International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 1 Volume No.7 January - February – 2023
DOI:10.46647/ijetms.2023.v07i01.040 ISSN: 2581-4621

GoAgro: Design and development of a precision farming robot

[1]Bhoomika K.M. (USN-1DS19EC025), [1]Bhuvan J. (USN-1DS19EC027),
[1]Hruday B.N. (USN-1DS19EC053), [1]Mithun V.P. (USN-1DS19EC079),
[2]Dr. Pavithra G., [3]Dr. Sindhu Shree M., [4]Dr. T.C.Manjunath,
[5]Aditya T.G., [6]Sandeep K.V., [7]Rajashekar M. Koyyeda,
[8]Dr. Suhasini V.K., [9]Dr. Vijayakumar K.N.
[1]Third year BE (ECE) students, Dept. of Electronics & Communication Engg., Dayananda Sagar College of Engineering, Bangalore, Karnataka
[2]Associate Professor, ECE Dept., Dayananda Sagar College of Engineering, Bangalore
[3]Assistant Professor, ECE Dept., Dayananda Sagar College of Engineering, Bangalore
[4]Professor & HOD, ECE Dept., Dayananda Sagar College of Engineering, Bangalore
[5]Second year BE (CSE) Student, PES University, Bangalore
[6]Assistant Professor, Electronics & Telecommunication Engg. Dept., DSCE, Bangalore
[7]Assistant Professor, EEE Dept., Tatyasaheb Kore Inst. of Engg. & Tech., Kolhapur, Maharashtra
[8]Prof. & Head, Mechanical Engg. Dept., DJ Sanghvi College of Engg., Mumbai
[9]Principal & Prof., Dept. of MCA, Bharati Vidyapeeth's Inst. of Mgmt. & Info. Tech., Mumbai

Abstract
Since a long time ago, agriculture has been a significant part of the Indian economy. 18% of India's gross domestic product is produced by the agriculture sector (GDP). A better answer for precision agriculture is provided by robotics and the internet of things. Selective harvesting is necessary when picking fruits or vegetables like tomatoes and apples. In traditional farming, each fruit is hand-picked by a worker, requiring a huge amount of labour to carry out selective farming. We suggest a robot that helps farmers with a variety of labor-intensive chores, such as selective crop harvesting and qualitative segregation, while also simultaneously providing data on crop health, soil nutritional status, and crop shelf-life detection. An android application is used to analyse, process, and send the obtained data to the farmer. Later, the weight, colour, and health of the particular crop are checked to grade its quality. The fruit is subsequently moved into the designated container after being graded. Spoiled or overripe fruits and vegetables would be plucked and dropped so as not to interfere with the plant's growth. A harvesting arm on the proposed robot would reach the fruit or vegetable and pick it from the plant or tree. The work given here is a mini-project that is taken up as a part of the curriculum completed by electronics and communication engineering students in the second year of the electronics & communication engineering department at Dayananda Sagar College of Engineering in Bangalore.
Keywords: Deep Learning, Machine Learning, AI, Wireless, IoT

1.Introduction

The declining number of agricultural employees and rising cost of fruit picking are only two of the issues facing the agriculture sector. In order to solve these issues, agriculture must be scaled up and labour costs reduced [1]. For labor-saving and industrial-scale agriculture, agriculture automation has advanced recently. However, physical labour is still used extensively in the sector of fruit harvesting. The creation of a robotic fruit harvester is a workable answer to these issues [2].

2. Significant works done

Two significant duties are involved in a robot's autonomous fruit harvesting:
(1) Using computer vision and a sensor, find and locate fruit on trees.
(2) The end effector of the robot arm moves to the location of the recognised fruit and harvests it without harming the target fruit or its tree [18].
We humans have reached the limit of our cognitive abilities due to the development of technology, and we are now attempting to combine the functions of a natural brain with those of an artificial one.

DOI:10.46647/ijetms.2023.v07i01.040 ISSN: 2581-4621

Artificial intelligence is a brand-new field that was created as a result of this ongoing investigation. It is the method by which a person can create a machine with intelligence [3].
As demonstrated, among the many factors that affect productivity, crop diseases receive the majority of the credit. It demonstrates how early disease detection and identification is crucial for boosting business margins. Satellite farming, which supports the management of farm activities by going site-specific, is specifically related to precision farming. It is mostly built on using technology to track, gauge, and analyse crop productivity. It is regarded as one of the fundamental components of the contemporary agricultural revolution. By the end of 2050, the world's population may total 9.6 billion people. To feed every individual, this would necessitate double output. Precision agriculture is developing mostly in line with two themes, Big Data & advanced analytics and robotics, claims McKinsey. Aerial photography, sensor technology, and accurate local weather forecasts with GPS capabilities are all included [4].

