Intelligent Farming and Crop Protection using Machine Learning

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ABSTRACT

IoT allows establishing solutions for better management of natural resources, where every object embedded with different sensors enables interaction with the physical and logical world is connected with other object in unique identifier so that data can be transferred without human to human interaction. This paper presents a novel approach called intelligent farming and irrigation system uses IoT and Machine learning algorithm for remote monitoring of real time database and controlling through wireless sensor network. Furthermore, Raspberry PI is also used here for controlling and monitoring data of various sensors. Hence, wireless monitoring of farm and irrigation system reduces human intervention and allows remote monitoring on android phone. Here, ML is used to detect animal activity outside the farm and protecting crop from animals through audible noise that scares animals. This paper also proposes and evaluates a cloud-based wireless communication system to control and monitor sensors, and actuators to assess the plants water need. It also involves controlling, monitoring and fault detection of street lights. Cloud computing is an attractive solution to store large amount of data generated by the wireless sensor network.

Keywords

Raspberry PI, Sensors, Irrigation System, Street Light, IoT, SSD and Machine Learning.

Article Received: 10 August 2020, Revised: 25 October 2020, Accepted: 18 November 2020

Introduction

Crops damaged across India declined from 29,989 hectares in 2010 to 19,962 hectares in 2018 equivalent to an area roughly a fourth the size of Surat city, according to the government. This is because of, crops damaged by wild animals rose 13 per cent, from 11,828 hectares to 13,321 hectares in Chhattisgarh and in Karnataka, damage declined 75 per cent, from 7,572 hectares to 1,900 hectares in 2010-2018. There are also various states of India where crops damaged by wild animals rises day by day, causes huge lost to farmers as well create a bad impact on agricultural sector of Indian government. Hence, an automated intelligence farming along with crop protection using current innovative technologies are required to farmers now a day.

Automated irrigation system provides the solution for watering the farm automatically even in the absence of human. No individual presence is needed for watering as the system is automated considering one or more of the various parameters available for irrigation scheduling such as soil moisture measurement, evapotranspiration estimates, leaf water potential canopy temperature etc. Soil moisture-based irrigation system, timer-based irrigation system, drip irrigation, sprinkle irrigation etc are the types of the automated irrigation system available. At this phase soil moisture-based technology has been chosen. In this project, the system is controlled by using the soil moisture measuring sensor which controls the flow of water. Main components required are soil moisture sensor, control circuit, gate valve, pumping unit, timer, power supply and programming guidance [1]. Agricultural Solar Fencing is one of the best methods for protection of crops and property from domestic and wild animal damages. This Agricultural Solar Fencing supply a low amount of electric current, which gives an electric current to those entering the fenced area. The Farm Sector Agricultural Solar Fencing offered by us is a new concept, introduced to keep out the animals ranging from snakes to elephants includes, wild boar, monkey, cattle and leopard. With the help of these Agriculture Solar Fencing systems, our clients can also safeguard the properties from theft. This resulted in increasing the yield by way of protecting the damages by wild animals which proved in enhancement in the returns.

The street lighting is one of the largest energy expenses for a city. An intelligent street lighting system can cut municipal street lighting costs as much as 50% - 70%. An intelligent street lighting system is a system that adjusts light output based on usage and occupancy, i.e., automating classification of pedestrian versus cyclist, versus automotive. An intelligent street light management proposes the installation of the wireless-based system to remotely track and control the actual energy consumption of the street lights and take appropriate energy consumption reduction measures through power conditioning and control [3].

The rest of the paper is divided as follow: Section 2 presents the related work. The State-of-Art of proposed system discussed in Section 3. The methodology which includes SSD

– Machine Learning technique is presented in Section 4. Section 5 presents working of system model. Section 6 shows system hardware and simulation results. The paper is concluded in Section 7.

Related Work

In [1], authors give an innovative technique to diminish water usage and refining irrigation system. Raspberry pi and Arduino are the main components and working method. Authors have used various sensors in such as soil moisture to moisture level of soil, infrared sensor to detect animals,

and ultra-sonic sensor to detect the water level. In [2], a low-cost smart irrigation system is developed for farmers to control the motor of water automatically and choose the direction of the water flowing in pipe using soil moisture sensor. Authors in [3] demonstrated Solar LED street light system to generate the energy from non-conventional energy source. Furthermore, light dependent resistor sensor is used for light operation in day and night time as per the presence of person. In [4], the researchers have developed a new streetlight monitoring system based on wireless sensor networks to control streetlight according to sunrise and sunset algorithm and light intensity using a digital temperature-humidity and temperature sensor, high power relay. In [5], the authors have developed an agricultural field monitoring and automation system using PIC16F877A microcontroller and GSM Module. In [8], presents the idea of Internet of Things application to prevent wild animal attacks in the crop field. A preventing and monitoring system is provided to prevent possible damages in an agriculture field, from wild animal attacks and severe weather conditions. Researchers have provided IoT based technical solution [9] to prevent farmers crops from wild animals and to maximize their crop production. Authors have used PIR sensors, cameras to detect animals using TensorFlow image processing Techniques. Raspberry Pi is also used as processing unit of the system along with sound buzzers to transmit Ultrasound waves.

