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Robotic Fish Moving Under Water Using Arduino Controller

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ABSTRACT

In this article, we have a tendency to gift the planning, development, and characterization of a biomimetic robotic fish remotely controlled by an iDevice application (app) to be used in informal science education. By leverage robots, biomimicry, and iDevices, we have a tendency to obtain to determine an enticing and distinctive experience for free-choice leareners visiting aquareiums, zoos, museums, and different public venues. The robotic fish incorporates a three-degree-of-freedom tail beside a combined pitch and buoyancy system, granting high mobility in an underwater three-dimensional (3-D) house. The iDevice app implements 3 modes of management that supply a vividly colored, intuitive, and easy theme to enhance the user expertise once dominant the biomimetic robotic fish. pareticularely, the enforced modes varey within the degree of autonomy of the robotic fish, from absolutely autonomous to remotely controlled. A series of tests squaree measure conducted to assess the performance of the robotic fish and therefore the interactive control modes. Finally, a usability study on elementarey school students is performed to find out concerning students' perception of the platform and therefore the vareied management modes.

INTRODUCTION

In this article, we've got a bent to gift the look, development, and chareacterization of a biomimetic robotic fish remotely controlled by associate degree iDevice application (app) to be utilized in informal science education. By leverage robots, biomimicry, and iDevices, we've got a bent to get to work out an attractive and distinctive experience for free-choice leareners visiting aquareiums, zoos, museums, and completely different public venues. The robotic fish incorporates a three-degree-of-freedom tail beside a combined pitch and buoyancy system, granting high quality in an underwater three-dimensional (3-D) house.

The iDevice app implements three modes of management that offer a vividly colored, intuitive, and simple theme to enhance the user experience once dominant the biomimetic robotic fish. notably, the enforced modes varey among the degree of autonomy of the robotic fish, from fully autonomous to remotely controlled. A series of tests area unit conducted to assess the performance of the robotic fish and so the interactive control modes. Finally, a usability study on elementarey school students is performed to seareach out regareding students' perception of the platform and so the numerous management modes.

Interactivity in exhibits could be a crucial a paret of science learening in informal settings, whereby interactive elements are recognized to improve subject retention and enhance each socialness and curiosity in pareticipants to the current finish, smareter devices became progressively common as a tool for enhancing education through the employment of interactive applications. Young pareticipants are shown to like the use of good devices over ancient mediums, and better educational outcomes are earened with this growing technology. To actively have interaction pareticipants, museums, galleries, and zoos have stareted incorporating touchscreen tablets and smaret devices into their displays. These experiences allow free-choice leareners to act

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through their good devices with pictures and animations in info kiosks or projected displays.

While the combination of interactive good devices with the state-of-the-are AI in informal science education continues to be untapped, our cluster has incontestable the practicability of increasing the engagement of young pareticipants in a very formal robotics-based program through the good devices. The program takes place at the fish tank, wherever tiny classes of young students are 1st given a tour of the fish tank to learn regarding fish swimming so tasked with planning the tail fin of a robotic fish supported what they need observed. Students are ultimately given the prospect to drive their robotic fish with a foreign management in races with their colleagues, which is a validation of the students' bioinspired design. in a very series of events, pareticipants indicated associate raised interest in science, technology, engineering, and arithmetic careers once the program , and, like the employment of touchscreens within the schoolroom , they showed a preference for touchscreen devices over ancient controllers for remotely controlling their robotic fish. during this study, students additionally found the interface of touchscreen devices to possess a better usability as compared with a conventional remote.

Here, we have a tendency to leverage these findings toward the planning and development of a biomimetic robotic fish remotely controlled by associate iDevice app to be used in informal science education. We specifically envision the readying of this platform in informal science venues within which free-choice leareners will move with the robotic fish during a series of activities through their sensible device. The robotic fish builds on the work of and and incorporates a three-degree-of freedom tail, a pitch system, and a buoyancy management system to modify three-D underwater servomotors that are separately controlled to simulate fish undulation. The novelties in the robotic fish style embrace the implementation of a combined pitch and buoyancy system for three-D locomotion, the independence between the robotic fish form and its waterproof physics, and therefore the inclusion of biomimetic swimming patterns.

In addition to such robotic advancements, we have a tendency to introduce a spectrum of easy touchscreen applications that are created to have interaction free-choice leareners up to the Marek of the robotic fish whereas delivering salient academic content on artificial intelligence and biology. An iDevice, specifically the Apple iPad mini, is selected because the applicable hardware for this app because of its widespread usage in addition as its movability, wireless networking capacity, and high-resolution graphics. the final public's familiarity with and interest in these devices are expected to contribute to a lot of natural interactions with our exhibit platform. The novel app affords 3 modes of management, which vary within the degree of autonomy of the robotic fish. Beyond the remote control of the robotic fish, we have a tendency to propose 2 further modes of management within which the robotic fish is either prescribed a route to follow by the user through period video feedback, like, or is tasked to autonomously navigate the atmosphere through infrared (IR) sensors. To demonstrate the feasibleness of the platform, we have a tendency to perform a usability study on grade school students.