3. Precision farming

Precision farming is more concerned with preserving environmental sustainability, industrial profitability, and machinery effectiveness. The farmers rotate their crops to increase crop health and variety, and they keep an eye on irrigation rates to prevent salt buildup from destroying their crops [17]. Additionally, adding fertilisers, water, seeds, and other agricultural inputs in order to grow a range of crops in various soil environments is a wonderful technique followed by the majority of farm managers. Additionally, it includes other components like computer-based applications, GPS soil sampling, variable rate technology (VRT), and remote sensing [5].
AI is a branch of computer science that can recognise its environment and should prosper to increase the likelihood of success. Work that is dependent on prior learning should be possible for AI. A few areas that improve machine work and aid in the development of more advanced technology are deep learning, CNN, ANN, and machine learning. It is explained that IOT refers to "thing to thing" communication [6].

4. Three important goals in farming

The three key goals are system cost reduction, automation, and communication. Medical science, education, finance, industry, security, and many more fields have all been affected by AI. AI implementation involves the machine learning process. This brings us to the "Machine learning" sub-section of this AI area. Machine learning serves the primary aim of providing the computer with historical data and statistical information so that it may carry out the work that has been set to it—solving a specific problem. Today's uses range from speech and face recognition to data analysis using historical data and experience. Numerous studies have looked into fruit localization and detection on trees using computer vision, and the majority of these works have been compiled in the review by Gongal et.al [7].
These techniques frequently employ cameras that are colour, spectral, or thermal. It is challenging to identify a fruit that is cast in shadow by another fruit when using a spectral camera. Based on the temperature difference between the fruit and the background, a thermal camera can identify fruit. The size of the fruit and its exposure to direct sunlight have an impact on this procedure. Fruit detection with a colour camera uses a variety of different features [16]. To segment an apple, Bulanon employed brightness and the RGB colour difference. analysed texture to find an apple. Linker combined a number of factors to increase the precision of fruit detecting techniques [9].
Using a colour camera, several image classification techniques for fruit detection can also be carried out. K-mean clustering was employed by Bulanon to detect apples. KNN clustering was used by Linker et al. and Cohen et al. to classify apples. Kurtulmus also classified apples using an artificial neural network [15]. For apple detection, Qiang employed a Support Vector Machine classification technique. However, because the colour information cannot be sufficiently collected, these approaches are challenging to employ in varying lighting circumstances. Fruit detection should be

carried out using several features, such as colour, shape, texture, and reflection, to improve accuracy and get around problems like clustering and fluctuating lighting [8].

5. Automated farming approaches

In order to carry out automatic fruit harvesting by a robot, the current study suggests "fruit detection and localization" and "fruit harvesting by a robot manipulator with a hand which is able to harvest without hurting the fruit and its tree." To determine the fruit's position in two dimensions (2D), we employed a colour camera and a Single Shot MultiBox Detector (SSD). The Convolution Neural Network (SSD) is one of the common object detection techniques (CNN). Te SSD can make accurate judgements based on colour and shape [14]. To give the robot arm a command, one must first establish a three-dimensional (3D) position. The fruit detected by the SSD is measured using a stereo camera in its three-dimensional (3D) position [10].

In order to determine the path taken by the robot arm, we used inverse kinematics. Based on inverse kinematics, we moved the robot arm to the position of the fruit. The harvesting robot's hand served as our end effector. By grasping and turning the fruit, the robot hand collects it without hurting the fruit or its tree. The UN Food and Agriculture Organization projects that by 2050, there will be a 2 billion rise in population. Only 4% more land will, however, be under cultivation by that time. Utilizing modern technical advancements to increase farming efficiency continues to be one of the most important requirements in this context [11]. While artificial intelligence (AI) has many practical applications in many other fields, it has the potential to fundamentally alter how we now view farming. AI-powered solutions will not only help farmers produce more with fewer resources, but they will also boost crop quality and assure a quicker time to market. The use of drone-based image processing techniques, the landscape of precision farming, the future of agriculture, and upcoming problems are all topics we'll cover in this essay [12].

6. Conclusions & Recommendations at the Next Steps

We are creating a prototype for a robot that will perform precision farming in this project report. In the final year of the 7th and 8th semesters of the UG-BE course, a synopsis of the project work that will be completed is presented. In this exciting field, a thorough literature review was conducted regarding the various algorithms that can be used for selective harvesting and segregation. During this time, all pertinent papers from various sources were gathered and studied in greater detail. A thorough analysis was then made, and the project problem was finally determined [13].

