Prototype for wireless remote control of underwater robotic development

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ABSTRACT

Human beings have been substituted with robots in the performance of tedious and risky activities that human beings do not like or are incapable of performing due to the size of restrictions or the existence of the world, such as outer space or the ocean's depths. It has evolved into a low-cost, dependable, and inexpensive medium that can be used by both scientific societies and different industries for various surveys, mapping, and other underwater activities. In this study of underwater robotics power, we create an underwater robot that can fly in three dimensions: up-down, left-right, and front-back. The robot's motion is monitored by three motors, which also enable it to perform other tasks. Due to the fact that one-third of the world's population lives within 100 kilometers of the ocean, and that we are so focused on land and atmospheric problems that we ignore the seas, it is important to observe marine life and calculate the temperature and strength of light underwater. This application allows determining the appropriate temperature and intensity for living sea creatures to preserve their lives.

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1. INTRODUCTION

About two thirds of the earth's surface are occupied by the ocean and has a major effect on long-term survival of humanity. Within 100 kilometers of the sea, around 37% of the world's population lives [1]. We have not discovered yet the true deepness of the ocean and its rich non -living and living resources since we have focused our heed on land and atmospheric problems. For instance, it is estimated that there are around 2,000 billion tons of manganese nodules on the Pacific Ocean floor near the Hawaiian Islands, where a significant carbon dioxide amount comes from the seafloor and remarkable sets of organisms live in hydrothermal vent areas, which were recently found by manned submersibles, as well as environments where a huge volume of carbon dioxide is released from the seafloor and unusual species of animals live in hydrothermal vent zones. Underwater robotics will help us in better understanding aquatic and other environmental issues, in addition to protecting and effectively utilizing the ocean resources of the earth. Also, with today's technology, which have enabled people to land on the moon and robots to fly to Mars [2], a range of complicated issues related to the unstructured, dangerous undersea climate makes it impossible to travel in the ocean.

2. RELATED RESEARCH

2.1. Remote control systems

Remote controllers are standard accessories for a wide array of products, including televisions, video games, audio systems, lighting controls and home automation in a wide range of designs, shapes and wireless technology including garage/port openers, air conditioning systems, fans and remote keyless entry (RKE) vehicles. Furthermore, they are included in various styles and wireless technologies. Due to the low-cost of IR modules, infrared (IR) technology is used for the most common remote controls. However, IR-based controls have a number of disadvantages, including the need for line-of-sight (LOS) aiming, narrow operating angles, poor communication range, distortion issues, and high current consumption associated with the IR LEDs, which results in short battery life. radio frequency (RF) remote controls solve these problems and are available in large quantities due to high consumer demand. Furthermore, technological advancements are bridging the RF-IR price gap.

RF remote controls have identical characteristics. The main components of an RF remote control include the user's command keys, a microcontroller unit (MCU) for digital message conversions for user commands, an RF message module and relay transmitter, an antenna and battery for the remote-control system. Having a stable overall transmission range, a long battery life and low unit costs are the most common challenges faced by the manufacturers with developing RF remote controls [3].

2.2. Remote definition of a robot

A robot is a virtual or mechanical entity that is operated by an electronic circuitry or a computer program, and is typically an electromechanical entity. Robots may also be described as physical agents that manipulate the physical world to perform tasks. Furthermore, a robot is a reprogrammable; multifunctional manipulator that uses variable programmed motions to transfer materials, pieces, instruments, or specialized equipment to perform a range of tasks.

Sensors allow robots to sense their surroundings, and effectors allow them to exert physical influence on them. Humans have been replaced by robots to aid with the performance of certain tedious and risky activities that humans choose not to undertake, or are reluctant to do due to the size of restrictions or the complexity of working conditions. Based on their performance characteristics, modern robots are known as mobile robots, consumer or manufacturing robots, or support robots. In the last two decades, our understanding and use of robots have progressed from science fiction movies to the experience of computer-controlled electromechanical machines embedded into a vast range of industrial settings. Robot manipulators are usually used on assembly lines for painting and welding car bodies, packing printed circuit boards with IC parts, testing and fixing systems in underground, nuclear, and undersea conditions, and even picking oranges and harvesting grapes.

