IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

FEASIBILITY OF WEED CONTROL THROUGH DRONE AUTOMATION USING DEEP LEARNING TECHNIQUES.

V. Ruthwika, B. Usha Sri, Dr. S. Uday Bhasker

G. NARAYANAMMA INSTITUTE OF TECHNOLOGY AND SCIENCES, for women, Shaikpet Rd, Ambedkar Nagar, Shaikpet, Hyderabad, Telangana 500104, India

ABSTRACT:

This work presents one of the applications of Industry 4.0 in Weed Detection using Deep Learning, a branch of Artificial Intelligence that deals with Image Processing to distinguish weeds from plants and RFID Controller to pinpoint laser to the spot. The objective of this paper is to control weed growth through the use of WELASER, a project that aids in weed removal. The specified region of interest is controlled by a drone carriable laser that behaves as an Automated Guided Vehicle (AGV), an essential component in Industry 4.0 that is developed using technological advancements. These AGV's work without human intervention and hence decrease manual labor. Camera sensors are utilized to capture image using Deep Learning Techniques. With the above concepts, the problem of Weed growth is tackled to a greater extent in affordable conditions.

KEY WORDS:

Deep Learning; RFID Controller; AGV; We-Laser; Drones.

INTRODUCTION:

AUTOMATED GUIDED VEHICLES:

AGV'S are the most important component in the applied areas of Industry 4.0.

Technologies such as AGV's are used for the improvement of internal logistics, computer vision for the detection of defective ones. Affording nestled comfortably among physical machines, software and intelligence documents, advanced smart sensing, it helps to examine this one aspect in isolation. AGVs are computer-operated vehicles, that are used for material handling. The vehicles are equipped with automatic navigation, multi-sensor control and network interaction. AGVs represent the factory-floor workhorse of the new industry.

Their role is crucial to keep the lines supplied with raw materials.

Leading players in the market for AGVs are Toyota Industries, Hyster-Yale Materials Handling, E&K Automation GmbH, Dematic

AGV's are very flexible equipment that facilitates the internal transport of elements which have many advantages such as traceability, security and flow automation. AGVs have become ad-hoc for different functions and applications in sectors such as **agriculture and livestock.**

The agrifood sector is beginning to use technologies such as spectral cameras such as KODAK, Cineagon for the detection of stones or plastics when the triage of fruits or vegetables is performed.

TYPES OF AGV's

1.Philo guided: This AGV guided by a conductive thread installed under the floor, which is accessed through small slots where a rod connected to the vehicle is inserted.

- This guidance method is very simple but it has the least flexibility, since the AGV's movement paths are limited to the paths previously set during installation.

2.Opto guided: This AGV guided by a mirror strip that extends through the AGV routes. The installation of these mirror guides does not require work as in the case of the wire guide, and the modification or creation of new routes is less complex.

3.Laser guided: This AGV is equipped with one or more laser units that scan to identify the largest possible number of reflectors in its environment to determine its position on the map of the installation that it has in memory.

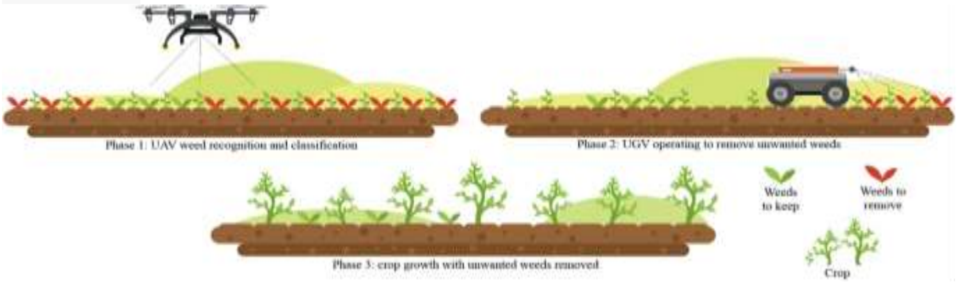
- Catadioptric mirrors are placed in a vertical position at strategic points throughout the installation. These mirrors will be reference points to calculate the position of the AGV, in the same way as **Optoguidance**.

