Humanoid Farmer

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Abstract:* Farming is the backbone of the Indian economy and it has been unchartered territory for a technological solution. As of late one of the innovations, Artificial Intelligence has paved the way for digital farming. As an important sector, Indian farming has been facing various challenges like an abrupt change in climatic conditions, spoiling of yields, soil nutrient requirement, pest and weed control, and so forth. Robots with an emerging technique Artificial Intelligence with the integration of various sensors, enhance the better outcome. The network foundation and characteristic simulation of the mobile parameters are set through an Ad-Hoc system or remote sensor-related with each portable robot. Artificial Intelligence with cloud data guarantees and empowers the associated coordinate with mobile robots in all conditions. Through Global Positioning Systems the actual position of the robot is known and the information is retrieved back to the Access point through Beacon message.

***Keywords:* Artificial Intelligence; Beacon message; Digital Farming; GPS; Environment monitoring.**

I. INTRODUCTION

Agriculture is seeing rapid adoption of Artificial Intelligence (AI) both in terms of agricultural products and in-field farming techniques. Subjective processing, in particular, is all set to become the most convenient technology in agriculture services as it can comprehend, learn, and respond to various circumstances (based on learning) to increase efficiency. Proximity Sensing, moisture sensor, and Image Sensing are the different technologies which are primarily used for wise information combination. One instance of this high-resolution data is Soil Testing. Proximity sensing requires sensors in contact with soil or at a very close range. This aids in soil characterization based on the soil below the surface in a particular place [1].The wireless network provides the privilege to build a separate multi-hop network and connection between the robot in the field and access point. There is no need for dependence on the settled system as the mobile nodes work under a decentralized and self-computing and arranging networks. While approaching the goal associated with the mobile nodes, it moves around the access point to discover and revert the information collected. The remote mobile node can be deployed anywhere and shaped on the network area in an unconstrained and quick way. Ad-hoc networks [2] are also called a multi-hop network for the favorable position assigning of the mobile node. Impromptu systems is an investigative way to locate a helpful and correct scientific portrayal for displaying in a few applications, for example, specially appointed correspondence between mobile PCs for conferencing and home systems administration, remote sensor systems, multi-bounce expansions of cell media transmission frameworks, and systems of vehicles. Availability is an essential and extremely basic property of a remote multi-hop network. Remote systems with settled foundation (e.g., cell media transmission systems or remote LANs), it is adequate that every portable hub has a remote connection to no less than one base station. Images of various yields under white light are captured to determine how crops are grown and evolved. Farmers can create various degrees of preparation depends on the yield (crop/fruit) category and include them into discrete stacks before sending them to the market. Remote sensing techniques alongside spectral imaging processing are fundamental to build crop metrics across thousands of acres. It has the potential to acquire a progressive change in terms of how farmlands are monitored by farmers both from time and effort perspective. The robot with knowledge of Artificial Intelligence in agriculture, have a lot of importance as far as overseeing unfavorable climate conditions, profitability gains, exactness cultivating, and yield the executives. Yield Monitoring and Health evaluation of a harvest or plant stays considerably the most noteworthy zones in farming to furnish Robotic solutions in collaboration with Artificial Intelligence [3].The image capturing and processing in Robots gather precision field images that can be passed through a convolution neural network to identify areas with which yields need water, growth, condition, and requirement in the mid-development stage. As far as tainted plants, by examining crops in both RGB and close infrared light it is conceivable to produce multispectral pictures utilizing devices that have the skill set to identify and notify. The expression "Perfect Place, Right Time, Right Product" summarizes exactness cultivating. This is a progressively precise and controlled procedure that replaces the dreary and labor-intensive part of farming. It likewise gives direction about yield turn, ideal planting and reaping time, water the executives, supplement the executives, pest attacks, and so on. Artificial skillset models trained on plant images can be used to recognize developments in plants. India is partitioned into six significant soil types. In this study, we have tried to make a comprehensive robot that can provide us with on-farm testing of soil, suitable yields to be grown for the exact situation, and bringing precision during harvesting of crops.

