

**FORM 2**

THE PATENTS ACT, 1970

(39 of 1970)

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The Patent Rules, 2003

**COMPLETE SPECIFICATION**

(See section 10 and rule 13)

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**TITLE OF THE INVENTION**

“A LI-FI ENABLED MACHINE LEARNING BASED CROP RECOMMENDER  
SYSTEM AND WORKING METHOD THEREOF”

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The following specification particularly describes the nature of the invention and the

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manner in which it is performed:

## **FIELD OF THE INVENTION**

**[001]** The present invention relates to the field of the Li-Fi implementation in combination with the Artificial Intelligence and Machine Learning based smart agriculture. It is an advanced system for agricultural crop recommender with novel techniques, methods, devices and apparatus. The invention more particularly relates to Li-Fi and machine learning based crop recommender system and working method thereof.

## **BACKGROUND OF THE INVENTION**

**[002]** The following description provides the information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

**[003]** Further, the approaches described in this section are approaches that could be pursued, but not necessarily approaches that have been previously conceived or pursued. Therefore, unless otherwise indicated, it should not be assumed that any of the approaches described in this section qualify as prior art merely by virtue of their inclusion in this section.

**[004]** The rapid advancements in communication technologies, coupled with the growing demand for precision agriculture, have paved the way for innovative solutions to address agricultural productivity and sustainability. This paper introduces a novel Li-Fi (Light Fidelity) based intelligent crop recommender system, that incorporates sensor technology and a knowledge-based inference engine to guide farmers towards most appropriate crop to be sowed for optimal yield.

5 [005] In recent years, the concept of precision agriculture has been gaining significant attention, promising enhancements in productivity and sustainability in farming. The integration of Li-Fi communication technology and artificial intelligence (AI) components in an inference engine, provides an effective platform for managing and interpreting complex farming data. The system comprises a Li-Fi receiver and transmission unit, a multitude of sensors, and a processing unit incorporating a fuzzification module, inference engine, knowledge base and defuzzification module.

10 [006] Accordingly, on the basis of aforesaid facts, there remains a need in the prior art to provide a Li-Fi and identification and deployment of machine learning based intelligent crop recommender system and working method thereof. Therefore, it would be useful and desirable to have a system, method, apparatus and interfaces to meet the above-mentioned needs.

### **SUMMARY OF THE PRESENT INVENTION**

15 [007] In view of the foregoing disadvantages inherent in the known types of conventional agricultural crop recommender systems, methods and techniques, are now present in the prior art, the present invention provides a Li-Fi and machine learning based crop recommender system and working method thereof, which has all the advantages of the prior art and none of the disadvantages.

20 [008] It is an object of the present invention, wherein the system primarily consists of three housing units. The first housing accommodates the Li-Fi transmission unit and the sensor array, which captures values of potassium, nitrogen, phosphorous, temperature, humidity, pH, rainfall, and other relevant data. The second housing contains the Li-Fi receiver, along with a USB to TTL

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converter unit. The third housing encompasses a processing/computing unit with fuzzy logic based decision support system, which could be a PC itself with appropriate input and display units to facilitate easy interpretation of the system's recommendations.

5       **[009]** Furthermore, the system functions by sending inputs from the various sensors through the Li-Fi transmission unit to the Li-Fi receiver. A USB to TTL converter unit in the second housing facilitates communication between the receiver and the processing unit. The processing unit employs a fuzzification module, transforming the crisp input data into fuzzy values to handle  
10       uncertainties and vagueness typically associated with environmental and soil data. A knowledge-based inference engine processes these fuzzy inputs according to knowledge extracted from training data, enabling the system to make appropriate crop recommendations.

15       **[010]** Li-Fi is a wireless communication technology which uses light to transmit data and position between devices. This technology can provide several benefits including higher speeds, improved security, and better reliability, especially in areas where interference is an issue. The Li-Fi receiver and transmitter in this invention serve as the communication bridge between the sensor units and the processing unit. The receiver and transmitter are  
20       comprised of multiple components such as a signal amplifier, level shifters/light modulators, light sources and light detectors to handle the communication process.

25       **[011]** Sensor technology plays a crucial role in collecting the environmental and soil data required for the inference engine to provide accurate crop recommendations. These sensors measure various variables including

temperature, humidity, pH, rainfall, and the amounts of potassium, nitrogen, and phosphorus in the soil. The precise and accurate data from these sensors can greatly enhance the prediction and recommendation ability of the model.

**[012]** The AI-based inference engine, with its fuzzification and defuzzification modules, lies at the heart of this system. Fuzzification is the process of transforming a crisp input value into a fuzzy value based on predefined membership functions. Defuzzification, on the other hand, is the process of converting a fuzzy output into a crisp value. The system uses these techniques to handle the uncertainty and vagueness that typically come with environmental and soil data.

