Underground Canal Debris Detection System

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ABSTRACT

This research tries to give a solution for one of the challenges that face the main and traditional irrigation system in Oman which is Falaj. The study will investigate the problem and will propose a modern solution that saves effort and costs and minimizes the risk on labor who are working on this system. The following report attempts to address the difficulty of accessing the dirt that occurs in the waters of the falaj and needs to be cleaned, because people will face the problem of distance and depth to reach this place, where they expose their lives to danger that may reach death. Therefore, the report proposes a solution to this problem, which is the design of the drone, which will detect dirt through Sending the image to the monitoring station of the device, and then the location of the cleaning is determined.

Keywords: Drone, Transmitter, Arduino, Detection System

INTRODUCTION

In the last decades, water resources and consumption has become one of the important issues that affect the farmers in many countries that do not have rivers or continues rains during the year. Arabic countries related to Gulf Cooperation Council and Sultanate of Oman is one of them are some of these countries that suffer from less rains and hot weather. There are many studies talking about such issues and their effects [1,2,3,4].

The important way to use and transport water in Oman to the needy stakeholders is the falaj irrigation system an UNESCO world heritage site. Underground canal is not only the source of water but also it is the cultural heritage and it showcase the technical advancement of Oman in the history to the world.

Any effect of the underground system that cause the water disappear from its channel has its direct impact on the economic standards of the Omani families. The drying of the falaj is increasing due to reasons like over exploitation of groundwater, poor maintenance of falaj infrastructures and the consequent abandonment. The problem of accumulated mud and stones in the underground channel of the falaj is one of the main reasons for reduction of the water level that comes out of it.

Currently, people in the villages go underground to search for the problem and walk for a long distance till find the place of the mud in the underground channels with poor oxygen and many other threats. So, there is a high demand for an automated system that can detect the place of the debris to let the people find the place directly. This innovative solution will save time, cost and reduce the risk on the laborers who are working in this maintenance.

LITERATURE REVIEW

Till date no drones are implemented for clean the falaj. But there are several inventions that are related to similar task like underwater emergency rescue operations, cleaning Ocean, used for underwater mapping, in aquaculture to remotely monitor their fishing farming operations, shipping companies uses UWD for routine evaluation of ships, in offshore by energy companies to carry out industrial inspections, by telecommunications and power providers to monitor the underwater infrastructures like fibre optic cables, pipelines, cleaning glasses of a skyscrapers, by government organizations for dams inspections, bridge piers and other water related public works, for education, security purposes [5].

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Probot, an underwater aquaculture drone manufactured by a startup named Probotic is used to clean aquaculture such as seaweeds from the net pens to prevent bio-film creations [6,7]. Underwater drones such as Seasam & iBubble are used for ocean clean-ups [8]. KEELCRAB is an Underwater drone used for maintenance and inspection of hulls in ocean [9]. In the design of underwater drones for collecting and cleaning debris from canals and rivers are discussed using Arduino as a controller [10,11]. A review about the various techniques used for underwater positioning systems like baseline positioning systems and its types such as LBL, USBL, SBL, GIB, FLS, OWTT, GPS surface beacon, sonars are discussed in detailed to evaluate the position and seabed identification [12].

In review about different types of cleaning techniques is discussed. Mechanic cleaning uses the metallic brushes, cutters, and rotating knives to clean the hull and aquaculture on the surface, Hydrodynamic cleaning uses water jet under pressure to clean the debris along with cavitation effects which makes the surface smooth and reduce the frequency of cleaning and the last method is laser cleaning uses the scanning system of laser radiation. Laser cleaning is the best among the 3 types [13].

The world's first wireless underwater drone named EXRAY was designed in 2021 which can communicate up to 50 meters in fully dark underground water. It weighs 7kg with a length of 70 cm. It has 7 thrusters for 6 degrees of movement [14]. TJ-Flying Fish drone is a drone which fly in the aerial and swim in the water designed by Tongji University, and the Chinese University of Hong Kong. The TJ-Flying Fish can reach up to a depth of about 9.8ft underwater with a speed of 2m per second. It is an autonomous drone and can be used in rescue operations, surveillance, searching and remote sensing [15].