The organization of this paper is as follows: In Section 2 we have provided a literature review on the research and development in Precision farming, node degree, connectivity and network establishment within the robot, automated vehicles for development crops/yields, and navigation of robot with inter bot communication. Section 3 highlights the perspective of composition based navigation of the mobile robot with collecting the information, calculating area, and one hop distance of each seed before planting and yield monitoring. Section 4 extends our discussion on the analytical simulation and evaluation of the network-based connection methodology with a specified range using the analytical method. A summary of the findings and conclusions are presented in section 5.

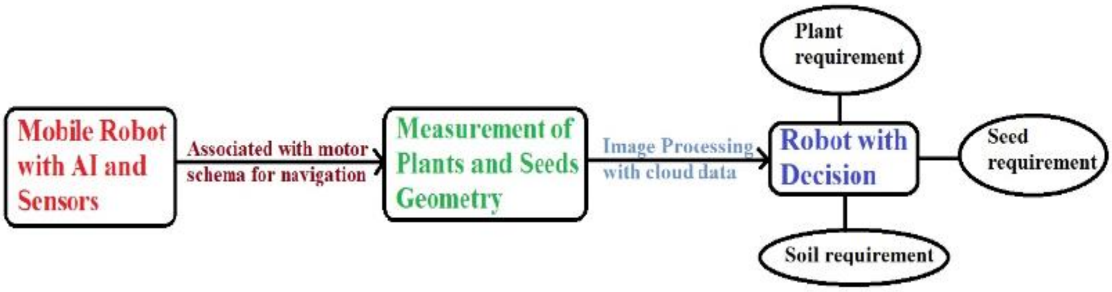

Fig 1. Block diagram of the robot with functions associated.

II. LITERATURE SURVEY

Precision farming is an idea of farm management dependent on the use of various technologies, to manage the spatial and temporal inconstancy related to agricultural production in all aspects. Its fundamental objective is the improvement of both yield execution and natural quality [4]. The vast majority of the organizations reported, utilize these techniques to explain explicit requirements or to fill significant gaps in the knowledge of farmers. The encouragement of various field activities can be achieved by using Autonomous mobile robots, which have the capability of providing, capturing and processing of multiple quantities of data depending on the yield in a complete field level. The automated vehicle guidance system is utilized for the development of various fields which includes development, seeding, weeding, exploring, use of composts, and water managing system of various yields [5]. The usage of autonomous vehicles yields accurate results than other systems used in the same field. Some predominant gatherings of Indian soil grouped by soil scientific categorization and chemical property are referenced below [6].

1) *Red Soil:* They are very wide in their spread. The red shading is because of the dispersion of iron in the concentration of the soil. These soils are commonly unbiased to acid in reaction, and lacking in nitrogen, phosphoric acid, humus, and lime.

2) *Lateritic soil* is made out of a blend of hydrated oxides of aluminum and iron with limited quantities of manganese oxide. The soils are wealthy in nutrients including organic matter.

3) *Black soil* contains a high extent of Calcium and Magnesium Carbonates and has a high level of fertility.

4) Alluvial soils: This is the biggest and agriculturally most significant gathering of soils in India.

5) *Desert soils* occur mostly in dry regions and significant substance is quartz. A portion of the desert soils contain a high level of dissolvable salts, fluctuating levels of calcium carbonate, and poor organic matter, the constraining variable is water. The soils could be reclaimed if legitimate facilities for irrigation are available.

6) *Forest and Hill soils* are high in organic matter. These soils occupy approximately 8.7% of the total land area.