State-Of-Art Of Proposed System

The block diagram of the block diagram of the proposed system as shown in fig 1 consists of sensing unit such as Soil Moisture Sensor, Ultrasonic sensor, DHT sensor, smoke sensor, Water level Sensor, Raindrop Sensor, LDR, ADC MCP3008, GSM, GPS module and 5V Relay for controlling water pump and Streetlight. All of these components are controlled by Raspberry Pi and data is stored onto the cloud google firebase [1],[5].

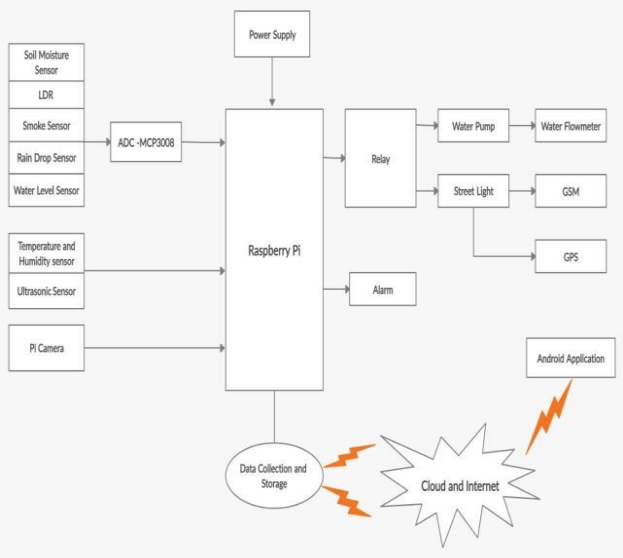

Fig. 1. Proposed System Model

A. Power Supply

One of the most exciting updates/upgrades of the new Model B+ is a fancy new power supply. The power supply is what takes the micro USB port voltage and creates the 5V USB, 3.3V, 2.5Vand 1.8V core voltages. The 3.3/2.5/1.8 are for the processor and Ethernet.

B. Sensors

Sensors are the device that converts the physical parameter into the electric signal. This project consists of too many sensors such as soil moisture sensor, DHT11 sensor, smoke sensor, Ultrasonic sensor, Water level sensor, Raindrop sensor and LDR. The output of the sensor is an analog signal, the signal is converted into a digital signal using ADC MCP3008 and then fed to the processor. The moisture sensor is used to compute the moisture content of the soil. Copper electrodes are used to sense the moisture content of the soil. The conductivity between the electrodes helps to compute the moisture content level. The DHT11 sensor is used to measure the temperature and humidity of the environment. The smoke sensor is used to detect the fire using smoke. Ultrasonic sensor is used to detect any motion near the field area and give distance of it. LDR value is depending upon the light in environments so LDR is used to detect the light and then depend upon the value of LDR street light is either ON or OFF and another LDR is placed under the street light for fault detection. Water level sensor is used for water level detection in main source of water which is used for irrigation purpose. Raindrop sensor is used for rain detection and it detect rain by detection moisture using plates. Fig. 2 shows different sensors used in proposed state-of-art system.

Fig. 2. Different Sensors

C. GSM and GPS Modules

GSM module is used to inform about the status of fault detection message to control center for street light and GPS module is used to find the location of faulty street light and send the location to the control center, shown in fig. 3.

Fig. 3. GSM and GPS Module

D. Raspberry PI

The Raspberry Pi is small, powerful and lightweight ARM based computers which can do many of the things a desktop PC can do. The powerful graphics capabilities and HDMI video output make it ideal for multimedia applications such as media centers and narrowcasting solutions. The Raspberry Pi is based on a Broadcom BCM2835 chip shown in fig.4. It does not feature a built-in hard disk or solid-state drive, instead relying on an SD card for booting and long-term storage.

