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विषय: एकस्व अधिनियम, 1970 की धारा 12 व 13 तथा एकस्व नियम, 2003 के अधीन परीक्षण रिपोर्ट
Subject: Examination report under sections 12 & 13 of the Patents Act, 1970 and the Patents Rules, 2003.

1. उपर्युक्त आवेदन के संदर्भ मे परीक्षण रिपोर्ट (अर्थात, एकस्व नियम, 2003 (यथा संशोधित) के नियम 24-ख(3) में विनिर्दिष्ट आपत्तियों का प्रथम कथन) इसके साथ संलग्न है। यह रिपोर्ट परीक्षण हेतु अनुरोध दिनांक 08/02/2022 के उत्तर मे जारी की गयी है। परीक्षण रिपोर्ट का उत्तर दाखिल करने की अंतिम तिथि (अर्थात, इस रिपोर्ट में लगाई गयी सभी आवश्यकताओं के अनुपालन की अवधि) आवेदक को आपत्तियों का प्रथम कथन जारी होने की तिथि से छः माह है।
   Please find enclosed herewith an Examination Report (i.e. a first statement of objections as specified in Rule 24-B(3) of The Patents Rules, 2003 (as amended)) in respect of above-mentioned application. This report is issued with reference to a request for examination dated 08/02/2022.The last date for filing a response to the Examination Report (i.e. a period to comply with all the requirements raised in this examination report) is six months from the date on which the first statement of objections is issued to the Applicant.

2. यदि रिपोर्ट के अंतर्गत लगाई गयी आवश्यकताओं का अनुपालन एकस्व नियम, 2003 (यथा संशोधित) के नियम 24 ख(5) में विनिर्दिष्ट अवधि के भीतर अंदर अनुपालन नहीं किया गया तो एकस्व अधिनियम 1970 की धारा 21(1) के अधीन वर्तमान आवेदन को परित्यक्त माना जाएगा।
   The instant application shall be deemed to have been abandoned under Section 21(1) of The Patents Act, 1970, unless all the requirements raised in this report are complied with in the period as specified in Rule 24-B (5) of The Patents Rules, 2003 (as amended).

3. आपका ध्यान एकस्व नियम, 2003 के नियम 24 ख(6) के प्रावधानों की ओर भी आमंत्रित किया जाता है।
   Your attention is also invited to the provisions of Rule 24-B (6) of the Patents Rules 2003.

4. आपको सलाह दी जाती है कि शीघ्र निपटान हेतु अपना उत्तर शीघ्र प्रस्तुत करें।
   You are advised to file the reply at the earliest for early disposal.

Rakesh Kumar Kushwaha
नियंत्रक पेटेंट/ Controller of Patents

संलग्न/Enclosed: अपरोक्त अनुसार/As above

टिप्पणी: यह इलेक्ट्रोनिक रूप से उत्पन्न रिपोर्ट है।
NOTE: This is an electronically generated report.

सभी पत्राचार नियंत्रक एकस्व को उपरोल्लिखित पते पर भेजा जाये।
All communications should be sent to the Controller of Patents at the above mentioned address.

FORM 2
THE PATENTS ACT, 1970
(39 OF 1970)
AND
THE PATENT RULES, 2003
COMPLETE SPECIFICATION
(See section 10 and rule 13)

AN AI BASED SYSTEM TO DETECT PERSON AND THEIR ACTIVITY IN LOW ILLUMINATED SPACE AND METHOD THEREOF

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The following specification particularly describes the invention and the manner in which it is to be performed.

Field of the Invention

[1] The invention relates to a system that can detect a person in the low illuminated region more specifically through any occluded object (like wall, door) with 1ft error rate. The present system can also capture the perfect location on the map and can visualize and predict the action and activities over a large distance.

Background of the Invention

[2] Person detection is considered a critical component of any computer vision system. For real-time computer vision systems, person tracking, recognition, and alignment, a good localization of the targeted person or object is necessary as an initialization step.