India having assorted geology and each region coming under the various climatic zone, it is soil types differ from region to region and one size fits all can't be applied thinking about the India topography and soil topology. The combination of decision support networks such as remote sensing, development of sensors, and controls helps to achieve the economic benefits effectively. Control of temperature, moisturizes, soil planning, proper monitoring of water flow, and the exact amount of nutrients required, are the few techniques actualized in profitable for agriculture [7].The robots can perform some tasks that humans cannot do due to the harsh conditions, such as environmental monitoring and control, crop monitoring, supply and treatment, and pest and disease detection. The mobile robots associated with the wireless Sensor Networks used for environmental monitoring, most of the systems with new techniques use sensors network for better outcomes. The literature collects multiple proposals for modeling and controlling the conditions of farming. Some of them obtain the models applying analytical equations. The target of climate control and the exact usage of sensors define and measure the state of yield. The most relevant variables collected by literature are temperature, the humidity of the air, solar radiation, and CO2 concentration [8].Besides, there are a few factors that have an impact on the condition of farming and ought to be estimated and controlled. Some of the aggravations are outer temperature, surrounding moistness, wind speed, wind bearing, outer CO2 fixation, spread temperature, crop temperature, and ground temperature. The ground robots can be utilized to apply medicines and composts to the yields to improve the accuracy and legitimize the items. Planting and harvesting are seasonal tasks that require a considerable amount of work. The robots (Autonomous robots and mobile robots) and sensors (image sensors, proximity sensors, and moisture sensors) contain end goal to achieve and also automatize the tasks. The implementation of the advanced technology in the field of crop mapping, soil requirements, and so forth, have increased the interest in farming.

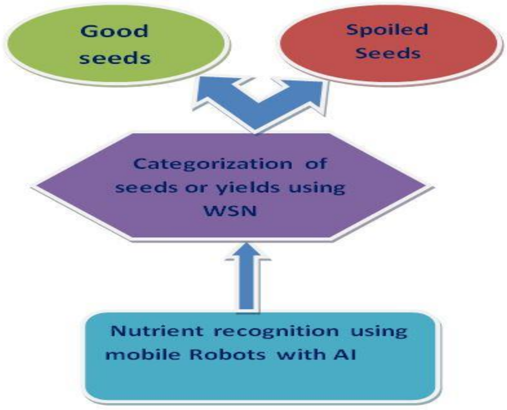

Fig 2. Approach of Robot in the field of recognition.