**[013]** The inference engine processes the fuzzy inputs in accordance with the knowledge extracted from training data that is embedded into the inference unit. This knowledge, coupled with an evolved model structure, forms the basis for the system's crop recommendations. The evolved model and generated knowledge are then embodied into a programmable hardware system as a processing unit.

**[014]** In the context of agriculture, this system can provide valuable guidance to farmers by recommending the most suitable crops based on the current and predicted conditions. The system's display unit provides an easily interpretable representation of the system's recommendations. Simple textual display allows farmers to quickly understand and implement the system's recommendations.

**[015]** In this respect, before explaining at least one object of the invention in detail, it is to be understood that the invention is not limited in its application to the details of set of rules and to the arrangements of the various models set

forth in the following description or illustrated in the drawings. The invention is capable of other objects and of being practiced and carried out in various ways, according to the need of that industry. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting.

[016] These together with other objects of the invention, along with the various features of novelty which characterize the invention, are pointed out with particularity in the disclosure. For a better understanding of the invention, its operational advantages and the specific objects attained by its uses, reference should be made to the accompanying drawings and descriptive matter in which there are illustrated preferred embodiments of the invention.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

[017] When considering the following thorough explanation of the present invention, it will be easier to understand it and other objects than those mentioned above will become evident. Such description refers to the illustrations in the annex, wherein:

[018] **FIG. 1-2**, illustrate a Li-Fi and machine learning based crop recommender system and working method thereof, in accordance with an embodiment of the present invention.

#### **DETAILED DESCRIPTION OF THE INVENTION**

[019] The following sections of this article will provide various embodiments of the current invention with references to the accompanying drawings, whereby the reference numbers utilised in the figures correspond to like elements throughout the description. However, this invention is not limited to the embodiment described here and may be embodied in several other ways.

Instead, the embodiment is included to ensure that this disclosure is extensive and complete and that individuals of ordinary skill in the art are properly informed of the extent of the invention. Numerical values and ranges are given for many parts of the implementations discussed in the following thorough discussion. These numbers and ranges are merely to be used as examples and are not meant to restrict the claim's applicability. A variety of materials are also recognised as fitting for certain aspects of the implementations. These materials should only be used as examples and are not meant to restrict the application of the innovation.

**[020]** Referring now to the drawings, these are illustrated in FIG. 1 & 2, the present invention discloses a Li-Fi and machine learning based crop recommender system and working method thereof. The system is comprised of, but not limited to, a Li-Fi receiver with a receiving control unit connected to a processing unit capable of evolving and implementing a fuzzy logic based machine learning model; a Li-Fi transmission unit with a transmission side control unit connected to the Li-Fi receiver, for sending inputs from the plurality of sensors; wherein the Li-Fi transmission unit with the transmission side control unit and the plurality of sensors are placed in the first housing; wherein the Li-Fi receiver with a receiving side control unit and a USB to TTL converter unit are configured to be placed in the second housing; and wherein the second housing is connected to a third housing, which is a system for identification and deployment of fuzzy logic based intelligent inference system to make suitable decisions for the suitable crop to be sowed for optimal yield.

**[021]** In accordance with another embodiment of the present invention, the inference engine which is a part of fuzzy logic-based system is configured to

process the input received from its fuzzification module in accordance with knowledge extracted from training data and embedded into the fuzzy logic-based system. The evolved model structure and extracted knowledge corresponding to the training data is then embodied into a programmable hardware system as a processing unit. This processing unit could be a Personal Computer.

**[022]** In accordance with another embodiment of the present invention, the system is configured for recommendation/prediction of at least one crop based on the sensor inputs and the embedded knowledge of the prediction/recommendation model, wherein the prediction/recommendation model structure is evolved from a training data set, wherein each training example consists of a set of inputs and one or more outputs.

**[023]** In accordance with another embodiment of the present invention, the display of the processing unit is configured to describe and confirm the particular crop, which is recommended by the system. The plurality of inputs includes values of potassium, nitrogen, phosphorous, temperature, humidity, pH, rainfall and the like as sensed by sensor unit(s) from the soil, environment or the historic data input.

**[024]** In accordance with another embodiment of the present invention, the Li-Fi transmission unit is further comprised of a Signal Amplifier, Level Shifters/light Modulators, and at least one single Light Source. The Li-Fi receiver is further comprised of an optical / photo sensor, IR photodiodes, a Signal Conditioning & Amplification, and a transimpedance amplifier.

