REMOTE INSPECTION DRONE

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BACKGROUND

FIGURE 1

CREDIT: JONATHAN MÜLLER

This project aims to develop and build a remote controllable unmanned watercraft system. The system developed was created as platform and tool for the inspection of wildlife, infrastructure, etc. The current market for unmanned inspection devices focuses on multi-copters and other aerial based systems. While effective, these solutions are expensive, complex, can be difficult to operate and repair.

EASE OF USE AND FLEXIBILITY

FIGURE 2

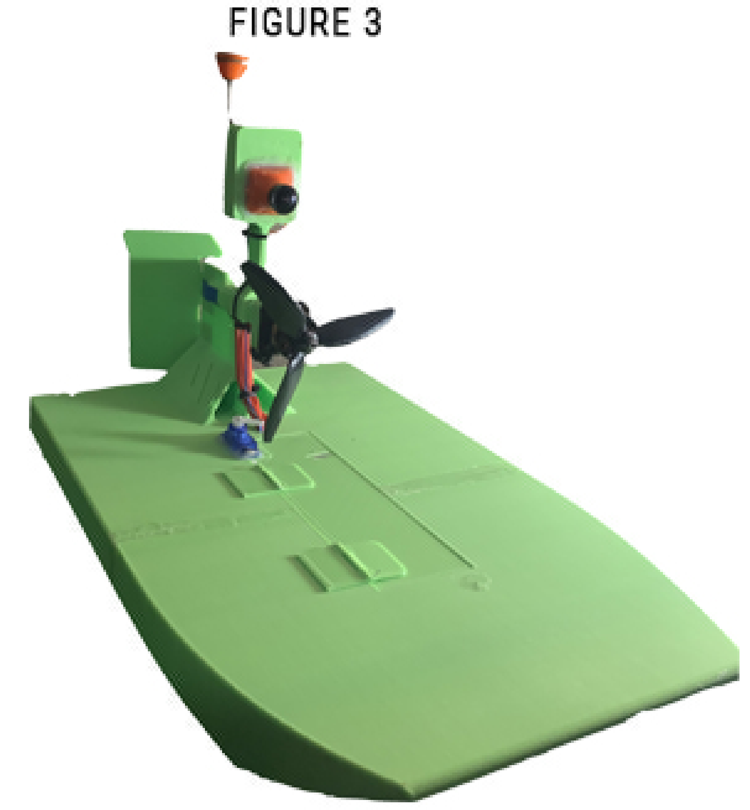
CREDIT: BECKER COUNTY WATER SAFETY DIVISION

Traditional methods of accessing waterways consists of a manned crew with a boat, trailer, and truck combo (Figure 2). Not only are these operations time consuming requiring a crew, they also require expensive equipment. This design seeks to offer an alternative method to inspection that costs less and has the capabilities to access locations that would be difficult or impossible with other solutions. Locations with high vegetation growth or low water levels as seen in Figure 1 are an example of the environment this design is suited for that may be problematic with a manned vessel.

PROPOSED SOLUTION

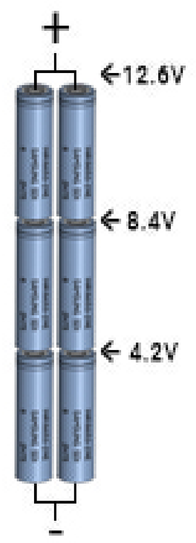
Inspiration for the design came from airboats used in swamps and bayous. The vehicle uses an air propulsion powertrain achieved using a motor and propeller system which allows for use on any water or snow surface. The operator uses a wireless video system that streams realtime video captured onboard the vehicle to allow for operations beyond visual line of sight. Electronic systems onboard have extensive waterproofing and ruggedization measures to prevent failure in harsh environments. The body of the vehicle is a flat-hull design similar to airboats and printed in two parts using PLA filament on a 3D-printer. Wall thickness needed to be above 5 layers to prevent water ingress and to ensure the vehicle will not capsize in use. Electronics were waterproofed by encasing them in a shell of epoxy resin using a 3D-printed mold to contain the epoxy as it cured. The assembled vehicle is depicted in Figure 3. Visible components are the propulsion system, rudder system, and video system.