Loon Copter, another two-way mode drone was developed by Oakland University. The drone fly in the aerial and float in the water surface to monitor the underwater movements and then it can sink into the water by filling its buoyancy chamber and then it can start its movement underwater. The drone is applied for underwater inspections, search, and rescue, to detect oil spills, study about marine life [16]. An autonomous amphibious unmanned aerial vehicle (AAUAV) system was developed to measure the water quality, underwater mapping, remote sensing application. The quadcopter designed has a weight of 31kg [17].

The author discusses the various underwater communications techniques such as underwater wireless optical communication (UWOC), underwater electromagnetic transmission (UET) and underwater wireless acoustic communication (UWAC). Optical communication underwater are affected by temperature difference in water, scattering and absorption in water. UWAC has limited bandwidth, multipath propagation, geo-metrical expansion, multipath effect and latency underwater. UET suffers from short distance coverage and attenuation [18]. An Amphibious Vehicle is designed to evaluate the water quality is designed using raspberry pi and needed sensors.

The drone will fly in the aerial and float on the water surface and collect the water sample to test. The drone will not submerge into the water [19]. A hybrid drone is designed to clean the solar panels by rolling on the solar panels and moving from one solar panel to another is discussed in [20].

Literature review shows that drones are used for various applications like searching, surveillance, rescue and inspection and the discussion about the various ways of underwater communication methods. In real time no drone was used for cleaning the debris of an underground canal.

RESEARCH FRAMEWORK

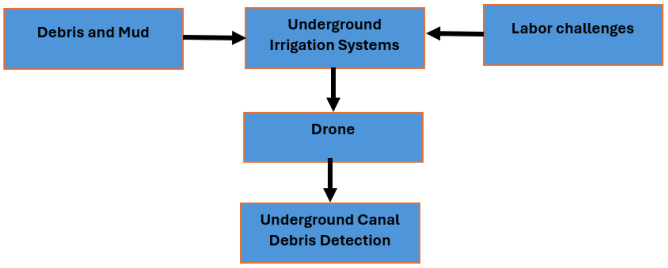

Fig. 1 Research Framework

This research framework initiated by study the famous irrigation system in Oman and the challenges that face this system. A modern solution is proposed to detect the debris and muds in the channels.

UNDERGROUND CANAL DEBRIS DETECTION SYSTEM

A. System Components

The suggested system which called Underground Canal Debris Detection System (UCDDS) contains the following components:

1. Transmitter: It is a wireless control device that can be controlled by sending signals and commands and receiving moving images that are transmitted directly from the plane to the display screen.

2. Arduino Nano: It is a precise and sensitive controller that operates at an operating voltage of 5 volts and its input voltage ranges from 6 to 20 volts, it will be an essential piece of the drone to control its operation.

3. Brushless Motors: It is a machine that converts electrical energy into mechanical energy using direct current. These motors, which are an integral part of the drone, as they are responsible for lifting the plane into the air.

4. Electronic Speed Controller: An electrical circuit designed to control the speed and direction of rotation of electric drive motors, and it can also be customized to act as a dynamic speed brake.

5. Camera: The camera is one of the most important components of the drone. This camera is a Hybrid Dual Split FPV (First-person view), it requires an operating voltage of 5 to 12 volts and this camera is made specifically for drones.

6. Acrylic Dome: Acrylic is a transparent thermoplastic that is often used as an alternative to glass due to its shatter resistance. It can be used in many applications such as surveillance cameras and underwater devices. The customer can choose the size, height or thickness he needs.

7. Buck converter: It is a constant voltage switch that changes the constant input voltage (constant voltage) to another lower constant voltage (Vin > Vout), based on the principle of pulse width modulation.

8. Battery: battery is used to give the power for the drone circuit.

B. System Flowchart

The system flowchart is shown in Figure 3. RC receiver will detect any signal that is sent by the transmitter. Then the receiver will send the signal to Arduino nano using the CCTV cable. There will be two connections the signal pin of reserve will connect to the RX pin of the nano and the ground pin of the receiver will be connect to the ground pin of the nano.