2.3. History of robots

Karel Capek, a Czech playwright, coined the name "robot" in his play Rossum's Universal Robots in 1920, with the word "robota" being the Czech word for "job" [4], [5]. Since that time, the term has been extended to a wide range of mechanical equipment, including underwater vessels,, tele controllers, and self-driving land rovers, among others. Almost all that is self-contained in any way. Nearly anything that is normally controlled by a computer and has a degree of autonomy has been referred to as a robot at some phase.

George Devol, who invented the word universal automation, designed the first programmable robot in 1954. Later, he abbreviated it to unimation, the name of the first robot corporation (1962) [6]. In 1987, unimation collaborated with general motors to create the programmable universal machine for assembly (PUMA) robot. The robot industry, on the other hand, is entering a period of rapid expansion. Robotics programs and courses have been launched at a number of universities. Mechanical engineering, electrical engineering, and computer science divisions, all offer robotics classes. In the 1990s, new applications of mobile robots and small robotics fueled a second wave of start-ups and science. The rovers of national aeronautics and space administration (NASA) will launch into Mars to search for answers about the water past of the planet.

The first common robot manipulator implementations generally required some sort of material movement, such as stamping or injection molding, where the robot simply attended a press to unload and then stack or transfer the finished component. Those early robots might be configured to carry out a chain of actions, such as closing a gripper, moving to position A, moving to position B, and so on. However, it lacked external sensor capabilities. Because of the enhanced contact of the robot with its surroundings, more complicated applications such as grinding, welding, assembly, and deburring need not only more complex motion but also some kind of external sensing like vision, force-sensing, or tactile [6], [7].

2.4. Underwater robot

The growing need for underwater systems for surveillance and tracking has piqued interest in developing underwater wireless communication applications that can be used for both point-to-point communication and to support underwater wireless sensor networks (UWSNs) [8]-[10]. Remotely operated vehicles (ROVs) are the most common underwater industrial unmanned robots that are tangled and controlled distantly; another category is autonomous underwater vehicles (AUVs) [11], due to high maintenance costs, operator exhaustion, and security concerns, ROVs and manned submersibles are only restricted to a few uses [11]. The market for innovative underwater robot technology is increasing, and fully autonomous, dependable underwater robotic vehicles are on the horizon. Various engineering projects in recent years have improved the vehicle's autonomy without reducing the need for human controllers. In the present underwater robotics technology, a self-contained, intelligent decision-maker AUV is the aim [12], [13]. Over 46 AUV models are available. The majority of the current AUVs are survey testing vehicles that have no manipulators [14]. Only a few numbers of them have worked on ice or in deep water, but their skills are till this moment in their infancy stage. AUVs have a vast range of feasible uses and have remarkable cost and protection advantages over ROVs. Nevertheless, various critical research challenges remain in order for the vessel to be reliable and completely autonomous, including a high-density power supply, on-board sensors for x-y navigation, and secure underwater communication technology [2], [15], [16]. Figure 1 shows sample of underwater robot.

Figure 1. Underwater robot

AUVs, UWSNs, submarines, aircraft, buoys, and divers are among the current technologies that rely heavily on acoustic communication. These devices are mostly designed to have a wide operational area and to be capable of long-distance communication (in the hundreds of kilometers), but they do have certain limitations: they are very costly, have very small data-rate transfer capabilities, and typically have very wide dimensions. They are frequently subjected to a wide range of problems due to acoustic communication, particularly when it comes to aspects related to networking, especially given that acoustic waves propagate slowly in water (1500 m/s) [8]. The wireless sensor network (WSN) model, in which nodes have been miniaturized, collaborates to create a sensing network that is spread for the atmosphere. Even though there has been a vastly advanced terrestrial technology in recent years, but due to the unique characteristics of the underwater world, it is a challenge to move any of the know-how built for terrestrial sensors to their underwater counterparts. Specifically, wireless underwater networks also have a number of issues [17], the most common of which is acoustic communication, which has a low data rate, high power consumption, and transmission speed issues. The key aim of this study is to create an underwater robot that can dive 100 meters at a speed of 3 kilometers per hour while traveling freely in three dimensions (up and down, left and right, front and back) [18]. In addition to this, the robot will be able to protect itself from bad water currents by floating to the surface of the water automatically. Moreover, this underwater robot is able to measure the intensity of illumination underwater and measure temperature for any area underwater. All these, by remote control. Therefore, the features and the significance of this research appear in designing a robot that can gather information easily, where we cannot physically obtain this information under many meters in seas and oceans, and exploring unknown places underwater. This saves the people’s lives by avoiding them from doing dangerous tasks such as measuring intensity of illumination and temperature in any area underwater. The remaining components of this research are outlined below: Clarify the problem formulation in section 3. Section 4 suggested a technique as well as implementations. Section 5 contains the tests and effects, as well as discussion of the results. Finally, section 6 concludes the paper and contains the findings and consequences for future research.