4. **3D Mapping**: This technology does not require the installation of any external element to the AGV, since, through sensors such as: cameras, LIDAR, ultrasound, they are capable of creating a virtual map of the environment in which they are working. It is the most flexible and adaptive system.

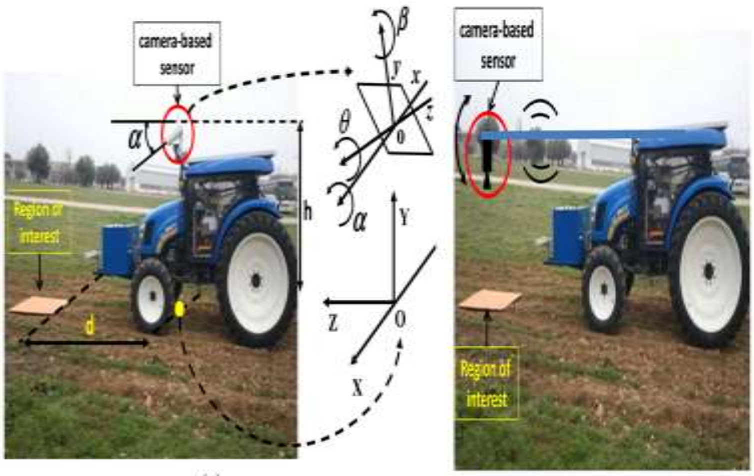
The Laser Guided Vehicle is an AGV that navigates with a laser positioning system. One such laser is WE-LASER.

It is an Eco-innovative weeding technique using laser in agriculture. The main objective of We-LASER is to develop a technological solution t**o end chemical treatments in the weed management.** Laser technology, and artificial intelligence are used to develop high-precision technology that could help farmers increase agricultural produce, while minimizing the use of labor and chemicals. This method not only enhances agricultural productivity but also safeguards the health of humans, animals, and other beneficial organisms.

Laser beams are based on electricity, which can be produced from non-fossil fuels. Based on the targeted nature of laser beams, the area exposed for weed control can be reduced substantially compared to commonly used weed control methods. The risk of affecting non-target organisms is minimized, and the soil will be kept untouched in the field, avoiding triggering weed seeds to germinate. **Recognition tools based on artificial intelligence make it possible to distinguish weeds from crop plants in agricultural environments in real-time**. Weeds can be detected using high resolution spectral cameras while positioning can be guided by precise laser scanners.



DRONE AUTOMATION Integrated Weed Management coupled with the use of **Unmanned Aerial Vehicles** (drones), allows for Site-Specific Weed Management, which is a highly efficient methodology as well as beneficial to the environment. The identification of weed patches in a cultivated field can be achieved by combining image acquisition by drones and further processing by machine learning techniques.



(a) (b)

The camera-based sensor consists of three main parts, namely: (a) CCD device; (b) optical lens and (c) ultraviolet and infrared cut filters for controlling the input of only those wavelengths of interest.

(a) (b)

The **CCD** is a **Kodak KAI 04050M/C** sensor with a **Bayer color cut filter-Schneider UV/IR with GR pattern**; resolution of 2,336 × 1,752 pixels and 5.5 × 5.5 µm pixel-size. It offers several externally controlled possibilities: (a) Exposure time, which determines the time taken to capture the image. (b) Red, Green and Blue gains, where a value can be set for each channel, including gains auto-calculation. (c) Definition of specific Regions Of Interest (ROIs).(d) Information about the operating temperature.

The **optical system** consists of a Schneider Cinegon 1.9/10-0901 lens, with manual iris aperture (f-stop) ranging from 1.9 to 16 and manual lockable focus, providing high stability in the agricultural environment. It is valid for sensor formats up to a diagonal value of 1″, i.e., maximum image circle of 16 mm, and is equipped with an F-mount which can be adapted to C-mount. Its spectral range varies from 400 to 1,000 nm, i.e., visible and near-infrared (NIR).