[3] Low light object detection is a challenging problem in the field of computer vision and multimedia. Most available object detection methods are not accurate enough in low light conditions. The main idea of low light object detection is to add an image enhancement preprocessing module before the detection network. However, the traditional image enhancement algorithms may cause color loss, and the recent deep learning methods tend to take up too many computing resources. These methods are not suitable for low-light object detection.

[4] The prior art WO2020036782 titled "Methods and systems for person detection in low illumination conditions" discloses a person detection system in low illumination conditions wherein the system can be trained in the low illumination levels to classify 3D objects obtained under low illumination conditions. Regions of interest obtained from 3D reconstructed images are

obtained by de-noising the 3D reconstructed image using total-variation regularization using an augmented Lagrange approach followed by face detection.

The regions of interest are then inputted into a trained CNN. The CNN can be trained using the system reconstructed under low illumination after TV-denoising. The elemental images were obtained under various low illumination conditions having different SNRs. The CNN can effectively recognize the 3D reconstructed faces after TV- denoising.

[5] The prior art CN110532875A titled "Night mode camera lens pays the detection system, terminal and storage medium of object" provides a detection system which comprises the following modules: image segmentation module used to find a frame or multiple images that background has a light source, so that attachment the characteristic processing of speck is occurred using a light source in the image, isolates the suspicious region in the image; characteristic extracting module used to extract doubtful because of fuzzy contour area caused by attachment, and carry out statistics calculating to a variety of clarity evaluation indexes in profile, whether comprehensive many indexes result in judgment region is attachment; the early-warning judgment module is for statistical nature extraction module determining area and marks aggregate-value, and the determining area that cumulative number is more than the alarm threshold value is carried out triggering the alarm.

[6] The prior art CN112287998A titled "Method for detecting target under low-light condition" discloses a method for detecting a target under a low-light condition comprises the following steps: selecting and dividing a data set, constructing

an original network structure for target detection under a low-light condition, pre-training models of the networks, and combining the pre-trained models of the networks through adhesive layers, performing iterative training on the bonding layer through the generated model, and training an optimal bonding layer to obtain an optimal network structure; and adopting an optimal network structure to perform target detection under low light conditions.

[7] The conventional methods can detect the objects in low illumination conditions but real-time monitoring of the activity of the object in such low light conditions is a challenge. There is a need for an efficient system that can detect and analyze the activities of the person in low illumination conditions and also a system that can detect objects through obstacles like walls.

[8] Further limitations and disadvantages of conventional approaches will become apparent to one of skill in the art through comparison of described systems with some aspects of the present disclosure, as outlined in the remainder of the present application and concerning the drawings.

[9] All publications herein are incorporated by reference to the same extent as if each publication or patent application were specifically and individually indicated to be incorporated by reference. Where a definition or use of a term in an incorporated reference is inconsistent or contrary to the definition of that term provided herein, the definition of that term provided herein applies and the definition of that term in the reference does not apply.

[10] As used in the description herein and throughout the claims that follow, the meaning of "a," "an," and "the" includes plural reference unless the context dictates otherwise. Also, as used in the description herein, the meaning of "in" includes "in" and "on" unless the context dictates otherwise.

Summary of the invention

[11] The following presents a simplified summary of the disclosure to provide a basic understanding to the reader. This summary is not an extensive overview of the disclosure and it does not identify key/critical elements of the invention or delineate the scope of the invention. Its sole purpose is to present some concepts disclosed herein in a simplified form as a prelude to the more detailed description that is presented later.

[12] The person of the present invention is to provide a system that can facilitate the detection of person activity in low illumination conditions even through occluded objects (like walls, doors).

[13] It is yet another person of the present invention to provide a system that can be able to capture the perfect location on the map and can visualize and predict the action and activities over a large distance.

[14] It is yet another person of the present invention to provide a system which has the potential to increase the security by two-fold in sectors like Bank, Nation-Border, Military Operations, Jewellery Shops, and other security intensive sectors.

