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DEVELOPMENT OF AN OBSTACLE AVOIDANCE ALONG WITH VOICE RECOGNITION FOR AN UNDERWATER VEHICLE USING THE FIN SYSTEM AND A MICRO PROCESSOR BASED SPEECH RECOGNITION

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ABSTRACT

Augmenting speech recognition to an unmanned Underwater Vehicle- a underwater glider, its movements is based on the buoyancy propelled for float and fixed wing stabilization in the gliders body. Collision is the main limitation of the underwater glider. A solution has been brought about using the fin system. To this a microprocessor based speech recognition is coupled. The system is designed to enhance the controls of the underwater glider. Recognition is based on the minimum Euclidean distance between energy function and sampled templates. In this paper the recognition systems is coupled with a UTeM underwater glider that has been modified from fixed to flexible wing.

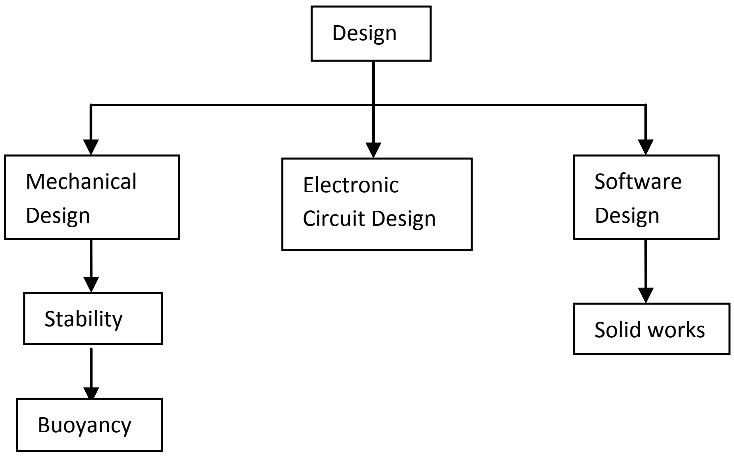
Introduction

Owing to the plethora of plastic waste in the seas, many of the underwater vehicles pay price along with humans and marine animals. Plastic blinds the underwater vehicle covering its lens hindering operation. This is a challenge for the gliders activity, since it cannot identify the trajectory of movement if the sensor and the camera is covered by plastic. These underwater vehicles require obstacle avoidance to avoid damage, and also to enhance the system to become more effective in terms of speed and glides. The underwater ballast tank system is used in previous UTeM glider for deep diving. Hence, the speed of the fixed wing glider is slow. The glider takes more time to submerge manually while facing obstacles. So a flexible fin system is required to overcome this problem.

To enhance the operation controls for this device we utilize a microprocessor based speech recognition also.

Methodology

There are 3 methods of implementation, software, hardware, electronic circuit design. The closed loop system of obstacle avoidance systems is used in an underwater glides. A PIC HC is used as the controller for the system. The fin has been driven by a PIC controller. Sensor is used to determine the error of wings between desired input and actual output.



Fin System

The main purpose of the fin system is the movement of the glider underwater avoiding obstacles.

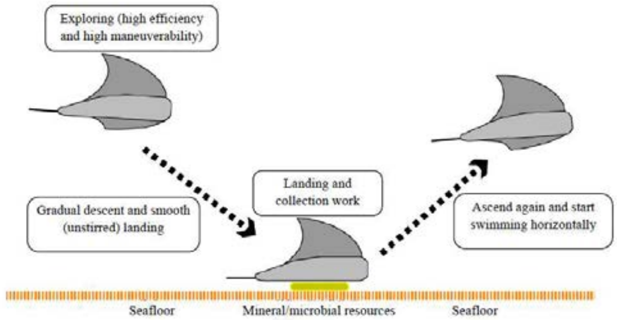
There are mainly two types of fins aiding to this: (1) Median; (2) Paired

(1) Median fins: Single, vertical fins are on the back and on the underside of the fish.
(2) Paired fins: They are present on either side of the fish body and are identical to the each other.

Furthermore, each fin has its own characteristic feature and tasks: the dorsal and fins save water level. The caudal fins consists movements of forward and steer. The pelvic fins help to balance. The pectoral fins help to brake.

In mechatronic technology, a flexible oscillating fin propulsion system was built to realize flexible movement of fish. Furthermore, advanced autonomous control logic was developed to create a lifelike swimming fish robot capable of 3D autonomous moving without cables. Below figure shows the appearance of a developed underwater vehicle (swimming in the water).