III. APPROACH

The robotic motion strategies are implemented due to the importance of the functioning tasks in the field of seeding, harvesting, and monitoring strategy. Generally, the autonomous robots haven't specified the desired path following based approach, however, the robot with an association of position-based control and vision control is used to complete the displacement task. A robot with an end task set to approach also helped some Under Ground Vehicle (UGV) to serve the purpose. To support the growing development of seeding and harvesting robots, new strategies are proposed for driving an autonomous mobile robot in the associated scenarios. The customary control structures like "Go as far as possible and afterward take right", "Watch out" directions comprises a portion of the conceivable practices that utilization an unbendable and inflexible way to deal with the route and don't give basic versatility. The motor schema with complex coverage trajectories is the strategy used to portray the collaboration between perception and decision making for a robot system under mobility. The motor schema [9] works simultaneously and autonomous likewise guarantee the association between the robots and the discovery of the object. The robot collects multiple proposals for modeling and controlling the conditions of the crop to have development in a suitable situation. Automatic vision method associated with a mobile robot, for detecting the crops, and necessary actions to be taken to control the prey. The integration of sensors, cameras, localization, and mobility factors with robots gives us a clear picture by creating a clear image, responding to the surroundings and nature of the field scout and working of the robot. The robot uses Motor Schema to navigate in the agricultural environment while creating a map of such an environment by executing the direct way created by the guide. The conduction of receptive or reflexive instantiation. Experience of image codification and cerebrum displaying gives a specific method for seeing intellectually and react to the circumstance. Each engine construction has a recognizable proof methodology called implanted perceptual pattern which gives essential information through sensor data to the robot to relate the environment. A sensor-driven motor gives proper engine activity. The mapping hypothesis connected to the robot to control the methodologies and actions to be performed in various situations. The versatile robots have information about plan and development as for the field on the multi-working platform. An armada of heterogeneous ground robots is created and integrated with imaginative sensors, upgraded end-task, and improved choice control to cover a huge assortment of agricultural circumstances. Innovation vision envelops another age of brilliant, adaptable, powerful, consistent, interconnected robotic frameworks working flawlessly alongside human colleagues in homesteads and food production lines. Groups of multi-modular, interoperable robot systems will self-sort out and organize their exercises close by and inside existing AgriFood frameworks [10]. Electric ranch and industrial facility robots with exchangeable apparatuses, including low-culturing arrangements, novel delicate robot getting a handle on innovations and sensors, will bolster the feasible heightening of agribusiness and drive fabricating profitability all through the natural pecking order. Current agri-mechanical robotic systems with man-made brainpower and Artificial Intelligent (AI) strategies to increase their efficiency. Elective robot associates for plant monitoring, parallel cultivating, and including advancements in various types of fields will additionally assist in the strengthening of Agriculture while securing nature, food quality, and wellbeing. Gale Shapley Algorithm is integrated with the robot to solve the stability problem which is associated with trial and error operations. With the new techniques or innovations in the agricultural sector, the GS algorithm functions have been extended to apply on Robots to be used for sowing seeds, analyzing the soil and harvesting the plants. This could be achieved where; Robot is given an area of land through the GPS which will be assessed by it through the proximity sensor. The algorithm works on a feedback and control manner. As the area of sowing, the field is known but the space to be kept between the plants or seeds to be sowed will be supplied by the farmer's preferences once, the area is scouted by the Robot, it decides how many seeds or yields to be placed or planted in the given area. This Gale Shapley (GS) Algorithm runs until the last part of the scouted area is covered, also it runs until the completion of seeds and plants which is to be sowed or planted. A mobile Robot already associated with artificial skill sets, data of plants and seeds, and GS algorithm support farmers to monitor the requirements of plants while it is in the developing stage. However, the size and area of each crop or plant vary according to the growth rate, the Robot will take this as a feedback and automatically plant the yields and appropriately sow the seeds [11]. This has been done to assure that plants are sowed with accuracy and precision.

IV. SIMULATION AND EVALUATION

This section explains the algorithm mentioned earlier and the evaluation of the same using analytical equations supporting the approach to achieve the end goal associated with the mobile robot.

A. GS Algorithm

In general, there exist many different stable matchings. Considering there are three different plots or field lines (A,B,C) to be covered by the robot by managing, recognizing and sending the captured information back to the access point and three different seeds or plants (X,Y,Z) which have their respective preferences of planting it on the field scout which is already in the storage data of mobile robot, where,

A,B,C – serves as the fields to be planted or sowed with the help of environment conditions. (Considered only 3 categories for the analytical calculations).

X,Y,Z – serves as the quality of yields or seeds which are sowed on the selected field plot.

The possible outcomes by Permutation and Combination give us the following different results:

A: YXZ B: ZYX C: XZY

X: BAC Y: CBA Z: ACB

There exist three stable solutions to this matching arrangement. The first line of the field gets the first choice and the last seed to be sowed(AY, BZ, CX), rest all considered as the second choice (AX, BY, CZ). Similarly, the seed selection goes first, based on the quality (AZ, BX, and CY). Considerably all the combinations are stable as there doesn't exist any instability neither with the field nor with the seed or yield to be planted on an area scout. The selection of the seeds on the particular field slot completely depends on the robot.

On the first note, the field is plotted by the seed or yield which the robot considers as the best (X), and then the rest of the seeds would be planted on the next row if the first field scout is limited. If the best quality seeds are limited, the rest of the field is planted by the next most qualified seed or yield (Y).