3. PROBLEM STATEMENT

The robot became something of an automaton in the 1930's and 1940's of the previous century. There was no evidence of intellect or even mobility in these devices. Since the control theory had such a strong impact on robotics, the construction of robots becomes more practical with the introduction of electronic circuits. Also now, several businesses, institutes, and universities are doing extensive research and fact-finding into the "knowledge" of robots.

As humans, we would do all of the factory work that killed thousands of people and maimed many more during the I.R. Many occupations are either dull or risky, such as domestic sweeping or exploring inside a volcano. Many tasks that humans would rather leave to robots are physically unavailable, such as visiting another world or conducting laparoscopic surgery. Robots find it possible to travel in automobiles and complete those tasks. They have robots that extract coal from mines and return it to the surface, which might have killed humans if they were doing such work. Human beings have been substituted with robots in the performance of tedious and hazardous activities that human beings do not prefer to do or are reluctant to do because of the size of constraints or the complexity of a setting such as outer space or the ocean's depths. And as we know, it is dangerous to send someone deeply underwater to study it, due to the lack of oxygen and light and other dangerous things. So, we will design an underwater robot that is guided by an electronic circuitry that can function deeply underwater and provide us with important information like intensity of illumination and other information without any human efforts.

In this research, we used hardware components, which are: NRF24L01 {TX/ RX (Transceiver)}, Arduino UNO [19], micro, Atmega [20], two power, supply (each with 3.7 V), three motors (DC motor), switches, liquid-crystal display (LCD) [21], light dependent resistor (LDR) [22], temperature sensor (LM35) [23]. Figure 2 displays the block diagram of the control part of the robot [24], [25]. Figure 3 depicts a data-transfer block diagram.

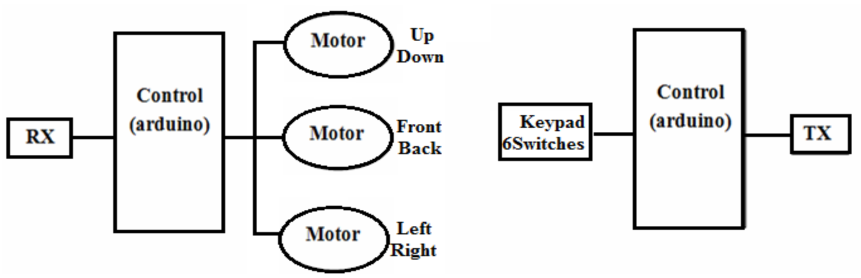

Figure 2. Block diagram of transferring data

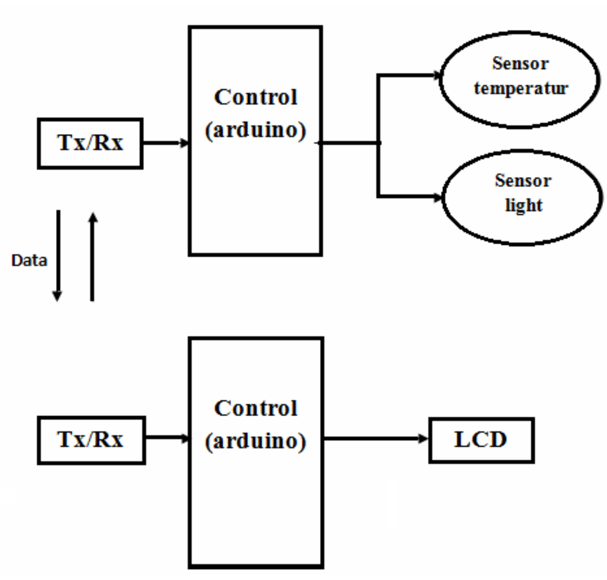

Figure 3. Block diagram of robot transfer data

4. METHOD

The robot design is divided into two parts: i) robot connections, which is built to operate underwater using the Arduino micro and the used sensors, in addition to the Arduino Uno and the DC motors, and ii) remote control connections, which is built to be used by the user to monitor the measurements received from the underwater robot and control its movement.