[15] It is yet another person of the present invention to provide a system which can be very useful to detect the patient's activities and if they fall, it can alert the authorities.

[16] It is yet another person of the present invention to provide a system that can facilitate disaster management and aid the authorities to detect the perfect location.

[17] It is yet another person of the present invention to provide a system which can facilitate car baking system, especially in dark conditions.

[18] In an aspect of the present invention, the system to detect the activity of an object in low illumination conditions is integrated with cameras that use radio frequencies and calculate the channel state information (CSI) and generate the graphs from gathered channel state information and convert them into heatmaps. the heatmaps are directly fed into the machine learning model which can predict the geo-location and activities of the person in real-time.

[19] In accordance with the aspect of the present invention, the system comprises a transceiver and a receiver of radio waves. The transceiver transmits the RF in the environment and a receiver capture the RF then calculates the CSI value and generates a Graph, then the graph is converted into a heatmap, and by applying the machine learning algorithm prediction and visualization of the position and activities of the object in real-time are achieved.

[20] In accordance with the aspect of the present invention, the system is utilizing radio waves to sense the environment and predict the location and activity of the person. The present system has a margin of error of 1ft in accurately predicting the position of the person in a night and through the occluded object (door or wall).

Brief description of the drawings

[21] These features and advantages of the present disclosure may be appreciated by reviewing the following description of the present disclosure, along with the accompanying figures wherein like reference numerals refer to like parts.

[22] The accompanying drawings illustrate the embodiments of systems, methods, and other aspects of the disclosure. Any person with ordinary skills in the art will appreciate that the illustrated element boundaries (e.g., boxes, groups of boxes, or other shapes) in the figures represent an example of the boundaries. In some examples, one element may be designed as multiple elements, or multiple elements may be designed as one element. In some examples, an element shown as an internal component of one element may be implemented as an external component in another and vice versa. Furthermore, the elements may not be drawn to scale.

[23] Various embodiments will hereinafter be described in accordance with the appended drawings, which are provided to illustrate, not limit, the scope, wherein similar designations denote similar elements, and in which:

[24] Fig 1 depicts the block diagram of the person detection system in low illumination conditions in accordance with the present invention.

[25] Fig 2 depicts the principle of human motion perception through Wi-Fi signals in accordance with the present invention.

[26] Fig 3 depicts the architecture of person detection system in accordance with the present invention.

[27] Fig 4 depicts the architecture of deep neural networks in accordance with the present invention.

[28] Fig 5 depicts the flow chart of the method of object detection in low illumination conditions in accordance with the present invention.

Description of the invention

[29] The present disclosure is best understood with reference to the detailed figures and description set forth herein. Various embodiments have been discussed with reference to the figures. However, those skilled in the art will readily appreciate that the detailed descriptions provided herein with respect to the figures are merely for explanatory purposes, as the methods and systems may extend beyond the described embodiments. For instance, the teachings disclosed, and the needs of a particular application may yield multiple alternative and suitable approaches to implement the functionality of any detail described herein. Therefore, any approach may extend beyond certain implementation choices in the following embodiments.

[30] References to "one embodiment," "at least one embodiment," "an embodiment," "one example," "an example," "for example," and so on indicate that the embodiment(s) or example(s) may include a particular feature, structure, characteristic, property, element, or limitation but that not every embodiment or example necessarily includes that particular feature, structure, characteristic, property, element, or limitation. Further, repeated use of the phrase "in an embodiment" does not necessarily refer to the same embodiment.

[31] Methods of the present invention may be implemented by performing or completing manually, automatically, or a combination thereof, selected steps or tasks. The term "method" refers to manners, means, techniques and procedures for accomplishing a given task including, but not limited to, those manners, means, techniques, and procedures either known to, or readily developed from known manners, means, techniques and procedures by practitioners of the art to which the invention belongs. The descriptions, examples, methods, and materials presented in the claims and the specification are not to be construed as limiting but rather as illustrative only. Those skilled in the art will envision many other possible variations within the scope of the technology described herein.

