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Integrated Intelligent Equipment for Soil Maintenance based on stm32 and 5G Data Sharing

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Abstract

With the introduction of policies related to carbon neutrality and the policy of soil remediation technology transformation in China, it is hoped to achieve the goal of "dual carbon" as soon as possible. Facing the pain points of the current technology: low intelligence of soil collection and restoration, unable to visualize data, low efficiency. The real-time performance is weak, and it cannot be repaired in real-time process. It needs to go through multiple steps such as soil collection, soil transfer, manual analysis, offline meeting, soil repair, detection effect tracking, etc., with huge emissions. The application scenario of the existing technology is single, and the energy consumption of all kinds of equipment is large. Heavy mechanized equipment is often used for soil remediation, which cannot be switched to adapt to the application terrain and scene. The patent relates to a smart soil remediation vehicle that, based on image recognition technology, analyzes pollutants in real time and treats light and heavy pollution separately. The above data is returned to the mobile monitoring platform to realize data visualization. Corresponding to different pollution automatic switching using different treatment methods. Heavy pollution: according to the replacement method to analyze the specific pollution sources of heavy metals, inject oxygen into the deep soil; When there is slight pollution: data will be transmitted to the solar car and microorganisms will be planted independently. Accurate area to achieve complex soil remediation. Multi-machine collaborative intelligent repair vehicle, track climbing, light and medium car coordination, real-time communication, applied to various terrain and repair scenes.

Keywords

Soil Remediation; Intelligent Vehicle; Deep Learning; Stm32.

1. Introduction

Soil collection and restoration is low in intelligence, data visualization is impossible, and the efficiency is low.For problem 1:5Gwifi module and cloud platform are adopted to realize wireless communication, and all detection structures are uploaded in real time.Weak real-time performance, unable to real-time process restoration, need to go through soil collection, soil transfer, manual analysis, offline meeting, soil remediation, detection effect tracking and other steps, huge emissions.

For problem 2: Detection reagents and drugs were loaded on the intelligent vehicle, and the YOLOv5 algorithm was used to analyze the detection results in real time, which solved the impact caused by the soil moving to the laboratory.The existing technology has a single application scenario, and the production energy consumption of all kinds of equipment is large. Heavy mechanized equipment is often used for soil remediation, which cannot be switched to adapt to the application terrain and scene.As for question 3: The intelligent vehicle adopts track design, it can move autonomously in

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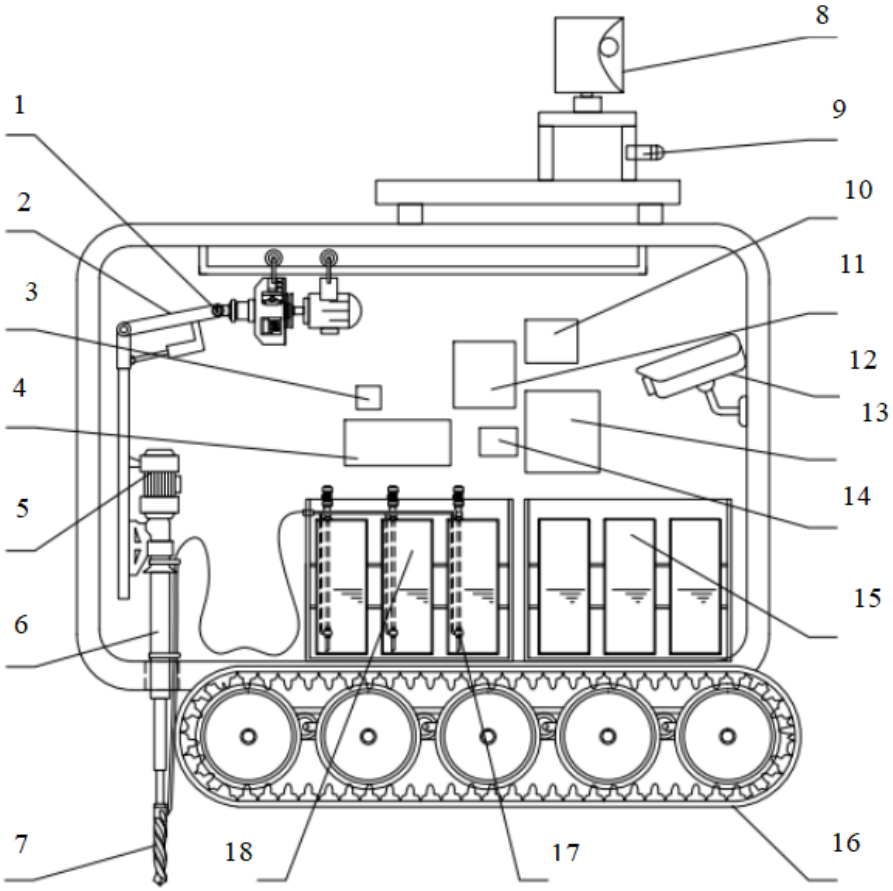
most terrains without manual operation, or it can be monitored remotely. With GPS positioning and navigation and lidar real-time mapping algorithm, it can complete the positioning and obstacle avoidance function, reduce the heavy mechanization of soil sampling and restoration, save energy and reduce emission, and it is widely used.