4.1. Robot connections

The robot consists of Arduino micro connected with NRF24L01 model, LDR and LM35 as shown in Figure 4. So, the data of temperature and intensity of illumination under the water is measured and then sent wirelessly to LCD screen. Also, the robot consists of Arduino Uno connected with NRF24L01 model and three DC motors as shown in Figure 5. The motors are controlled by switches located in remote control to move the robot up and down, front and back, left and right.

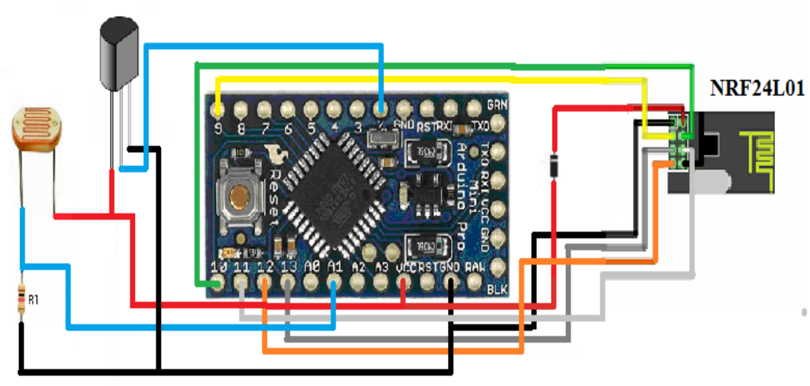

Figure 4. Arduino micro, LDR, LM35 and NRF24L01 connection

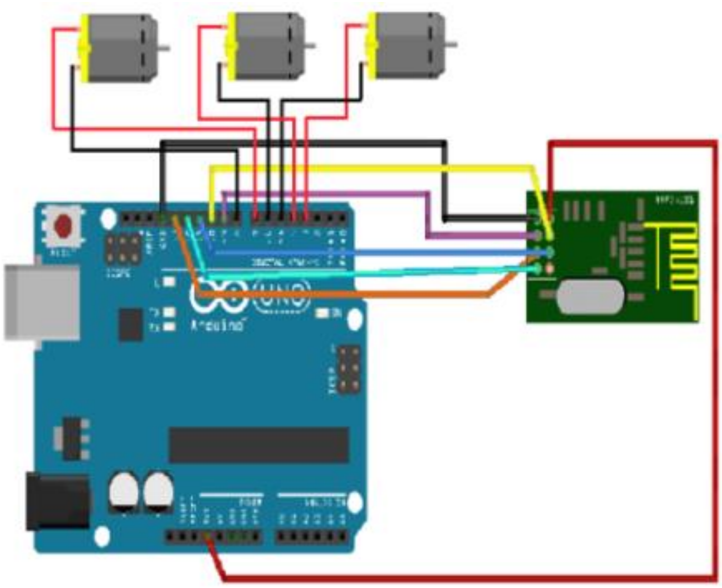

Figure 5. Arduino Uno, NRF24L01 and DC motors connection

4.2. Remote control connections

The remote control consists of Arduino mega, NRF24L01 model and LCD. The LCD is connected to mega Arduino to display measurements of temperature and intensity of illumination. Figure 6 shows the Arduino mega, NRF24L01 and LCD connection. Also, the remote control consists of Arduino Uno, NRF24L01 model and 6 switches as shown in Figure7.