FIGURE 3



SYSTEM DESIGN

POWER SYSTEM

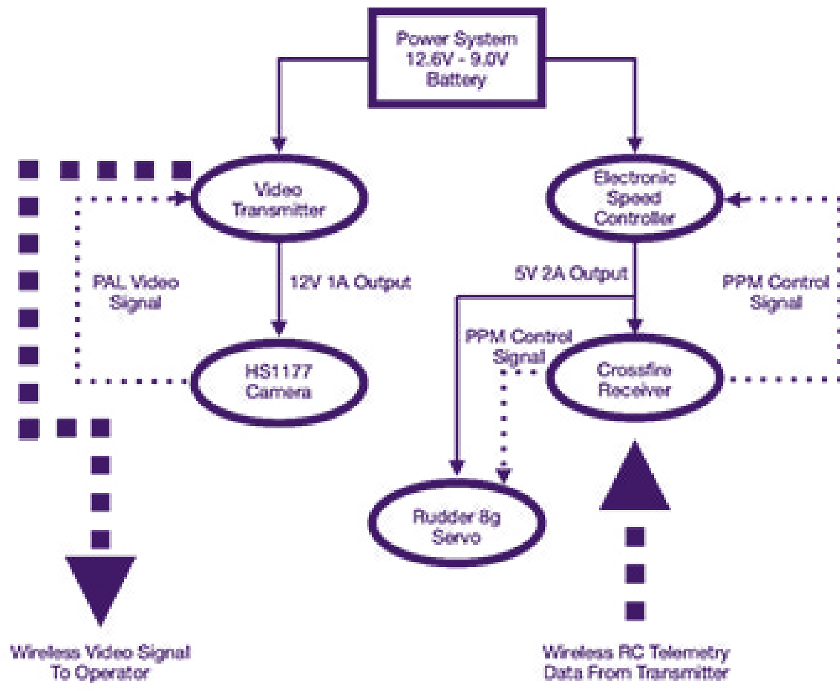


The power system on the vehicle consists of six LGABB41865 lithium-ion cells arranged in a configuration of 3 series and 2 parallel. This produces a battery with a peak voltage of 12.6V and a capacity of 56.16Wh resulting in ~30 minutes of runtime. The cells allow for the vehicle to pull up to 40A at 12.6V for a peak power output of half a kilowatt.

WIRELESS VIDEO RECIEVER

The wireless video system is received by a pair of FPV (first person view) goggles. The goggles contain a receiver circuit, antennae, and two video monitors. The receiver decodes the PAL (phase altered line) video signal and displays it on the monitors so the operator can navigate without direct line of sight. The goggle form factor also keeps the operators hands free to control the vehicle.

FIGURE 4

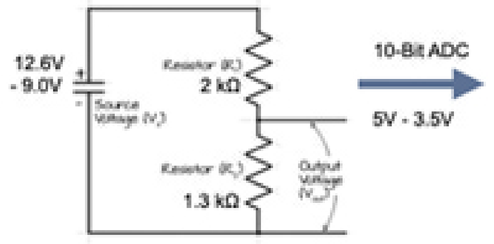


WIRELESS VIDEO TRANSMITTER

The video transmitter used in the design has an output power of 600mW which exceeds the power ouput that is allowed under Part-15 rules by the FCC. This requires the operator to hold an amateur radio license in the US. The 600mW transmit power corresponds to well over 2km of range even in non-ideal conditions. The transmitter is paired with a Sony HS1177 CCD camera that encodes video as a PAL signal which is then sent to the receiver.

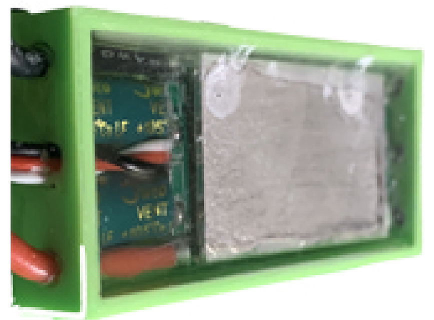
WIRELESS CONTROL SYSTEM

The wireless control system used was developed by Team Blacksheep to use the 900MHz ISM band while providing low-latency and 12+ km range. The system also allows for telemetry data to be passed through serial communications which was leveraged to give the operator battery health data. The control surface used is a Taranis QX7 controller. This device was programmed to pass inputs on the analog stick to the vehicle as throttle and rudder position information. The left stick controls throttle on the vertical axis and the right stick controls vehicle yaw on the horizontal axis. Also programmed into the controller is a safety lockout sequence that prevents accidental spin-up of the propeller to avoid harming the operator.



WATERPROOFING

Waterproofing electronics to survive in wet conditions was an important aspect when designing the electronics system for the vehicle. Because this design utilizes high current electronics coupled to a battery system capable of 500W, ordinary methods used to waterproof electronics did not work. The solution to this was to 3D-print molds to cast the electronics in two-part epoxy. Other methods such as conformal coating did not provide enough isolation to the circuit which resulted in shorted and burned components.



FUTURE DIRECTION

- Develop microcontroller system to enable GPS automation of vehicle
- Develop hand-off system between automated and manual control
- Epoxy cast autonomy system to prevent water exposure
- Incorporate HD video recording for enhanced inspection capabilities

ACKNOWLEDGEMENTS

Thank you to Dr. Hamari and the ECET department. Also a special thank you to those at Hiniker Pond during the testing phases for putting up with all the noise.

REFERENCES

Team Blacksheep. “TBS Crossfire R/C System.”

ARRL. “FCC Part-15 Rules: Unlicensed RF Devices”

ARRL. “PART 97—AMATEUR RADIO SERVICE”

CONTACT INFORMATION

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