The following figure shows the concept of fish movements for prototype of the flat fish robot. This is aimed at building an underwater vehicle with flexible oscillating wings that can move smoothly based on “the principle of wing flapping.

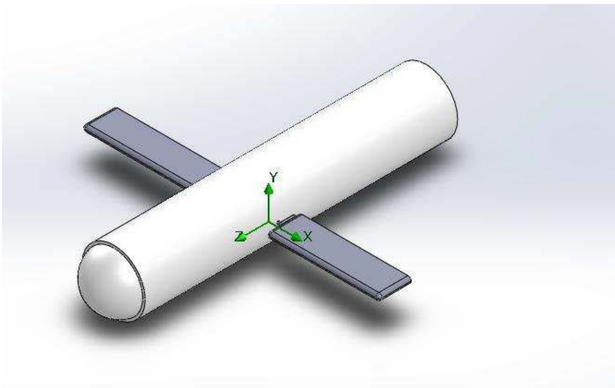


Hardware Implementation

A SK400 board, servo motor driver, sensor and power supply are used as parts for implementation. A sensor must be used to sense the obstacle in front of the glider. HC-SR04 is a ultrasonic ranging module, whose features are,

1. 2cm - 400cm non-contact measurement function,
2. Ranging accuracy can reach to 3mm
3. The modules include ultrasonic transmitters, receiver and control circuit.

It works at DC 5V with 5mA current. It can detect obstacles in the range 2 to 4cms. It can also measure at 0-15 angles.



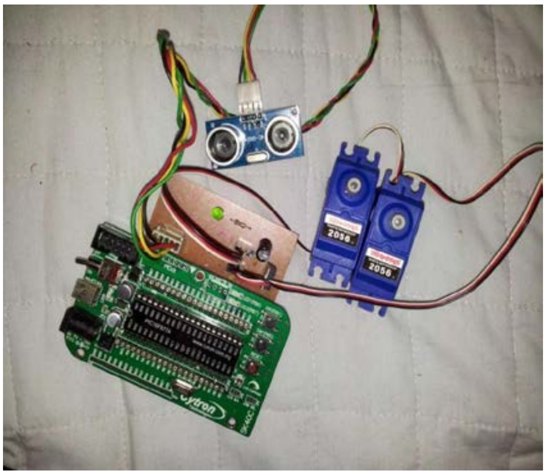
Mechanical Construction

Underwater glider designed in a hydrodynamic shape to reduce friction when moving in the water. The glider is made of fiber-glass due to its strength, durability, flexibility and non-corrosiveness. Underwater glider volume is: 106cm x 90cm x 20cm wide.

Water proof servo motor, Traxxas 2056 is used to control movement of the wing.

Software

It includes drawing and C-language programming. Solid works, PIC C-complier, express PCB software are used to accomplish software implementation. In this paper, PIC C-complier, CCS is used to type the code. Also, it is used to simulate the code before uploading it to the PIC16F877A. The figure below shows an electronic controller interface that is used.



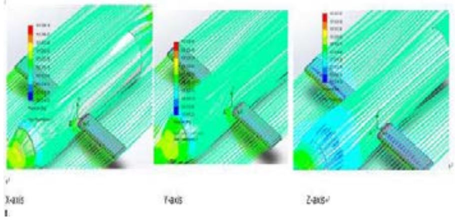
Result and Discussion

This experiment is based on the simulation result of flow trajectories in solid works simulation.

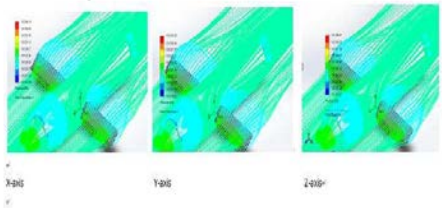
Suitable Wing Angles

For Submerge

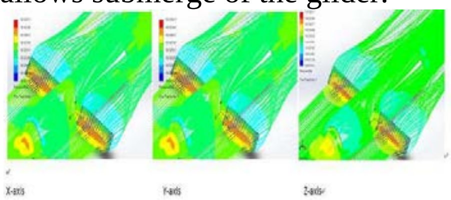
1. At 0 degree, upper and lower pressure on both of the wings is same. Same pressure above and below the glider move it forward.



2. At -30 degrees, pressure applied at the front of the wing is a bit higher than the pressure at the end of the wing. The high pressure causes the wing to turn down and therefore the glider goes down whilst moving forward.