Then the nano is connected to esc. The digital pin of nano is connected to signal pin of esc and then the esc will provide the power supply for nano it is 5 volts. Next, the esc is connected to the Brushless motor and then Brushless motor will rotate.

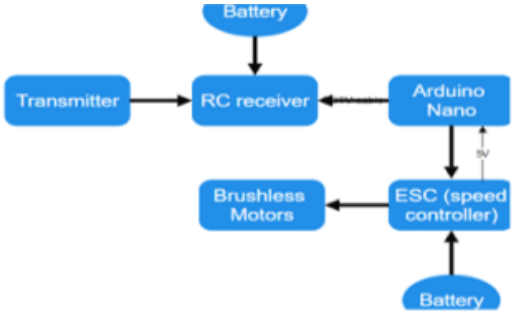

Fig. 2 UCDDS Flowchart

C. System Circuit Diagram

Figure 3 shows the circuit connection done in the submarine module. Here the propellors are fixed in brushless motors. The Brushless motors are then connected to an electronic speed controller (ESC). The electronic speed controller is connected to a 12v battery and to an Arduino Nano. The Arduino nano is powered by 5v from ESC. Arduino nano is then connected with the receiver using the CCTV cable and finally the receiver is connected to transmitter. The receiver is to be powered by 5v so a 12v to 5v converter is used to power the receiver.

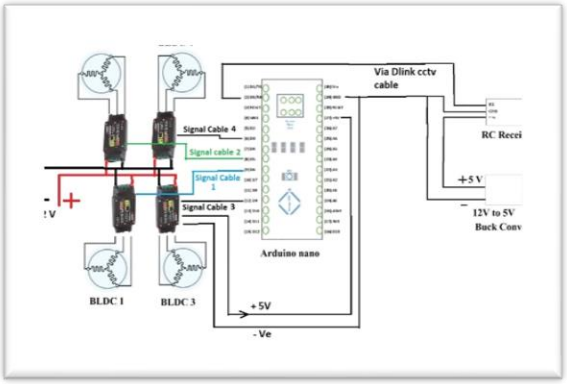

Fig. 3 UCDDS circuit diagram

D. System Real View

The real protype view for the drone after connecting brushless motors propellors and covering the connections by PVC pipes as shown in Figure 4. The prototype is tested and evaluated for mud detection.

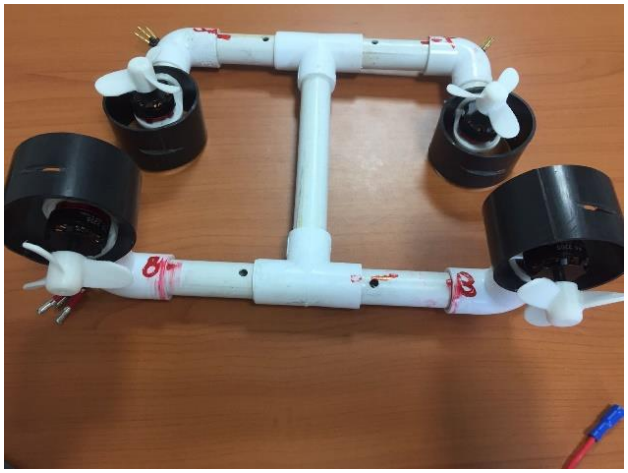

Fig. 4 UCDDS protype real view

CONCLUSION

Underground water is one the main resources for irrigation in Oman. This research describes the obstacles that face this system. An innovative solution is proposed through UCDDS which identifies the place of mud and debris. This solution enhances the safety of the labor by detecting the mud in the underground place. Also, it reduces the cost and time of the work. Generally, this work effects positively on the agriculture environment.

As future work, this system could be improved by adding the following features to UCDDS:

1. adding cleaning tools to the drone to clean the canal after detecting the debris through adding automated arms to the drone. These arms can be controlled from the base station to destroy the block of mud to open the canal. So, the UCDDS will function for detecting and removing the debris.

2. Enhance the quality (resolution) of the detected images or video through using an infrared (IR) camera (with an IR light), or a thermal camera. This will give a clear view for surrounding area detected by the drone>

3. Improve the battery lifetime by using saving energy functions.

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