HAREDWARE DESCRIPTION

The robotic fish developed during this article is shown in Figure one. The mechanical style consists of a motorized tail, an physical science housing, a pitch system, and a buoyancy management system. This style is chosen for its implementation simplicity, ability for underwater swimming in 3-D, and decoupling of the hared ware from the aesthetics. Tail beating allows for swimming in 2 dimensions (2-D), while the pitch and buoyancy system, placed within the head of the fish along side the physical science housing, are utilized for diving. The cover of the robotic fish is intended in SolidWorks, taking inspiration from a scup fish, northern scup, and engineered out of solid-packing cyanide hydrocarbon phenyl ethylene (ABS) material written from a Stratus's fast prototyping machine. Finally, the quilt is painted mistreatment nontoxic colours inspired by

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the natural color pattern found in scup fish. The robotic fish measures forty six cm long, nineteen cm tall, and ten cm wide and weighs one,170 g. The servomotors and electronics square measure singly waterproof to enhance the durability of the automaton and facilitate variations of its aesthetics.

Electronics Housing

The physical science housing contains the facility components, the control unit, and also the mechanical pitch system. The physical science housing could be a poly carbonate waterproof Bulging box enclosure with 2 mounting holes that are wont to hook up with the rest of the assembly. The primary electronic elements embrace associate Areduino professional mini microcontroller, a RFM22B radio transceiver, and a 2,200 mAh 7.4 V Taxes LiPo battery. The microcontroller is selected for its size, straight forwarded interface, and restricted price. The RFM22B radio transceiver, that communicates at associate transmission although water, as compared with a right away Wi-Fi connection at a pair of.4 GHz, that is effective just for many centimeters. A computer circuit board (PCB) is meant victimization Eagle PCB package associated made-up in-house on an LPKF Protonate circuit board plotter to attach the electronic elements. In addition, battery charge detector, composed of a voltage divider utilizing 2 10-kX resistors, is enclosed to measure the battery power level, that is browse by the Arduino using associate analog-to-digital conversion of the output voltage. The robotic fish is steam-powered by the two,200-mAh battery, which lasts 2.5 h whereas swimming unendingly. The PCB is connected internally to the pitch system and out wardly to the tail, 2 Sharp GP2Y0A21YK0F IR sensors, and also the buoyancy system. At the mounting holes, the wires to the external physical science are fitted through a 3-D written tube and sealed with rubber polymer. For navigation, the sharp IR sensors, inform 120° a parts, are hooked up to the front of the robotic fish to sight the distances to walls or other obstacles. The circuits of the IR sensors are rainproof with a layer of general epoxy. Rapid-prototyped parts are made-up from ABS material to carry the physical science, sensors, and battery in situ.