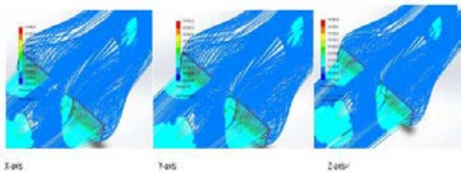


3. At -45 degrees, same as above, allows submerge of the glider.



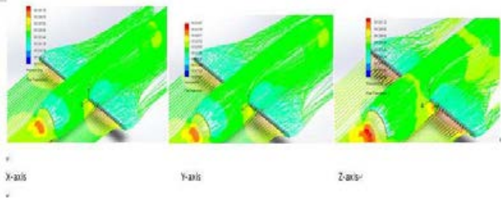
4. At -60 degrees, the pressure is smaller when compared to the above angles (-30 and 45). The glider might stop moving forward because the forward speed is low.

Thus, -45 is a suitable angle for submerge.



For Rise

1. At 45 degrees, the glider can be raised up.



Process of Speech Recognition for the above System

A generalized process for speech recognition is as given below,

1. Signal Acquisition:
   This process transforms physical speech into data which a computer can deal with. The data is also stored for further processing, an in built analog to digital converter in the microcontroller is utilized for this purpose.
2. Analysis:
   This stage reduces amount of data from the previous process and it extracts the required information needed for recognition. In this case energy function of the sample is calculated.
3. Similarity calculation:
   This is the core of the recognition process. It determines similarity between an unknown sample of speech and a reference template. It measures distance between two templates and the information is used in the next process for decision making. The dynamic time wrapping algorithm is used.
4. Decision Logic:
   It uses the distances measured form the stage 3. The distance between input sample and various templates in database are compared.

A Motorola M68HC16Z1EVB evaluation board might be used for this purpose.

Implementation of Speech Recognition Algorithm

1. Signal detection:
   Prior to the analysis of the speech data, detection of the start of the speech data is essential. It is noted that the starting point of the recorded data. Detection of the beginning of the speech input is based on the upper and lower threshold average magnitudes. The recorded input speech waveform is examined until the input has exceeded a pre-defined upper threshold value. The index at that point within the array is recorded as the initial beginning point of the speech waveform. Next, the algorithm steps backward through the speech waveform until it goes below a lower threshold. This is the actual starting of the waveform.

2. Signal_Acquisition:
   The input speech is sampled at 25 kHz for a second. The above routine detects the presence of speech before commencing recording. Fifty samples are read at a time and the energy of these are calculated. When the energy exceeds a predefined threshold, a period of exactly one second is recorded. This one-second recording is also checked against accidental triggering due to loud background noise of the

microphone. A second level routine checks the energy between the 4600^{th} and the 4854^{th} samples. This energy is compared against an upper threshold. When the sound exceeds this threshold value, the one second is accepted and the next stage begins.

3. Initial data Compression:
   At 25 kHz, 25000 samples are obtained. In order to reduce the amount of data in order to improve the speed, only energy fourth sampled was used. This reduced the size to 6250. This is a good sample value since it exceeds the Niquist rate of 3000Hz, which the upper frequency limits of speech.

4. Normalization:
   The "proportional normalization" technique is used to compensate for variations in energy due to distance variation between user and microphone.
   The following expression is used to determine the normalized value,
   V=U+(U-L)(M-Mx)/(Mx-L)
   Where, V= normalized sampled magnitude
   U=un-normalized data value

   L=minimum amplitude

   M=maximum value

   Mx=maximum amplitude

5. Distance Measurement

This is the stage where actual recognition process begins. Here, dynamic time wrapping is used. It allows correct matching of the templates even though they were recorded at different speeds.

6. Decision logic:
   It is nothing but the one which compares the distance values obtained from the distance process.

Results

Due to limitations of the memory capacity within the evaluation system, only up to four words are tested at a time. It is also observed that some words are more easily recognized as compared to others. The difficulty in differentiating some words is due to similarity in the energy patterns between them. An example is the words Left and Right that gave only 35% accuracy between them, whereas, a 100% accuracy was achieved for the words such as Astern and Ahead. Moreover, stored templates had greater effects on the accuracy of recognition. For a badly recorded template that is considered as a reference, the accuracy of subsequent recognition will be reduced drastically. Hence, it is required to have multiple templates or an average of more than one template be used for each command. Alternately, some form of adaptive process should be used to update and store the templates.

Conclusion

In the world today, where man slowly ventures out into the seas from land is need of means to explore and learn about it completely, with very little to lose. This Underwater vehicle serves this exact purpose with excellent controller options that increases efficiency via voice control.

Future Scope

This vehicle has a limited surveillance distance thanks to the cable required to communicate with it. A wireless model of the same would make the vastness of the sea appear minuscule.