In the next subsequent round, the second row of the selected plot is sowed or planted with the next most qualified seed (Y) (considering the availability of the yields), and then the rest of the yields are planted. If this quality of seeds (Y) is limited, the remaining seeds (Z) are planted in the same field slot. If the slot is limited, the seed which is left (Y) is sowed in the next field slot. This process is repeated with either of the cases, seeds or yield are completely sowed or the field slot is completely planted with seeds or yields.

B. Mobile robot on the field

The subsequent system ought to have a specific least degree with the minimum distance between each yield which is planted or the seed which is sowed.

$$d_{min}(N) \geq n_0 \Leftrightarrow min \; \forall \; n \in N \;\; d(n) \geq n_0 \qquad (1)$$

where,

$d_{min}(N)$ = Minimum distance to be maintained with the neighbouring seed.

d (n) = Area of the considered seed or yield.

n = Number of neighbour seeds.

N = Total number of seeds sowed.

n_0 = The minimum area recorded for the growth of the seed.

The following calculations give us clear knowledge about the robot with motor schema and Artificial Intelligence usage of finding an obstacle, monitoring the seed or yield, and also area scout. A minimal distance between the two seeds or yields provides a privilege to grow and have an equal amount of nutrients supplied.

a) Calculation 1

Stage I: Computing the separation between two seeds or crops.

If, $d(i) < D^{th}$ …. Moves away

Stage II: Computing the separation between two hubs.

On the off chance that, $d(i) > D^{th}$ …. Moves close

where,

d (i) = Distance of the seed or the grown crop.

D^{th} = The area scout given for the respective crop.

Proportionately, we can figure the basic number of seeds n for the given area plot r_0.

One Dimensional:

$$P(d = n_0) = \frac{(2r_0)n_0}{n_0!}.(e \; - \; 2r_0) \qquad (1)$$

Two Dimensional:

$$P(d \; = n_0) = \frac{(\pi r^2)n_0}{n_0!} \bullet (e - \pi {r_0}^2) \qquad (2)$$

where,

P (d = n_0) = Probability of area of the seed planted and pre-recorded area of the same seed.

n_0 = The minimum area recorded for the growth of the seed.

r_0 =The area of the field where seeds or yields to be planted.

e = A limitation factor and its value - 2.71828.

b) Calculation 2 (Runs each t units of time)

Stage I: Neighbour Discovery

First seed Neighbour = Find the next Neighbour

Stage II: Compute the position P between two yields or crops.

Compute P utilizing Formula (2)

Stage III: Compute the new position for the next seed

Compute that area scout utilizing Formula (2)

If the robot finds the end in the first line of the field, the robot is directed to move to the next lane. If all the lines of the field are covered, the robot sends the completion information to the access. The connectivity between the mobile robot and the access point is ensured by the Ad-hoc network.

C. Variable Sensor Robot Controllers:

Air temperature RHT03 UAV/UGV Raspberry Pi.

Ground temperature MLX90614 UGV Arduino.

Air humidity RHT03 UAV/UGV Raspberry Pi.

Ground humidity SEN92355P UGV Arduino.

Luminosity TSL2561 UAV/UGV Raspberry Pi.

CO2 concentration MG811 UAV/UGV Raspberry Pi.

Automotive Robot Architecture (AuRA) is considered as one way of executing the direct way created by the guide. The guide relies upon detecting methodologies and seed monitoring. The robots pursue the way guided by the pilot. The guide with a robot is prepared with dynamic sharpening for following the predetermined way with engine mapping and perceptual pattern.

1. Stay on the way (a walkway or sidestep).
2. Avoid-Static-Obstacle (Huge stones, trees, and so on.).
3. Avoid-moving-obstructions (Animals).
4. Find the crossing point (To decide the finish of the way).
5. Find milestone (Building for limitation).

