIST

7.1 Jordan Valley Organic Farm Kerala State India

Under the watchful eye farming experts who work under Kerala Government and Kerala Agricultural University, IY Twist undertook this project. The data collection was done via IY Farm Software, with the hardware being IY Logic for smart monitoring. Parameters monitored included humidity, air temperature, leaf wetness and rainfall. An automated moisture sensor was used to control water consumption by plants. The data acquired were visualized through the IY Farm dashboard, which gave a pretty good idea about when to apply pesticides and insecticides. Plants such as ginger, beans and beetroot were improved at affordable and low costs; encouraging signs for applying this technology to bigger farms and other crops.

7.2 Azeezla High-tech Organic Farm

This project allowed IY Twist to partner with the Indian Ministry of Agriculture in collaboration with local panchayats. Sensors used included IY Farm and IY Logic. Management of agriculture by monitoring and collecting temperature and soil humidity data are done through these sensors. IY Logic platform was connected to various cloud platforms, that collects all relevant data and geo-locates them in maps. A better understanding of the ecosystem and the right conditions for farm crops too achieve a quality yield was learned through this project.

7.3 Government of Kerala and Department of Agriculture and Farmer's welfare

IY Twist and Department of Agriculture joined hands to educate farmers about IoT technologies, and how this technology can benefit their farms to obtain the quality yields they deserve. IY Farm mobile application can help farmers track weather conditions that are specific for agriculture in each farmland or plot. These conditions include temperature, humidity, rainfall, wind direction and speed, soil moisture, leaf wetness, and atmospheric pressure. IY Logic Plug and Sense! Sensor platform is connected by a Meshlium to cloud platforms. This hardware can collect data and transmit them to FMIS while geo-locating the exact patch of farmland on the map. It gives a good idea to farmers about how plants are coping in their environment and they will be watchful of their crops.

8. HOME GROWN BIOTECH EXOTIC FRUITS

IY Twist partnered with a private farm named Home Grown Biotech, located at Adimali in Idukki. Home Grown Biotech is owned by Renny Jacob where he cultivates exotic fruits of the varieties of Jaboticaba Litchi, Rambuttan, Pulasan Nutmeg, and Mangosteen Passion Fruit along with Miracle Fruit. IY Farm and IY Logic sensors collect all the data that is related to plants and the soil of farmland along with environmental parameters. Waspnote Plug and Sense! is connected by Meshlium into a cloud platform. This data can pinpoint the exact location of exotic fruit plants by using the technology of the geo-locating system. All these data are transmitted to FMIS, which contains software that helps the farmer to manage these exotic fruit plants. This project brought to light, the adapting conditions of exotic and non-native plants. The data received also helped in restoring trees that were survived behind after deforestation.

9. CONCLUSION

With the rapid advance in technology, computers and the internet are being used in every home as well as business enterprises. Farmers have started using computers to input and analyze the information they obtain in the form of data for ease of running their agricultural businesses. Computers have mostly helped farmers to organize financial data along with interacting with their clients and customers. Digital technology has helped farmers to monitor their farmlands which include crops, livestock, and all that is related to the agricultural business. There is a vast influx of data from various parts of the farm and vehicles used for agriculture, other types of machinery and weather stations. The data is vast and analyzing these will need proper organizing of them; so that, informed decisions can be formed based on the knowledge at hand. The ability to do so is revolutionizing the farming sector and putting farmers at ease. A wide range of farm crops can be cultivated in large farms with thorough monitoring. Thus, IoT indeed simplifies agriculture in its way.

10. OBJECTIVES OF SMART AGRICULTURE REVOLUTION

Making aware of precision farming to farmers is a task in itself. Giving an idea about the steps in the production chain, and various transactional activities through an online medium or otherwise is not easy. Some of the factors involved in objectives are:

- Product safety and productivity
- Local and global market presence
- The health of plants and animals
- Nutritional responsibility
- Sustainability
- Cost and waste reductions

11. SMART AGRICULTURE

- Based on data sensing, communications, storage, processing or analyzing and using this to make important decisions.
- The fundamental block is Farm Management Information Systems (FMIS), into which sensors transmit data.
- Farming applications:
 - a) System for yield measurement
 - b) System for milk quota
 - c) Monitoring of plant diseases and forecasting for spraying
 - d) Weather monitoring
 - e) Managing greenhouse

f) Monitoring of livestock for any diseases

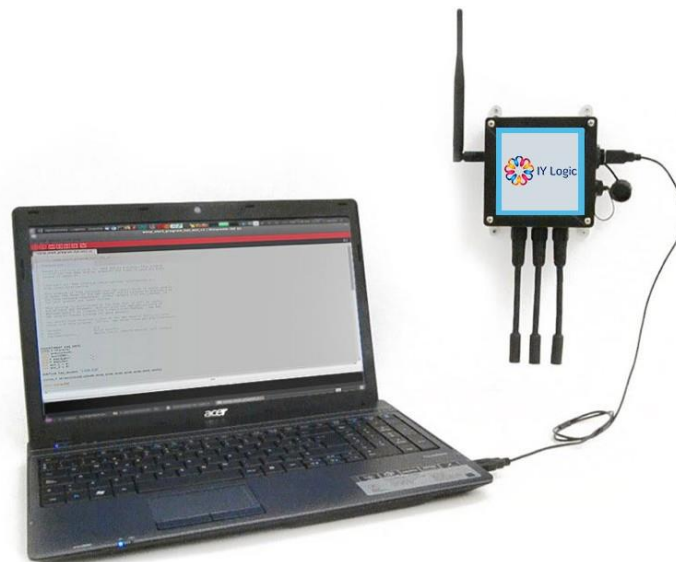
IoT and the data generated can help farmers correlate information from past for correct treatment of crops and farmland.

12. THE CASE OF IY TWIST

Sensing technology firms form the building block of Smart Agriculture plans. Some of the companies just deal with an integration option between sensors and networks. IY Twist provides farmers with versatility. The company offers farmers the possibility of changing communication protocol or cloud solutions based on their convenience and comfortability. They also offer a platform where sensors can be added according to the requirements of the farm. Through interoperability, customization of Smart Agriculture, provided by IoT solutions for farming, is possible. IY Logic Sense Smart Agriculture gives farmers options to monitor important parameters that are related to farming and agriculture.



13. SMART AGRICULTURE KIT



IY Twist serves as an operational tool for significant partnerships which include data analytics, cloud computing and agri-tech solution providers. These various organizations merge their skills, ultimately helping farmers out to ensure quality yield from vast farmland. Sensing and data management services form the crux of Smart Agriculture. It can be said with precision and clarity that, IY Twist is revolutionizing the farming industry through IoT and automation of the entire agriculture business. With designing software and hardware for Smart Agriculture, IY Twist provides software development kits (SDKs). This enables an easy transition of crops from farm to market in minimal time. IY Twist Technologies has its headquarters in Bangalore and Development Centre in Cochin India.