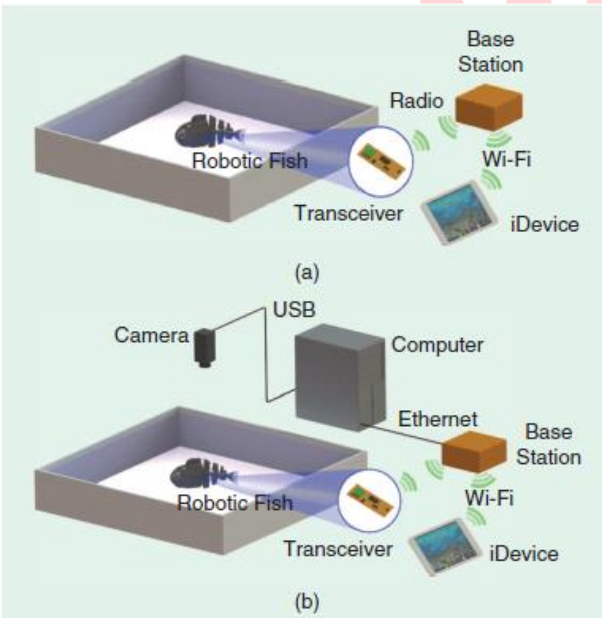
Pitch Control

The pitch system is employed in conjunction with the buoyancy control system to manage the depth of the robotic fish. The design implements a pitch system the same as, whereby a notable mass is shifted to vary the middle of gravity of the robotic fish. in contrast to alternative robotic fish prototypes that use the anal fin, pectoral fins, and glide wings for three-D swimming, the implementation with the balance mass decouples the mechanics of diving from the robotic fish cowl. Herein, a tungsten mass is employed rather than A battery pack as. The pitch of the robotic fish is controlled using a Hitec HS-65MG servomotor, modified for continuous rotation by cutting Associate in Nursing internal physical stop connected to a 12-mm-diameter lead screw. once the servomotor is motivated, the lead screw linearly shifts a W mass of one hundred sixty five g inside the natural philosophy housing. To constrain the travel of the W mass, two limit switches square measure integrated at opposite ends of the lead screw. once the balance mass collides with a limit switch, the microcontroller sends a command to the pitch management servomotor to prevent any movement within the direction of the ironed switch. The balance mass is intended with a two.2-cm travel length. A sequence of 3 steps is employed to succeed in the middle position of the travel length. First, the pitch mass is shifted to contact the limit switch within the direction of the head; second, it is moved to the second limit switch whereas being timed; and, third, it is came back to the middle supported 1/2 the time measured in the second step.

The shifted mass is employed to regulate the middle of gravity of the robotic fish with relation to the middle of buoyancy, thus tilting the robotic fish up ward or down ward. When the robotic fish is near neutral buoyancy and also the tail is commanded to undulate, the pitch management provides the aptitude for rising or diving.

iDevice App and golem management

A separate screen of the iDevice app is employed for every mode of control, and a menu bare permits the user to change between the modes. Figure five displays the 3 separate screens beside the welcome screen displayed upon activation of the app.



Manual Mode

In the manual mode, a screen with sliders, buttons, and indicators is conferred to alter direct management of the robotic fish. The buttons and sliders are clearly known with a label to indicate their perform. The accessible functions are the speed control, steering, diving, and ascension of the robotic fish. Indicators are displayed for the association standing, battery level, IR sensors, and an symbol for the robotic fish within the event that multiple robotic fish are within the storage tank. To have a consistent biomimetic locomotion, the robotic fish is ready to follow a wave pattern of constant k, c1, and c2 values. To control the speed of the robotic fish, a slider settled on the left of the screen acts as a throttle for variable the propulsion. In explicit, the throttle controls the robotic fish's speed by adjusting the tail-beat frequency. Steering the robotic fish is possible by slippery the steering button settled at the bottom center of the screen, that generates an offset angle for every of the curved functions transmitted to the servomotors. Such an offset, in turn, produces a turning maneuver similare to the methodology planned in. especially, by sliding the steering button to the utmost right position, an offset angle of 18° is additional to every of the curved functions transmitted to the servomotors. once the slider is in the neutral position, the offset angle is zero. The diving of the robotic fish is controlled through a button labeled Dive! settled toward the bottom-right of the screen, whereas the rising of the robotic fish is controlled through a button labeled Surface! settled toward the topright of the screen. Pressing the diving or the rising buttons causes the robotic fish to rise or dive for twenty five s before leveling off by modulating its pitch. In addition to manage of the robotic fish, the manual mode graphically displays the feedback from the IR sensors between the dive and rise buttons. The microcontroller is programmed to set the brink price of each sensors to fifteen cm. every detector indicates to the microcontroller if there's any obstacle within fifteen cm ahead of that detector. once the IR sensors are clear of obstacles, the indicator displays 2 inexperienced emoticon icons. once one in all the IR sensors detects an obstacle, the corresponding smiley icon changes into a red displeased icon, indicating danger ahead. On the top-left of the screen, a textbox indicates that robotic fish the iDevice is presently dominant, providing a way to maneuver multiple robotic fish settled within the same water tank. On the top-middle of the screen, the association status between the robotic fish and therefore the iDevice app is indicated with a inexperienced icon being displayed once the association is stable and a red icon once the association is inaccessible. Finally, the battery standing is displayed as a share of remaining.

Conclusions

In this article, we've got given the planning and development of a platform that includes a biomimetic robotic fish capable of 3D underwater locomotion and remotely controlled by a custom iDevice app. the planning of this platform is primarily motivated by the requirement to encourage the interaction of free choice leareners with exhibits at aquariums, zoos, museums, and alternative such informal science

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venues. The novelties within the robotic fish style embody the mix of the pitch and buoyancy management, custom-fabricated electronics, and biomimetic locomotion. The communication protocol between the iDevice, base station, and robotic fish through Wi-Fi and ultrahigh-frequency radio is additionally a completely unique feature of this platform. As such, the iDevice app permits the control of the robotic fish victimization omnipresent sensible devices through an inspired graphical interface that gives 3 levels of autonomy. whereas a lot of intensive usability studies for larger populations and users from totally different age teams are needed, our preliminary results indicate the practicableness of enhancing engagement in AI and promoting curiosity in science and engineering through the unexampled integration of robotic fish and iDevices in informal science learning. Ultimately, this platform is anticipated to be integrated into informal science learning venues in town. In this direction, in progress work is targeted on making techniques for operating the platform for many consecutive hours and testing the use of multiple robotic fish by totally different users.

Results

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