The sensor is highly sensitive to NIR radiation and to a lesser extent to ultra-violet (UV) radiation. The NIR heavily contaminates the three spectral channels (Red, Green and Blue) producing images with hot colors. This makes identification of crop lines and weeds unfeasible because during the treatments these structures are basically green. To avoid this undesired effect, the system is equipped with a Schneider UV/IR 486 cut-off filter. Its operating curve specifies that wavelengths below 370 nm and above 760 nm are blocked, i.e., both UV and NIR radiation.

CD RW drives used for cut and burn technique:

In a CD reader, the source of light is a semiconductor laser at a fixed wavelength of 780 nm which is in the infrared and not visible to the human eye; you can't see the CD player's laser shining on the CD with your naked eye.

Lasers in these drives tend to have a pulse output of about 100 - 250mW and continuous power 50 - 125mW and work in the infrared range at a wavelength of 780nm. Average operating current is about 100 to 150 mA, pulse up to 200mA.

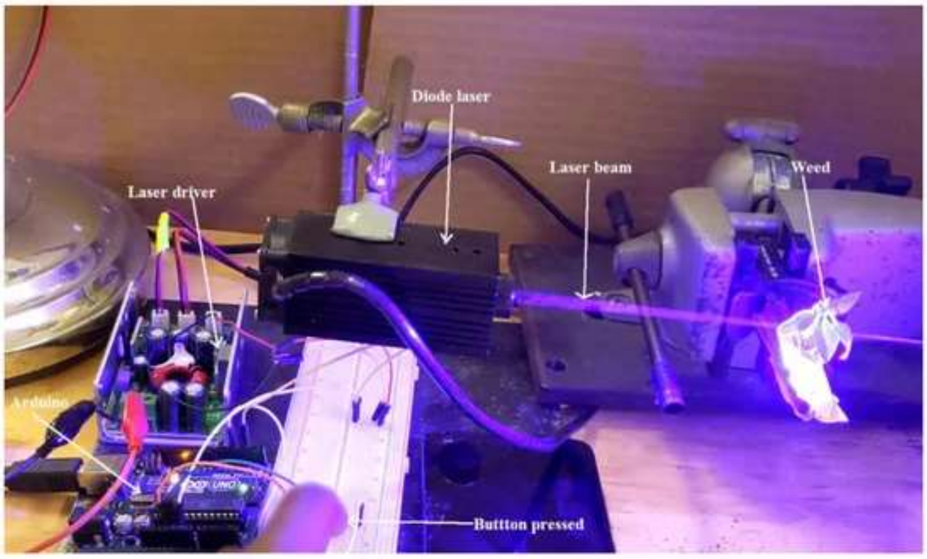
There are two lenses: The first transforms the divergent diode light into an parallel beam, the second focuses it to a near point.

Laser diode must be placed exactly on the axis of the lens, otherwise you cannot focus the beam. The laser diode should never be turned on if it is not placed in a sufficiently large metal cover.

In DVD-RW drives there are 2 burning laser diodes: red for burning of DVD and infrared for burning of CD. The DVD-ROM drives (reading only) can offer you a weak red diode like 1mW. They are good only to produce pointers or very faint laser-light show. They won't burn or cut anything.

Power required to kill weeds: It was found that weed management is possible by exposing the stem of the two weed species between 0.8 and 2.65 mm diameter to a laser beam dosage without necessarily severing it, with 80% effectiveness at 0.5 s treatment time, and 100% effectiveness using a 6.1 W laser for 1.5 s.