Fig. 4. Raspberry PI

E. Relay and PI Camera

The relay module is an electrically operated switch that allows you to turn on or off a circuit using voltage and/or current to a great extent higher than a microcontroller could handle. There is no connection to the low voltage circuit operated by the microcontroller and the high-power circuit. The relay protects all circuits from each other. The channels in the module have three connections named NC, COM, and NO. Depending on the input signal trigger mode, the jumper cap can be placed at a high-level effective mode which 'closes' the normally open (NO) switch at high-level input and at low-level effective mode which operates the same but at a level below that. This system Relay is used to control the water pump for irrigation purposes shown in fig. 5. In this module Raspberry pi camera shown in fig. 6, is use for capturing image of animal entering into the farm and through Machine learning algorithm detecting those animals

Fig. 5. Raspberry PI

Fig. 6. Raspberry PI Camera

Single Shot Multibox Detector – Machine Learning Algorithm

We present a method for detecting objects in images using a single deep neural network. Our approach named SSD [10], Single Shot means that the tasks of object localization and classification are done in a single forward pass of the network, MultiBox is the name of a technique for bounding box regression, and Detector is an object detector that classifies those detected objects. At prediction time, the network generates scores for the presence of each object category in each default box and produces adjustments to the box to better match the object shape.

SSD is simple relative to methods that require object proposals because it completely eliminates proposal generation and subsequent pixel or feature resampling stages and encapsulates all computation in a single network. This makes SSD easy to train and straightforward to integrate into systems that require a detection component. Experimental results on the PASCAL VOC, COCO, and ILSVRC datasets confirm that SSD has competitive accuracy to methods that utilize an additional object proposal step and is much faster, while providing a unified framework for both training and inference. For 300 × 300 input, SSD achieves 74.3% mAP (Mean Average Precision) on VOC2007 test at 59 FPS on a Nvidia Titan X and for 512 × 512 input, SSD achieves 76.9% mAP, outperforming a comparable state-of-the-art Faster R-CNN model. Compared to other single stage methods [10], SSD has much better accuracy even with a smaller input image size.

The SSD approach is based on a feed-forward convolutional network [10] that produces a fixed-size collection of bounding boxes and scores for the presence of object class instances in those boxes, followed by a non- maximum suppression step to produce the final detections. The SSD algorithm code available at [11].

Working Of System Model

In this paper Raspberry PI 4B is used as main hardware. Here MCP3008(Analog to Digital IC) is use for conversation of analog data (Real world data) of sensors in to digital. There is 8-channel in this IC to connect the analog sensor. Soil sensor is interfaced with MCP3008 to detect the moisture in the soil. Soil sensor will analyze the soil moisture and as per requirement, it will control the pumping action of the water pump. The water pump will operate according to the soil sensor input through the relay. In addition, Water flow meter is connected with motor pump and it calculate total flow of water. Water level and raindrop sensor is interface with MCP3008 for monitoring the level of water in well and detection of rain, respectively. if rain is

detected then all pumping action will be shutdown. In addition, the DHT11 sensor is used for detecting the temperature and humidity of the surrounding area.

Ultrasonic sensor is used for motion detection and it is directly interfaced with Raspberry PI. If any motion is detected through the field in region of 50 cm, then PI camera capture image of this motion and then using SSD Machine Learning algorithm it will identify object such as animal, humans and many more. If any animal detected in image namely cow, pig and many more and which is harmful for crops so counter animal voice is raise for protection of the crops.

The smoke sensor is also connected with ADC and use for detection of any fire action in near field area and raise the alarm if fire detected so farmers can take some measure against this situation. In street light fault detection system, one LDR is used to sense the sunlight which is interfaced with MCP3008 according to this it will control the action of street lights and there is one individual LDR is placed under the street light for fault detection which is also connected with MCP3008. When any fault detected then location of faulty street light is send via message using GSM module and location is providing by GPS module, both directly connected with Raspberry PI. The flowchart of working model is shown in fig.7.

All the sensed data of sensors is collected and stored in google firestore. This firestore data is accessed by the app which is created in a flutter.

Fig. 7. Flowchart of Working Model

System Hardware And Simulation Results

Fig. 8 shows hardware part of the system model. Here Raspberry PI is the main controller of the project. Sensors are connected with Raspberry PI through ADC MCP3008 and DHT11 sensor is directly connect with Raspberry PI. GSM and GPS Module is also directly connected Raspberry PI. Water pump is connected with 5V relay Module and LDR is used for automatic control of street light.