References

[1] Gert Kootstra & Xin Wang & Pieter M. Blok & Jochen Hemming& Eldert van Henten, Selective Harvesting Robotics: Current Research, Trends, and Future Directions, Published online: 29 January 2021, at Current Robotics Reports.

[2] Automated visual fruit detection for harvest estimation and robotic harvesting, December 2016, Conference: International Conference on Image Processing Theory, Tools and Applications (IPTA'16)

[3] Dr. S. Pariselvam , Mr. P.Anandajayam, Mrs. S. Kalaivani and Manakula Vinayagar, Detection of Fruit Quality by CNN Algorithm, Institute of technology Puducherry.

[4] Harpreet Kaur, Plant diseases detection based on Region based segmentation and KNN Classifier, January 2019, Chandigarh university

[5] Madhushree K V, Poornima G, Seema N, Subash K B, Srinath G M. Green leaf disease detection and infection identification using raspberry pi, International Research Journal of Engineering and Technology (IRJET)Volume: 07 Issue: 06 | June 2020

[6] Yesudas, Santhiya S, Parimala R., Mohammad Harris S., Leaf Disease Detection Using Raspberry Pi LAYA APR 2019, IRE Journals, CCCA – 2019, Volume 2 Issue 10, ISSN: 2456-8880

DOI:10.46647/ijetms.2023.v07i01.040 ISSN: 2581-4621

[7] Reddy, G. Rama Mohan, Nettam Sai Sumanth, and N. Sai Preetham Kumar Reddy, G. Rama Mohan, Nettam Sai Sumanth, and N. Sai Preetham Kumar., Plant leaf disease detection using cnn and raspberry pi. International journal, 5.2 (2020).

[8] Kanungo, Tapas, Campisi, T. Severino A, et.al., An efficient k-means clustering algorithm: Analysis and implementation, IEEE transactions on pattern analysis and machine intelligence, 24.7 (2002): 881-892.

[9] Dr. Pankaj Mohindru , Gagandeep Kaur , Dr. Pooja, Simulative Investigation of Plant Diseases using KNN Algorithm.

[10] Raju Anita, D Suresh, P Gnaneswar, M Puneeth., IoT Based Automatic Soil Moisture Monitoring System using Raspberry Pie.

[11] Yuki Onishi, Takeshi Yoshida, Hiroki Kurita, Takanori Fukao, Hiromu Arihara & Ayako Iwai, An automated fruit harvesting robot by using deep learning Nov 2021.

[12] Autobot for precision farming by Mohammed Abu, Basim, Abhishek Hariharan G, Deva Dharshini U., 2021 International Conference ICEEIMT, Multi-Tasking Agricultural Robot, International Journal of Research in Engineering, Science and Management Volume-3, Issue-1, January-2020

[13] Yan Dutta, Swapnoneel Roy, Patrick Kreidl, Ladislau Boloni, Multi-Robot Information Gathering for Precision Agriculture Smart Phone Operated Multipurpose-Agricultural Robot International Journal of Engineering Research & Technology (IJERT).

[14] Devaraj, Abirami, et.al., Identification of plant disease using image processing technique, 2019 International Conference on Communication and Signal Processing (ICCSP). IEEE, 2019.

[15] Adithya T. G., Pavithra G., T. C. Manjunath, Praveen N., “Stewart Platform Conceptualized Robotic Type of Designs for Aerospace Applications”, Journal of Remote Sensing GIS & Technology, Vol. 8, No. 1, pp. 1-5, 2022.

[16] T.C. Manjunath, Pavithra G., Ravi Rayappa, Rajasekhar Koyyeda, Satvik M. Kusagur, Praveen N., Gopalaiah Gopalaiah, Arun Kumar G., Spoorthi Jainar, “Safety Features Design During the Installation of Fixed Robots in Industrial Sectors Using Image Processing”, MAT Journals, Journal of Analog and Digital Devices, Vol. 5, No. 3, pp. 13-15, 2020.

[17] Spoorthi Jainer T.C Manjunath, Pavithra G, Ravi Rayappa, Rajasekar Koyyeda. Satvik M Kusagur, Praveen N, Gopalaiah, Arun Kumar G, “Transfer Function Based Controller Design for a Mobile Robot Using Image Processing and Computer Vision”, Journal of control system and control instrumentation, Vol. 6, No. 3, pp. 10-12, 2020.

[18] Praveen N., T.C. Manjunath, Pavithra G., Ravi Rayappa, Rajasekhar Koyyeda, Satvik M. Kusagur, “Medical Robots & its Applications in the Current Health Sector”, Journal of Analog and Digital Devices, Vol. 5, No. 3, pp. 1-6, 2020.