[32] The present invention is related to a system which can facilitate detection of object activity in low illumination conditions even through occluded objects (like wall, door). The present system can be able to capture the perfect location on the map

and is able to visualize and predict the action and activities over a large distance.

[33] In the preferred embodiment of the present invention the system can detect the activity of an object in low illumination condition is integrated with cameras which use radio frequencies and calculates the channel state information (CSI) and generate the graphs from gathered channel state information and convert them into heatmaps. The heatmaps are directly fed into the machine learning model which can predict the geo-location and activities of the person in real-time.

[34] In accordance with the preferred embodiment, the present system comprises a transceiver and a receiver of radio waves. The transceiver transmits the RF in the environment and a receiver capture the RF then calculates the CSI value and generates a Graph, then the graph is converted into a heatmap, and by applying the machine learning algorithm prediction and visualization of the position and activities of the object in real-time are achieved.

[35] In accordance with the preferred embodiment, the system is utilizing radio waves to sense the environment and predict the location and activity of the person. The present system has a margin of error of 1ft in accurately predicting the position of the person in a night and through occluded object (door or wall).

[36] Referring to **Fig 1** is the block diagram of the system **100** for object detection in low illumination condition and even through occluded surfaces. The system employs integrated cameras **101** to capture the object and activity of such detected

object. A transceiver **102** transmits the RF in the environment and a receiver **103** capture the RF signals. A pre-processor **104** determines the CSI value and generates a graph. A heatmap generator **105** converts the graph generated by the pre-processor **104** into heatmaps and this inputs along with RGB image captured by the camera **101** are transmitted as inputs to a processor **106** employing a machine learning model to determine the accurate position and activity of the detected object in real time.

[37] Referring to **Fig 2** depicts the principle of human motion perception through Wi-Fi signals. When a person is in a signal link, the propagation of wireless signals will be reflected, scattered, and diffracted by the influence of the human body. The signal received at the receiving end is a composite signal that is propagated by the direct path and the human body reflection path as well as the reflection path of the floor ceiling. If the line of sight (LOS) length from the transmitter to the receiver is d, then the distance between the reflection point of the ceiling and the floor and the LOS is R. Combining the free-space propagation equations and signals with the reflection scattering generated by the human body, the impact of the human body on wireless signal propagation can be defined as:

$$P_{rx}(d) = \frac{P_{tx}G_{tx}G_{rx}\lambda 2}{(4\pi)2(d + 4R + \varepsilon)2},$$

where P_{tx} is the transmitting power of the transceiver end, $P_{rx}(d)$ is the receiving power of the receiver end, G_{tx} is the transmitting gain, G_{rx} is the receiving gain, λ is the wavelength of the Wi-Fi signal, and ε is the approximate change of the path length caused by the scattering of the signal by the human body. Because the signal scattering paths caused by different actions are different, according to the above equation, different human actions will cause the difference in receiver receiving power, and by establishing the mapping relationship between these differences and different human actions, the basic idea of Wi-Fi human motion perception is determined.

[38] Channel State Information (CSI) signal can achieve universal, low-cost, fine-grained human perception, due to: maturity of Wi-Fi technology and the widespread use of Wi-Fi devices; CSI data can be easily extracted from commercial Wi-Fi devices using tools released by Halperin and Wi-Fi signal transmits a modulation scheme using OFDM (orthogonal frequency division multiplexing) under the IEEE 802.11N protocol, and OFDM can encode the CSI data to a plurality of subcarriers of different frequencies. The radio channel information at the subcarrier level can be obtained from the original CSI measured in the Wi-Fi data link. In OFDM transmission systems, it is assumed that a general model of channel state information can be represented as: $Y = H X + noise$, where Y and X represent the received signal vector and the transmitted signal vector, respectively; noise is additive white Gaussian noise; and H is the channel impulse response (CIR) complex matrix in the CSI frequency domain, reflecting the channel gain information at the subcarrier level.