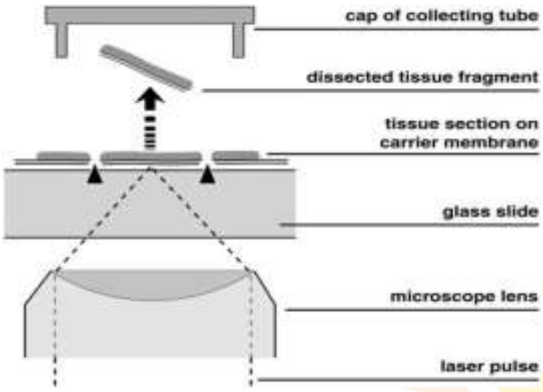
LASER SET UP:



For the laser diodes to be effective on a weeding robot in the field, the treatment time needs to be as short as possible.

Batteries used for drones: Batteries rated for 101 to 160 watt hours are utilised. Larger and higher capacity drone batteries have a few more restrictions, but they can still be carried on a plane with airline approval. Batteries installed in a drone are acceptable as well as up to two spare batteries in your carry-on. RFID devices are utilised to control the laser pinpointing phenomenon which is drone carriable.

DEEP LEARNING TECHNIQUES



- The rise of deep learning (DL), a subfield of Machine learning (ML) and artificial intelligence (AI), is a giant leap towards revolutionizing automation in precision agriculture and transforming weed detection for site specific weed management (SSWM).
- DL techniques have been integrated with ground as well as aerial-based technologies to identify weeds in still image context and real-time setting. DL has contributed significantly in precision agriculture domains involving, disease detection, crop plant detection, crop row detection, crop stress detection, fruit detection, freshness grading, fruit harvesting, and site-specific weed management (SSWM)

SSWM

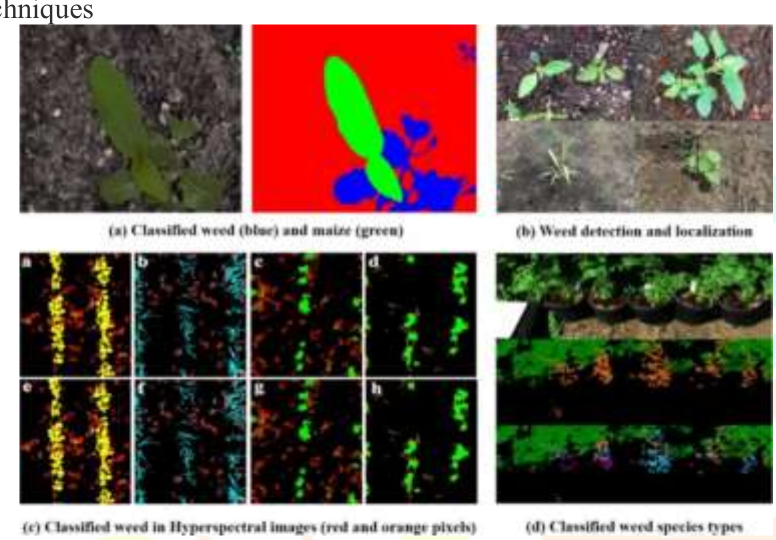
SSWM is a procedure that requires varying weed management practices adjusted according to weed location, density, and population. These practices are accomplished using **variable rate technology (VRT)** that sprays herbicide in real-time as decided by the central brain of the machine, the vision-based image processing algorithm

Variable rate technology includes two kinds of approaches such as Map based and Sensor based:

- Map-based is an approach in which the map of an area is generated based on the georeferenced samples of soil or plants.
- Since this process involves manual soil sample collection for further analysis, therefore it is an expensive and time-taking process.
- **Sensor-based mapping is a faster process** that involves data collection and processing on-the go. All the processing is accomplished in real-time by leveraging the application of ML or DL techniques during in-field motion of ground or aerial technologies.
- Morphological features were based on shape measurements and descriptions such as, area, diameter, perimeter, and convexity
- Textural characteristics included the arrangement of gray level pixels in specified area of a digital image. These characteristics were estimated based on the statistical and structural features defined using regularity, roughness, closeness, uniformity, or entropy
- Integrating DL techniques enhances the advanced algorithms to classify weeds from crop plants in real-time. This is a crucial step as in-field weeding machines decide their spraying pattern based on these algorithms.
- Developing such algorithms is a challenging task while classifying similar weed species that share similar colour or shape properties as a crop plants in early growth stages. weed classification becomes more challenging in an extensive and complex background with a wide field of view.
- **The neural networks (NNs) in DL** transforms the digital image into hierarchical levels of representations with each hierarchy carrying more specific information about the image than the previous ones which makes DL special and better than conventional ML techniques (or shallow learning) tends to use only one or two layers of representations of the input data that is manually engineered, called, feature engineering.