[19] Muniyandy Elangovan; Mohamed Yousuf; Mohamed Nauman; Mohammed Nayeem. "Design and Development of Delivery Robot for Commercial Purpose". International Research Journal on Advanced Science Hub, 4, 07, 2022, 192-197. doi: 10.47392/irjash.2022.047

[20] Muniyandy Elangovan; Mohammed Nayeem; Mohamed Yousuf; Mohamed Nauman. "Energy opportunities for delivery robot during Disaster". International Research Journal on Advanced Science Hub, 4, 06, 2022, 180-185. doi: 10.47392/irjash.2022.043

[21] Karthikeyan A.G.; Kishan K; Pattabiraman M; Prathiv S. "Medical Assistive Robot (MAR)". International Research Journal on Advanced Science Hub, 2, Special Issue ICAMET 10S, 2020, 71-75. doi: 10.47392/irjash.2020.201

[22] Ramanathan S; Akash V; Arun Prasad R; Venkat Rahul M. "Pick and Place Robot for Surface Mounting Devices". International Research Journal on Advanced Science Hub, 2, 8, 2020, 75-81. doi: 10.47392/irjash.2020.97

[23] Gayathri N Shenoy; Chithu Rajan; Shibi Varghese; Vignesh M.V; ShanmugaPriya M; Priya S; Aparna George. "STERILOID: Room Sanitization Robot". International Research Journal on Advanced Science Hub, 2, 8, 2020, 100-104. doi: 10.47392/irjash.2020.101

[24] R. Devi Priya, R. Sivaraj, Ajith Abraham, T. Pravin, P. Sivasankar and N. Anitha. "Multi-Objective Particle Swarm Optimization Based Preprocessing of Multi-Class Extremely Imbalanced Datasets". International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems Vol. 30, No. 05, pp. 735-755 (2022). Doi: 10.1142/S0218488522500209
[25] Deshmukh K P. "Wireless Transceiver Module HC-12 based Automatic Water-level Monitoring and Control System". International Research Journal on Advanced Science Hub, 2, 10, 2020, 24-28. doi: 10.47392/irjash.2020.184
[26] Naveenkumar S; Kirubhakaran R; Jeeva G; Shobana M; Sangeetha K. "Smart Health Prediction Using Machine Learning". International Research Journal on Advanced Science Hub, 3, Special Issue ICARD-2021 3S, 2021, 124-128. doi: 10.47392/irjash.2021.079
[27] Hari Prasada Raju Kunadharaju; Sandhya N.; Raghav Mehra. "Detection of Brain Tumor Using Unsupervised Enhanced K-Means, PCA and Supervised SVM Machine Learning Algorithms". International Research Journal on Advanced Science Hub, 2, Special Issue ICSTM 12S, 2020, 62-67. doi: 10.47392/irjash.2020.262
[28] Sona Solanki; Asha D Solanki. "Review of Deployment of Machine Learning in Blockchain Methodology". International Research Journal on Advanced Science Hub, 2, 9, 2020, 14-20. doi: 10.47392/irjash.2020.141
[29] Shreekar Kolanu; Shikhar Jyoti Dutta; Saurav Roy; Maheswari M.. "A Diabetic Diet Suggester and Appointment Scheduler Chatbot using Artificial Intelligence and Cloud". International Research Journal on Advanced Science Hub, 3, Special Issue 6S, 2021, 77-81. doi: 10.47392/irjash.2021.170
[30] Praveen Kumar Mishra; Prabhakar Tiwari. "Cyber Security in Smart Grid". International Research Journal on Advanced Science Hub, 2, 6, 2020, 26-30. doi: 10.47392/irjash.2020.33
[31] Salini Suresh; Suneetha V; Niharika Sinha; Sabyasachi Prusty. "Latent Approach in Entertainment Industry Using Machine Learning". International Research Journal on Advanced Science Hub, 2, Special Issue ICARD 2020, 2020, 304-307. doi: 10.47392/irjash.2020.106
[32] Gayathri N Shenoy; Chithu Rajan; Shibi Varghese; Vignesh M.V; ShanmugaPriya M; Priya S; Aparna George. "STERILOID: Room Sanitization Robot". International Research Journal on Advanced Science Hub, 2, 8, 2020, 100-104. doi: 10.47392/irjash.2020.101
[33] Mohan Kumar B.N; Rangaraju H.G. "Array Multiplier and CIA based FIR Filter for DSP applications". International Research Journal on Advanced Science Hub, 3, Special Issue ICEST 1S, 2021, 52-59. doi: 10.47392/irjash.2021.020