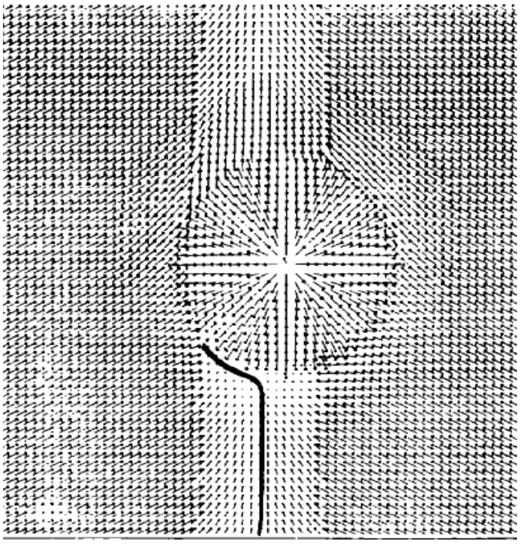

Fig 3. Robot steps in a dead spot due to obstacle detection on the field.

On the off chance that the way is veered off enormously from the predefined way because of some nearness of un-modeled obstructions or situating blunder. The guide at that point finds another worldwide way and is processed utilizing the defined instructions.

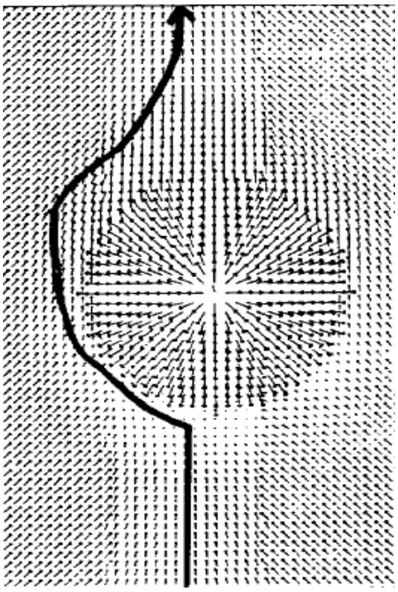

Fig 4. Obstacle is passed and robot following its normal way in the same field.

If the deviations are in satisfactory range, the pilot or engine mapping sidestep the deterrent and makes a robot to pursue a similar way of movement.

V. CONCLUSION

Precision agriculture tries to apply various innovations to gain information about the spatial and worldly changeability of yields. The usage of the actively connected and wireless sensor network mobile robots to capture the field maps, monitoring the seeds or crops, managing the requirements of the crops or seeds, and to take remarkable action upon the plants. Also with that, mobile robots are capable of monitoring the environment which is considered as one of the noted factors for the development of the crop and also at the time of the harvest. Monitoring the surroundings and environment the robot could eventually give the best information collected on the field such as, watering and spraying pesticides to the plants. As a matter of fact that the utilization of robots for seeding and gathering is in a prior advance of improvement, a progression of methods of discernment, situating, and getting a handle on have been created. The most generally utilized robots in agribusiness are UAVs and UGVs. The International Labour Organization (ILO) released its report 'Working on a Warmer Planet: The Impact of Heat Stress on Labour Productivity and Decent Work', which said that by 2030, What could be compared to more than two percent of complete working hours overall is anticipated to be lost each year, either because it is too hot to even think about working or because labourers need to work at a more slow pace. This could be said the same for farming activities where labour is required at large scale from sowing seeds to harvesting seeds which are manually done either in the harsh winter of northern India or the scorching heat of the south and north India both. A mobile Robot could help the farmers overcome these perilous situations. The COVID-19 situation which has led to the migration of labourers has left the farmers with no choice but to harvest crops on their own. The flexibility with the usage of multi-robots is the crucial factor, which is really implemented in the field are having many advantages and room to have developed in a wide range. All things considered, different structures like, bio-inspired robots are picking up enthusiasm, just like the utilization of multi-robot networks that can go farther than single-robot ones.

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