[39] In an exemplary embodiment let the obtained measured CSI values H of the 2 × 3 frames received by the Atheros AR9380 NIC (that is, 2 transmit antennas and 3 receiving antennas) under the condition that the channel bandwidth is 20 MHz and the time is T, then CSI values of 336 subcarriers can be obtained.

[40] Referring to **Fig 3** illustrates the architecture of object detection by the system of the present invention. The camera captures the object activity as explained in Fig 2. The

Teacher-Student Architecture is implemented to train the custom machine learning model by giving RBG image and CSI value together. The present system utilizes NumPy's histogram2d (Python Library) to generate the heatmaps.

[41] Referring to **Fig 4** illustrates the architecture of deep neural networks which maps a CSI tensor to three output tensors: SM, JHMs and PAFs, where JHMs and PAFs are used later for the joint association. Let the that dimensions of stacked CSI represent temporal information (5), EM frequency (30), and transmitting pairs among antennas (3 * 3), respectively. Because of the different relative distances and angles among transmitter and receiver antennas, the 3 * 3 transmitting pairs capture 9 different 1D summaries of the same scene. Although the difference is subtle due to the small intervals comparing to distances to the human body, these 1D summaries are directly induced by the spatial layout of sensors. By reorganizing and reweighing, these 9 numbers can potentially be to reconstruct 2D information of the scene. Hence, 2D convolution is performed along the 3 * 3 dimension of the input tensor. The input tensor (150*3*3) contains 5 CSI samples corresponding to one video frame. The outputs are SM, JHMs and PAFs, all resized to c*46*82. The input tensor is first up-sampled to 150 * 96 * 96, feed to a residual convolution block, and U-Nets. U-Nets outputs are then down sampled to match ground truth using kernels with stride 2 on height and stride 1 on width. It is found that SM (full body heatmaps) and JHMs (local joints/limbs heatmaps) are highly complementary, and one U-Net for SM and JHMs produced similar results as two independent U-Nets.

[42] Observe that, the feature map after down sampling part of U-Nets has an RF size of 140, which is larger than the height and width of the up-sampled 150 * 96 * 96 tensor. This ensures that the feature maps in U-Nets observed all 9 views among transmitter and receiver antennas. With supervision from annotations, the feature maps in U-Nets are forced to match the 2D spatial layout of the SM, JHMs and PAFs.

[43] In an exemplary embodiment, it can be observed that the CSI is recorded at 100 Hz from receiver antennas and videos at 20 FPS from an RGB camera attached with receiver antennas. The videos are only used for annotating CSI. Then the CSI samples and video frames are synchronized according to time stamps. In order to reduce the correlation between person body and environment, the data is collected under 6 scenes in a laboratory office and 10 scenes in a classroom. Eight volunteers were asked to perform daily activities while the number of concurrent persons in the video varied from 1 to 5. From each video frame, ground truth annotation for CSI is generated as follows: For body segmentation, Mask R-CNN to produce Segmentation Masks (SM) of persons, a 1*46*82 tensor are used, where 46 and 82 are height and width, respectively. For pose estimation, a Body-25 model of OpenPose is used to output body Joint Heat Maps (JHMs) and Part Affinity Fields (PAFs). For each frame, JHMs is a 26*46*82 tensor, where the 26 corresponds to 25 joints and 1 background. The PAFs is a 52*46*82 tensor where 52 is for x and y coordinates of 26 limbs.

[44] **Fig 5** depicts the method flow chart for object activity detection in low illumination condition in accordance with the present invention. The method **500**
comprising steps of: capturing image and motion data through camera sensors **501**; determining the channel state information value through the RF signals transmitted and received through Wi-Fi routers **502;** generating heatmaps with respect to determined CSI values **503;** processing the heatmaps and RGB image data by employing teacher-student convolutional neural network **504;** determining the accurate position and activity of the detected object **505**.