2. Design Idea

2.1 Mechanical Structure



The overall design includes the following parts: 1 Steering gear;2 Shrink the slide rod ;3 Ultrasonic Module;4 stm32 ;5 Motor ;6 Shrink rod ;7 Drill Bit ;8 Solar Battery ;9 LiDAR ;10 Raspberry PI ;11 Gyroscope ;12 Industrial camera ;13 Bluetooth Module ;14 OLED ;15 Detection reagent ;16 track ;17 Submersible pump;18 Fill liquid tank.

Fig 1. Mechanical structure

The intelligent car is built on the track driven by the motor. The interior of the intelligent car contains three parts, one part is the related equipment used for sampling, the second part is the related equipment to complete the detection, and the third part is the related control circuit that transmits the detection results to the supreme position machine.

The first part consists of the drill, telescopic rod, driving motor, pulley, and rotary steering gear. The tasks that can be completed include: the motor drives the telescopic rod to drive the drill into the soil for sampling. After the telescopic rod is contracted, the telescopic rod is rotated through the steering engine, and then the pulley is slid to dump the sample into the chemical detection box.

The second part includes reagents related to chemical detection, including chemical solvents for detection of various heavy metals, similar to: Copper will turn blue when put into sulfuric acid, and iron will bubble when put into sulfuric acid. Cameras will take real-time photos of chemical reagents,

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and image recognition and detection will be carried out by YOLOV5 algorithm on Raspberry PI, and the detection results will be sent to the cloud platform through 5G -- wifi module. The camera is suspended on the internal shell of the vehicle and is directed in the direction of the agent. In the side of the car equipped with gyroscope, 5Gwifi module, Bluetooth module, GPS positioning module, gyroscope module.

2.2 Control Part

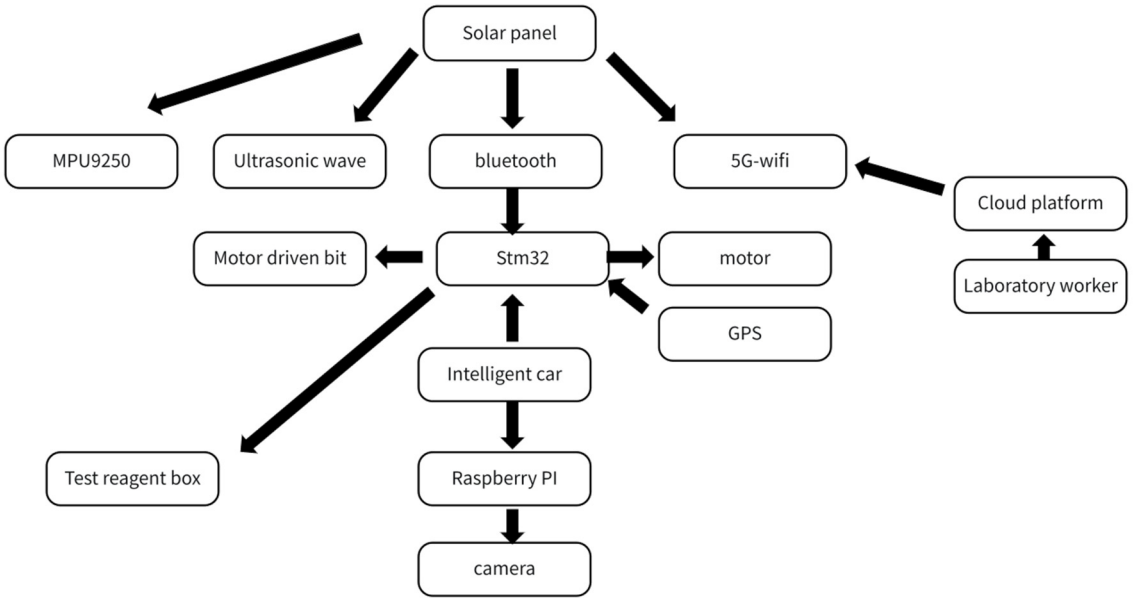

Fig 2. Circuit control

The car works on a large area of abandoned land to be repaired. The phone sets the working area, working time and GPS location of sampling position for the car, and the car starts to work after receiving the work task through 5Gwifi module. The motor controlled by Stm32 drives the crawler to run. When arriving at the designated sampling site, the telescopic rod is first extended, and the drill rod is driven into the soil by the stm32 control motor for sampling. After sampling is completed, the shrink rod is first shrunk, the rod is lifted by the steering gear at the top, and the sampled soil is poured into the detection chemical reagent through the pulley. The industrial camera driven by raspberry PI filmed the reaction of reagent changes, which was analyzed by the yolov5 algorithm carried by Raspberry PI. The specific pollution source of heavy metal pollution was analyzed, and then the corresponding chemical agent was driven into the soil through the injection tube and drill. If the pollution was not heavy metal pollution but mild pollution, the carried microorganisms were scattered on the soil surface. During the journey, the ros Lidar controlled by the Raspberry PI can be used for real-time mapping and navigation to achieve obstacle avoidance and positioning. The gyroscope module can complete stm32 to obtain the pitch and roll Angle. Tracks allow smart cars to work on any difficult terrain. The Bluetooth module enables information transfer between multiple vehicles. The 5Gwifi module can transmit all the detected information, such as time and place, to the cloud platform for analysts to consult. The Oled display can display the location, power and working mode of the smart car in real time. The solar module can charge small devices such as OLED displays and 5Gwifi modules. When the smart car has no power, it can still transmit the location information of the car to the cloud platform through 5Gwifi module. Temperature and humidity detection equipment, and temperature and humidity controller.

