Deep learning and Multiple Sensors Data Acquisition System for Real-Time Decision Analysis in Agriculture Using Unmanned Aerial Vehicle

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Abstract

This research was conducted to develop user-friendly application to connect multiple sensors while using UAV to collect field data. The on board and ground sensors were connected in the same application for ease of data collection in one software application. In the on board sensors, thermal and RGB cameras were connected and transmitted the images . The soil moisture content information, humidity information were collected. In addition, the image analysis and machine-learning algorithm was added to classification of the objects while landing.Deep YOLO algorithms were implemented for classification of people ,Tractor and other barrier. The Michihibiki module was also connected with IoT application for soil moisture content measurement in the large fields. The user application is divided into three modules: Hardware Module for Sensors Networks (HMSN), Software Module for Data Acquisition (SMDA),and Deep Learning for Decision Analysis (DLDA). This research will be extended further with real-time analysis and decision support systems for UAV-based agricultural operations and safety systems.

Keywords: UAV, Machine Learning,Deep Learning, Multiple Sensors

1.Introduction

In precision agriculture, Unmanned Aerial Vehicle (UAV) have the flexibility for data acquisition and analysis in real time from multiple sensors. However, the numbers of sensors and their data analysis from single processing unit still not available. In addition, the UAV operation needs frequent landing due to limited battery charge. Consequently, the real-time application requires the application of Artificial Intelligence (AI) in the decision making process for soil moisture sensing, safety in UAV flying operation starting from takeoff and landing. Deep learning and multiple sensors data acquisition process could serve in the decision analysis while using an UAV. Therefore, the purpose of this research is to develop real-time data analysis system to enable AI for using UAV in the agricultural operations more robustly with safe landing.

2. Methodology

2.1 Hardware Module for Sensors Networks (HMSN)

2.1.1 RGB Camera (on-board)

Using DJI phantom3's 4k RGB camera was used to collect crops image information.

2.1.2 Thermal Camera (on-board)

A thermal camera was installed to measure soil moisture information that is VuePro and AV interface (Figure 1).

Figure.1 Soil moisture and datasets communication

2.1.3 Wireless Radio Frequency Transmitter (on-board)

Using nRf24L01 module was used to transmit soil moisture information; An FPV module was used to transmit visual information from camera to remote user (Table 1).

Table 1 Specification of data transmission module

Module Name	Frequency Band	Interface	Speed	Operating voltage
nRF24L01	2.4GHz	SPI	1Mbps/2Mbps	3.3V-5V
FPV	5.8GHz	USB/WIFI	10Mbps	6V-12V

2.1.4 Moisture Sensors (On-ground)

Using MCU's ADC (Analog to Digital Converter) was used to get soil data, and estimate soil moisture.

2.1.5 Temperature Sensors (On-ground)

Using MCU's GPIO (General Purpose Input/output) pin to connect DS18B20's signal pin. One GPIO was used to simulate with 1 wire timing diagrams for getting temperature information remotely (Table 2).

2.1.6 Humidity Sensors (On-ground)

An MCU's GPIO pin was connected AM2302's signal pin. GPIO was simulated within 1 wire-timing diagrams for getting humidity information.

Table 2Specification of sensors module

Sensor Name	Range	Accuracy	Interface	Operating Voltage
Soil Moisture	0-100%	Up to ADC	Analog Signal	3.3-5.5VDC
DS18B20	-55+125°C -10 +85°C	±0.5°C	1-wire	3.3-5.5VDC
AM2302	0- 99.9% -40+80°C	2% ±0.5°C	1-wire	3.5-5.5VDC

2.1.7 GPS Sensor (On-Ground)

Connecting GPS's UART with MCU's UART1, and code to parse packet for getting longitude and latitude information (Table 3).

Table 3Specification of Sensors Module GPS Sensor

Name	Received sensitivity	Accurac y	Interface	Update rate	Operating Voltage
Mt3339	-164dBm	2m	UART	1-10 /s	5 VDC

2.2 Software Module for Data Acquisition (SMDA)

2.2.1 Development of GUI

The user interface were connected with software module to decision analysis using Visual C++ (Figure 2).

2.2.2 Data Acquisition System

2.3 Deep Learning for Decision Analysis (DLDA)

was used to recognize classifiers ().The human classifiers were initially identified for safety used Darknet to train datasets and recognized human and tractor presence from image data.

3. Results and Discussion

3.1 Data Transmission from HMSN

Using HMSN was enabled through wireless local area network (WLAN) and established lightweight protocol to transmit soil information such as soil moisture data to application. Then, data was loaded to the land station system and saved in the database.

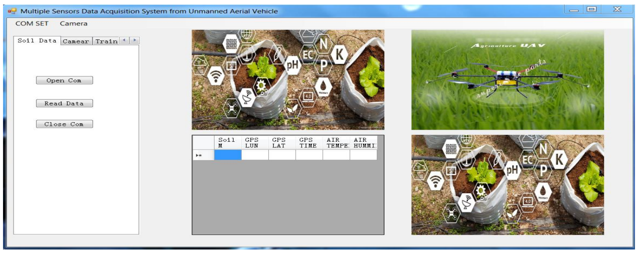

Figure.2 GUI for data acquisition system

3.2 Data Analysis through SMDA

The software module was developed for data analysis in real time application. The Deep learning (Yolo) algorithm was embedded with the HMDN module (Figure 4).

3.3 Decision Analysis for Safety Using DLDA

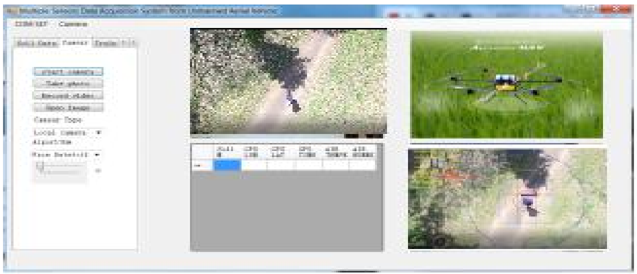

Figure.4 Deep learning system to enable safety system

4. Conclusions

The user application for controlling multiple sensors was developed for decision analysis using Deep learning algorithms. Results indicated this application system could accurately obtain data on real-time and could improve the efficiency of data acquisition.

The system can detect objects and ensure their precise position. And can accurately assess the safety level of the landing and guide the drone to safely land.

References

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