- **DL or layered representation learning** uses a very complex network structure that automates the process of learning all the features from an input image. Unlike ML, DL automatically extracts local as well as global features from these layers of representations jointly rather than in succession.
- The key reason why industries and university researchers are adopting this approach is because DL has the ability to sift through unstructured and large-scale data which is usually in the form of audios, videos and images where the DL algorithm performs classification and detection tasks on similar distribution Plethora of open-source application programming interfaces such as, Keras TensorFlow and PyTorch , could be credited to train a DL model in few hours depending on the size of the data with adequate computational power.

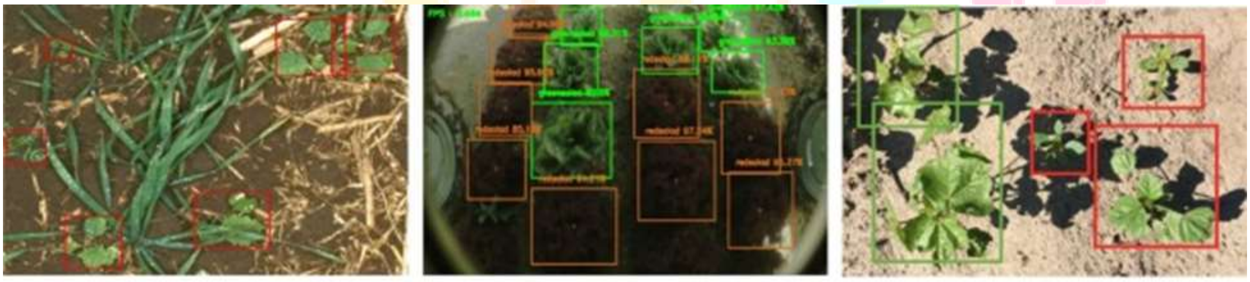
Proximal sensing refers to the use of sensors that are employed close to an object. These sensors generally take time for image acquisition as they are scanned through an object delivering information in multiple bands. After image acquisition step, the output is processed for human interpretation either on high-end computers or edge platforms using DL techniques



- UNMANNED WEEDING ROBOTS
- Unmanned weeding robots (UWRs) for real-time weed detection

In-field weeding operation demands two crucial steps, (1) identifying weeds amongst crop plants with high accuracy, and, (2) accurately localizing weeds for weeding operation. Some of the weeding robots are listed below:

A further advancement on the application of DL on these systems is driven by research that uses resource-constrained edge computers for on-the-go processing and decision making. Currently, many industries and university-based research are inclined towards the use of small palm-sized edge GPUs that demands less power and low latency to handle real-time weed detection.



a) Weed detection (Agrointelli) b) Weed detection in vegetable crops c) See and Spray