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3. Test

Table 1. Obstacle test

	advance	back
0.16m/s	√	√
0.43m/s	√	√
0.77m/s	√	√
1.22m/s	√	√
3.24m/s	√	√
5.37m/s	√	√

The intelligent vehicle can avoid obstacles. As shown in the table above, the speed of obstacle avoidance can be completed from 0.16m/s to 5.37m/s under the two states of forward and backward facing.

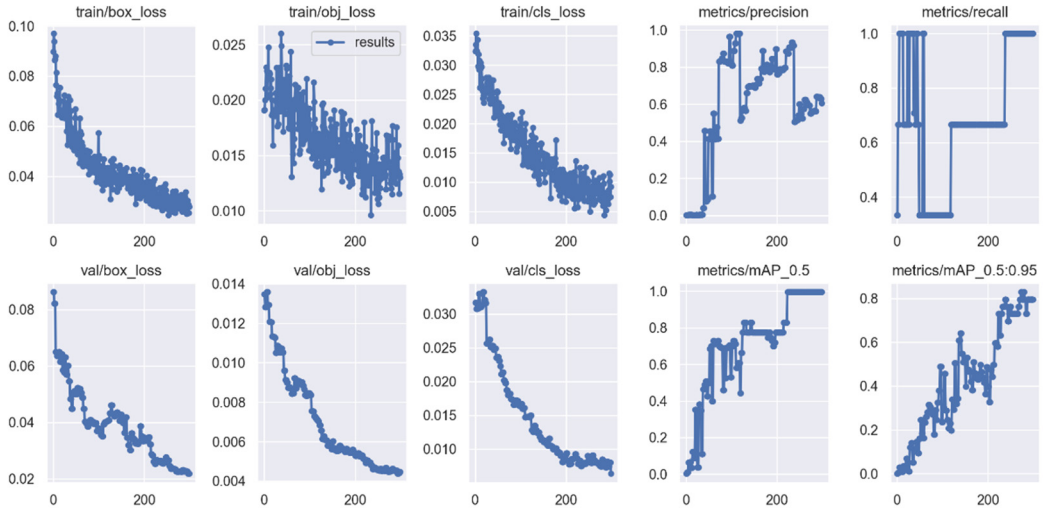

Fig 3. Identification effect parameter

As shown in the figure above, the intelligent vehicle uses yolov5 model to identify charging piles, which has high effect and accuracy.

Table 2. Velocity detection

	47mm advance	47mm back	19mm advance	19mm back
0.15m/s	×	×	×	×
0.34m/s	×	×	×	√
0.45m/s	×	×	√	√
0.73m/s	√	√	√	√
1.25m/s	√	√	√	√
2.31m/s	√	√	√	√
5.47m/s	√	√	√	√

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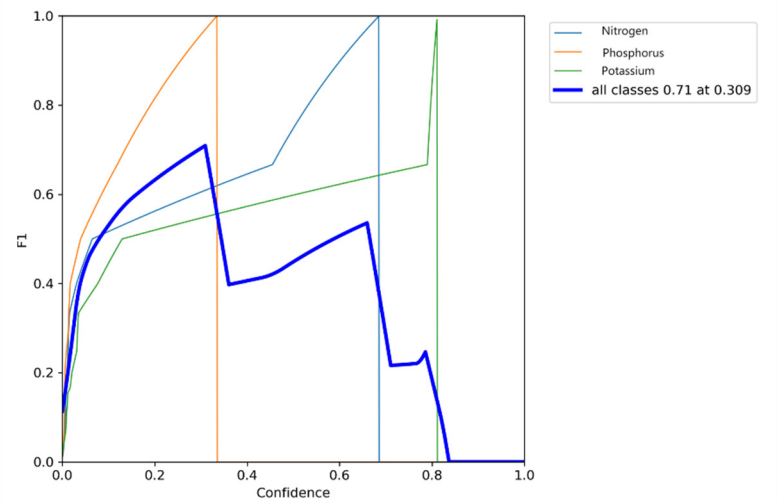

Fig 4. Identification effect parameter

4. Conclusion

Soil resources are exhausted and vegetation restoration is urgent. At present, there is little development of intelligent miniaturized in-situ soil remediation equipment. Based on stm32 core control board equipped with raspberry PI upper control, this paper completed four-wheel track drive and visual detection to identify pollutants. Furthermore, two green restoration methods, REDOX reagent and microbial injection and seeding, are combined to complete the restoration operation, which helps restore land resources. Carbon neutrality is also reliable and marketable.

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