[45] In an exemplary embodiment the system has potential to increases the security by two-fold in sectors like Bank, Nation-Border, Military Operations, Jewellery Shops, and other security intensive sectors. The system can be very useful to detect the patient's activities and if they fall, it can alert the authorities.

[46] In an exemplary embodiment the system can also facilitate disaster management and aid the authorities to detect the perfect location.

[47] No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

[48] It will be apparent to those skilled in the art that various modifications and variations can be made to the present invention without departing from the scope of the invention.

There is no intention to limit the invention to the specific form or forms enclosed. On the contrary, the intention is to cover all modifications, alternative constructions, and equivalents falling within the scope of the invention, as defined in the appended claims. Thus, it is intended that the present invention cover the modifications and variations of this invention, provided they are within the scope of the appended claims and their equivalents.

We claim:

1. A system **100** to facilitate object detection in low illumination conditions and even through occluded surfaces, such system comprises:

    a. integrated cameras **101** to capture the object and activity of such detected object;
    b. a transceiver **102** transmits the RF in the environment and a receiver **103** capture the RF signals;
    c. a pre-processor **104** determines the channel state information (CSI) value and generates a graph;
    d. a heatmap generator **105** converts the graph generated by the pre-processor **104** into heatmaps;
    e. a processor **106** to determine the accurate position and activity of the detected object in real time

    wherein the heatmaps along with RGB image captured by the camera **101** are transmitted as inputs to processor **106** employing deep neural network.

2. The system **100** as claimed in claim 1 wherein the heatmap generator **105** utilizes NumPy's histogram2d (Python Library) to generate the heatmaps.

3. The system **100** as claimed in claim 1 wherein the deep neural networks maps a input CSI tensor to three output tensors: Segmentation Masks (SM), Joint Heat Maps (JHMs) and Part Affinity Fields (PAFs).

4. The system **100** as claimed in claim 1 wherein the input tensor is first up-sampled and fed to a residual convolution block, and U-Nets.

5. The system **100** as claimed in claim 1 wherein the U-Nets outputs are down sampled to match ground truth using kernels.

6. The system **100** as claimed in claim 1 wherein SM (full body heatmaps) and JHMs (local joints/limbs heatmaps) are highly complementary, and one U-Net for SM and JHMs produced similar results as two independent U-Nets.

7. A method **500** for object activity detection in low illumination condition, such method comprising steps of:

   a. capturing image and motion data through camera sensors **501**;
   b. determining the channel state information value through the RF signals transmitted and received through Wi-Fi routers **502;**
   c. generating heatmaps with respect to determined CSI values **503;**
   d. processing the heatmaps and RGB image data by employing teacher-student convolutional neural network **504;**

e. determining the accurate position and activity of the detected object **505**.

8. The method **500** as claimed in claim 7 wherein, wherein the heatmaps are generated utilizing NumPy's histogram2d (Python Library).

9. The method 5**00** as claimed in claim 7 wherein the deep neural networks maps a input CSI tensor to three output tensors: Segmentation Masks (SM), Joint Heat Maps (JHMs) and Part Affinity Fields (PAFs).

10. The method 5**00** as claimed in claim 7 wherein the input tensor is first up-sampled and fed to a residual convolution block, and U-Nets and then the U-Nets outputs are down sampled to match ground truth using kernels.

Dated this – 08/02/2022

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On Behalf of Applicant
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ABSTRACT

AN AI BASED SYSTEM TO DETECT PERSON AND THEIR ACTIVITY IN LOW ILLUMINATED SPACE AND METHOD THEREOF

A system which can facilitate detection of person activity in low illumination conditions even through occluded objects (like wall, door). The present system can be able to capture the perfect location on the map and is able to visualize and predict the action and activities over a large distance. The system is integrated with cameras which use radio frequencies and calculates the channel state information (CSI) and generate the graphs from gathered channel state information and convert them into heatmaps. The heatmaps are directly fed into the machine learning model which can predict the geo-location and activities of the person in real-time. Fig 1 is the system for object activity detection in low illumination conditions.