**[025]** The above-mentioned invention is provided with the preciseness in its real-world applications to provide a machine learning based crop

recommender system and working method thereof. Further, the prediction/recommendation model structure, evolved from a training dataset, which consisted of sets of inputs and one or more outputs. The evolved model and the knowledge corresponding to the training input were embodied into a programmable hardware system as a processing unit. The system's fuzzy logic based inference engine predicts and recommends suitable crops based on the embedded knowledge and the prediction/recommendation model. Based upon the prediction made by inference system, display unit displays the recommended crop.

**[026]** The proposed Li-Fi based crop recommender system exemplifies an effective integration of communication technology, AI, and sensor technology. It holds the potential to significantly enhance decision-making processes in farming, leading to improved agricultural productivity and sustainability.

**[027]** It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-discussed embodiments may be used in combination with each other. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description.

**[028]** The benefits and advantages that the present invention may offer have been discussed above with reference to particular embodiments. These benefits and advantages are not to be interpreted as critical, necessary, or essential features of any or all of the embodiments, nor are they to be read as any elements or constraints that might contribute to their occurring or becoming more evident.

**[029]** Although specific embodiments have been used to describe the current invention, it should be recognized that these embodiments are merely illustrative and that the invention is not limited to them. The aforementioned embodiments are open to numerous alterations, additions, and improvements.

5 These adaptations, changes, additions, and enhancements are considered to be within the purview of the invention.

**We Claim:**

1. An Li-Fi based crop recommender system, comprising:

a Li-Fi receiver with a receiving control unit connected to a processing unit with an intelligent fuzzy logic based machine learning model, for receiving a plurality of inputs from a plurality of sensors;

a Li-Fi transmission unit with a transmission control unit connected to the Li-Fi receiver, for sending inputs from the plurality of sensors;

wherein the Li-Fi transmission unit with the transmission control unit and the plurality of sensors are placed in a first housing;

wherein the Li-Fi receiver with a receiving control unit and a USB to TTL converter unit are configured to be place in a second housing; and

wherein the second housing is connected to a third housing, which is a processing system containing fuzzy logic based machine learning model as processing module, the unit also provides a suitable display unit for displaying its recommendations.

2. The system as claimed in claim 1, wherein the machine learning model is configured to process the input received from the receiver unit in accordance with knowledge extracted from training data and embedded into the machine learning model.

3. The system as claimed in claim 1, wherein the evolved model structure and generated knowledge corresponding to the training input is then embodied into a programmable hardware system as a processing unit.
4. The system as claimed in claim 1, wherein the system is configured for recommendation/prediction for at least one crop based on the embedded knowledge and a prediction/recommendation model, wherein the prediction/recommendation model structure is evolved from a training data set, wherein each training example consists of a set of inputs and one or more outputs.
5. The system as claimed in claim 1, wherein display unit is configured to describe and confirm the particular crop, which is recommended by the system.
6. The system as claimed in claim 1, wherein the plurality of inputs includes values of potassium, nitrogen, phosphorous, temperature, humidity, pH, rainfall and the like as sensed by sensor unit(s) from the soil, environment or the historic data input.
7. The system as claimed in claim 1, wherein the Li-Fi transmission unit is further comprised of a Signal Amplifier, Level Shifters/ light Modulators, and at least one single Light Source.

8. The system as claimed in claim 1, wherein the Li-Fi receiver is further comprised of an optical / photo sensor / IR photodiode, a Signal Conditioning & Amplification, and a transimpedance amplifier.

5 9. wherein the Li-Fi transmission unit is further comprised of a Signal Amplifier, Level Shifters/ light Modulators, and at least one single Light Source.

**Dated this 05<sup>th</sup> day of September 2023**



**Signature of Applicant**

**Applicant:** Prof. (Dr.) Shakti Kumar

## ABSTRACT

### A LI-FI ENABLED MACHINE LEARNING BASED CROP RECOMMENDER SYSTEM AND WORKING METHOD THEREOF

**[030]** The present invention discloses a Li-Fi based crop recommender system and  
5 working method thereof. The system consists of a Li-Fi receiver and transmission unit,  
a multitude of sensors, and a processing unit with a fuzzy logic based machine learning  
model, all housed separately but connected. The sensors gather agricultural data such  
as potassium, nitrogen, phosphorous, temperature, humidity, pH, and rainfall levels,  
which is transmitted using Li-Fi technology. The processing unit contains a fuzzy logic  
10 based machine learning model. This intelligent model uses knowledge derived from  
the training data to process inputs received from the receiver unit through its  
fuzzification module. The processed information is then converted into actionable  
knowledge and is displayed on its display. The outcome of this process is used by a  
crop recommendation or prediction model. The model structure and knowledge are  
15 evolved from a training data set, which consists of a set of inputs and one or more  
outputs. The recommendation or prediction made by the system is visualized on a  
display.

Accompanied Drawing **[FIG. 1-2]**

**Dated this 05<sup>th</sup> day of September 2023**

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