Fig. 8. System Hardware

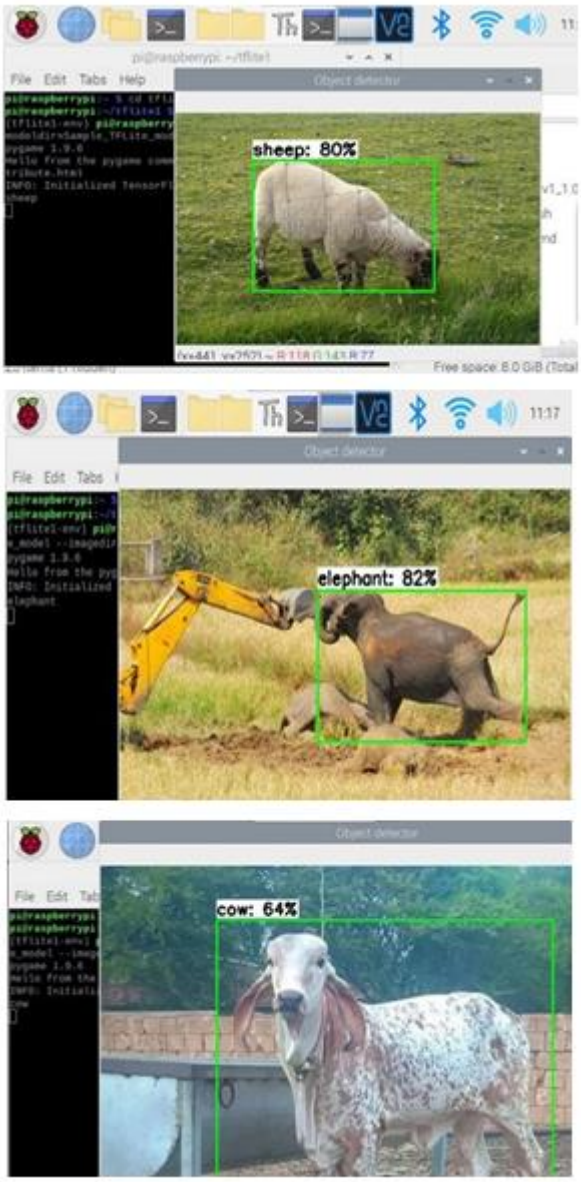

Fig. 9. Animal Detection using SSD – ML Algorithm

Fig. 9 shows 90% accuracy of animal detection using Single Shot MultiBox Detector machine algorithm arround the farm. If any animal detected in image by SSD algorithm, which is harmful for crops so counter animal voice is raise for protection of the crops.

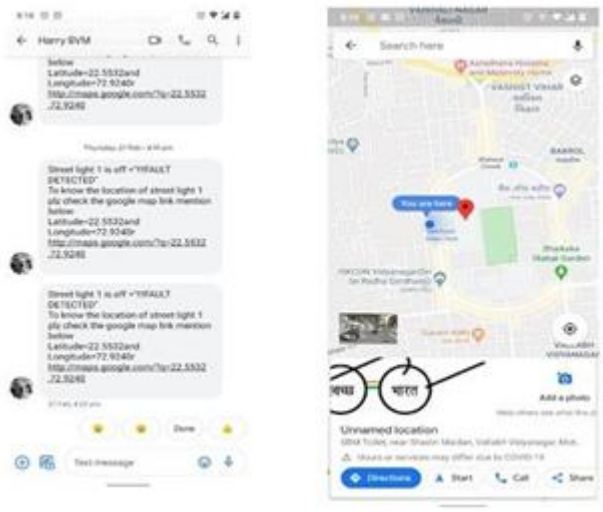

Fig. 10. Location of Faulty Street using GSM and GPS

Fig. 11. Android Application Showing Real Time Readings of Sensors from Google Firestore

Fig. 10 shows when any street light fault detected, then location of faulty street light is send via message using GSM module and location is providing by GPS module. Fig. 11 shows our android application connected to google firestore shows real time readings of all sensors connected in system model through Raspberry PI.

Conclusion

This paper shows novel approach Intelligence Farming and Crop Protection using ML will help farmers in protecting their crops and saving them from significant financial losses. It will also help them in achieving better crop yields thus leading to their economic wellbeing of country. This proposed system model is also used for the optimal use of water in agricultural field without the intervention of farmer by using soil moisture sensor that senses the moisture content of the soil, which turns ON/OFF the water pump automatically according to the need of water for irrigation and thus it will be helpful in saving water in the region where there is scarcity of water. This system model also includes IoT based smart street light and fault detection is a cost effective, practical, ecofriendly and the safest way to save energy. It clearly tackles the two problems that world is facing today, saving of energy and detecting location of faulty street light. Here we have used LEDs which have long life and emit cool light can be used for fast switching. Hence, such systems will be very much useful for the government to reduce the utilization of conventional power and recording of data of faulty street light. Therefore, such systems should be implemented on a large scale once, can bring significant reduction of the power consumption across the nation.

Acknowledgement

We would like to express our sincere thanks to Electronics and Communication Department and SSIP, BVM Engineering College to support in completing and funding this project. We learnt various new ideas to help the farmers and betterment of society with various technical uses.

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