Remote sensing-based weed detection

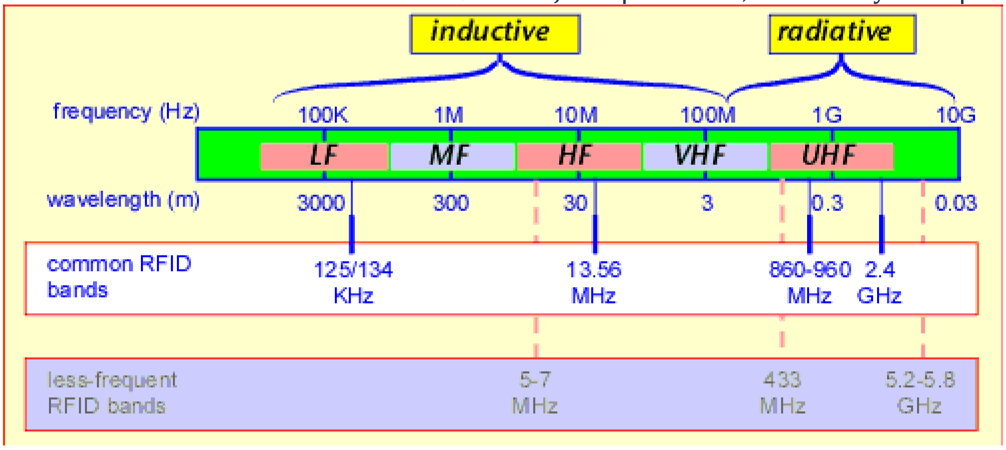
Remote sensing is an indirect data acquisition process followed by data manipulation operation such as, pixel transformation or pixel clustering to convert the images into a human-readable format. Different categories of sensors used in this process include RGB camera mounted on a gimble attached with a DJI Phantom 4 Pro, 10-band multispectral sensor by Micasense (RedEdge MX), and Headwall's Nano Hyperspec (Headwall)

a) DJI Phantom 4 Pro b) Multispectral sensor on M600 c) Headwall's Nano Hyperspec®

RFID devices

RFID can involve inductive loops or actual RF transmission. There are many frequencies used to from 100KHz up to GHz. With amplitude modulation, several 0s or 1s would be at steady state which would be difficult to detect as the coupling in the detector and amplifier is AC, so each bit is usually split into two, a low state and a high state.

RFID controllers are simple and easy to use RFID technology-based hardware component that efficiently reads radio-frequency identification (RFID) tags, which enables to open door locks, it can similarly be used to spot weeds using laser. **The devices offer excellent transmission performance to utilize them for access control applications**.



An RFID system consists a set of emitters or tags periodically or upon interrogation, transmit a short digital radiofrequency message containing an identification code, which could be weed spots as well. These data can be obtained remotely by a computer equipped **(AI based image processing using DL techniques by a laser)** with an RFID reader. The RFID reader measures the received signal strength (RSSI) of the RF signal, which is an indicator of the range from tag to reader.

The main advantage of RFID systems—with respect to other RF technologies, which could be used for infrastructure-to-vehicle (I2V) communications—is its low cost and minimum infrastructure maintenance, which results in a high scalability and easy deployment of the infrastructure.

CONCLUSION

The gift of technology to mankind is immense which makes life simpler and more comfortable. In our work, a drone carriable laser is designed and presented that uses KODAK spectral camera with CCD device, UV/IR cut filter which is implemented to **Site Specified Weed Management.** Through DL techniques, specified region of search is allotted to drone which pinpoints the laser to weeds. This method is affordable and environment friendly since it uses lightweight drone that is controllable- without human intervention, hence its role is vital in applied areas of Industry 4.0.

REFERENCES:

- **https://agritech.tnau.ac.in/pdf/5.pdf**
- **https://danyk.cz/laser_en.html**
- **https://www.mdpi.com/2072-4292/13/21/4486**
- **https://www.frontiersin.org/articles/10.3389/fagro.2019.00003/full**
- **https://www.mdpi.com/2624-7402/5/1/17**
- **Albanese et al., 2021, Yang and Xu, 2021, Jiang and Li, 2020). (Chowdhury et al., 2021, Liu and Wang, 2021), (David et al., 2021, Rai and Flores, 2021)**
- **(Bah et al., 2019, Pang et al., 2020), (Gao et al., 2020b, Butte et al., 2021) (Ismail and Malik, 2021, Sa et al., 2016).**
- **(Onishi et al., 2019),(Fernández-Quintanilla et al., 2018, Liu et al., 2021). (Sermanet et al., 2014),(Berge et al., 2012)**