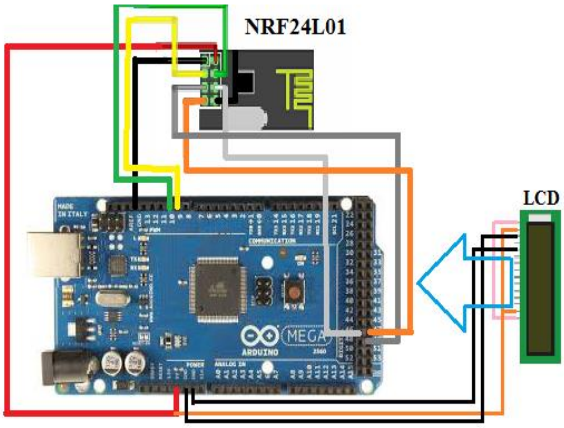

Figure 6. Arduino mega, NRF24L01 and LCD connection

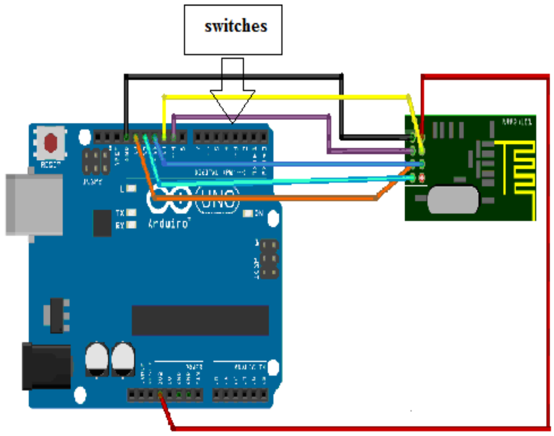

Figure 7. Arduino Uno, NRF24L01 and switches

5. RESULTS AND DISCUSSION

In this design, the robot can function underwater and move freely in 3D (up and down, left and right, front and back). The movement of the robot is in two directions automatically; so, our robot is able to protect itself by floating to the surface when it loses contact. The other way is manually movement using 7 switches. We control the robot by three motors, and the signals will move wirelessly using NRF24L01 model. Then, the robot senses these signals from it.

A robot can be described as a smart system that can do several tasks at the same time such as protecting itself. In addition, a robot can provide us with many information such as Intensity of illumination and temperature on any area underwater. Figure 8 shows the measured data. Also, Figure 9 shows the prototype of the underwater robot design.

Figure 8. Data screen reading

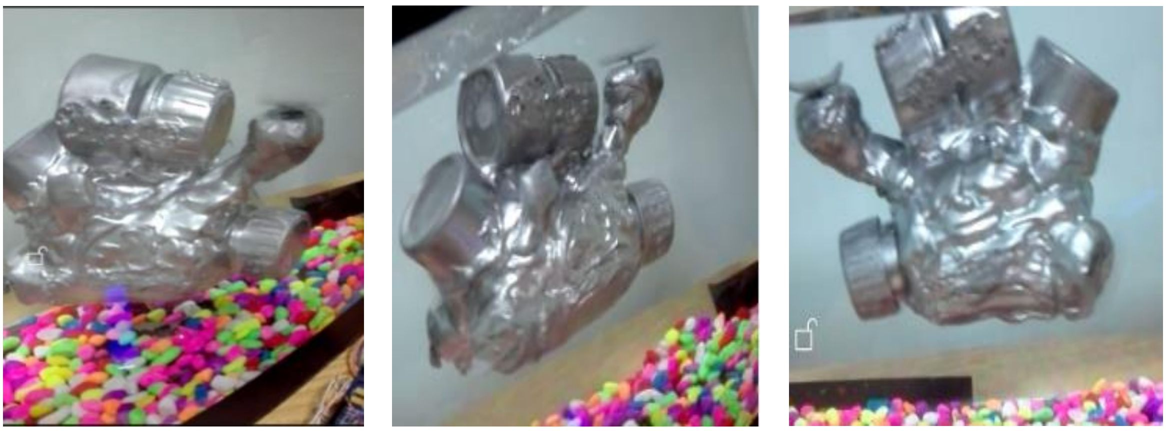

Figure 9. Underwater robot design

6. CONCLUSION AND FUTURE WORK

It is worth noting that robotics' significant uses are not limited to factory workers in this case, the robot is taking the place of a human employee. There are a few several other uses for robotics in situations where humans are either inefficient or inconvenient. Undersea and world-wide discovery, satellite recovery and restore, and explosive device calming are only a few examples. Finally, prosthetics, such as artificial limbs, are robotic systems that require research and construction techniques close to those used in industrial manipulators. As new technology in diverse subsystems evolve and future application areas are explored, underwater robotics represents a rapidly increasing research field and exciting market.

This article presents underwater robot controlled by three motors. Switches allow the robot to go up and down, left and right, front and back in three dimensions. Since water occupies roughly two-thirds of the planet and has a significant impact on every human's potential life, it is critical to research marine life. Our goal is to solve a variety of problems and make it easy to obtain whatever knowledge we need remotely and without exerting any effort.

Due to the fact that one-third of the world's population lives within 100 kilometers of the ocean, and since we are so focused on land and atmospheric problems that we ignore the seas, it is important to observe marine life and calculate the temperature and strength of light underwater. This application allows determining the appropriate temperature and intensity for living sea creatures to preserve their lives.

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