IMPLEMENTATION OF A PROTOTYPE BOAT WITH WIND AIDED AUTONOMOUS NAVIGATION

H.K.M. Gunasekara, U.N. Gnanarathna, K.T.M.U. Hemapala, D.D.A.S. Jayasiri
Supervised by: Dr Thrishantha Nanayakkara

ABSTRACT

The aim of the project is to use an autonomous vessel that can navigate in rough water. This avoids intensive human involvement in controlling marine vessels, which used to collect row data for industries like fisheries, tourism, and defense applications. Moving to autonomous minimizes the use of communication link and accommodates more baud rate for transferring row data to host station.

1. INTRODUCTION

Robotic applications are becoming increasingly popular and significant in industrial, commercial, and scientific applications. The purpose of having a robot with self decision-making ability is to minimize human involvement in hazardous and tedious work environments. The development of practical and useful unmanned autonomous robots continues to present a challenge to researchers and system developers.

Two main streams of research areas have emerged in the mobile robotics community. In autonomous vehicle robot research, the goal is to develop a vehicle that can navigate at relatively high speeds using sensory feedback in outdoor environments such as fields or roads. These vehicles require massive computational power and powerful sensors in order to adapt their perception and control capabilities to the high speed of motion in complicated outdoor environments. The second area of the research deals with mobile robots that are designed to work in indoor environments or in relatively controlled outdoor environments. The problem of autonomous navigation of mobile robots, involves certain complexities that are not usually encountered in other robotic research areas. In order to achieve autonomous navigation, the real-time decision-making must be based on continuous sensor information from their environment, either in indoor or outdoor environments, rather than off-line planning. An intelligent machine such as mobile robot that must adapt to the changes of its environment must also be equipped with a vision system so that it can collect visual information and use this information to adapt to its environment. Under a “general” and adaptable control structure, a mobile robot is able to make decisions on its navigation tactics, modify its relative position, navigate itself way around safely or follow the known path.

Autonomous navigation requires a number of capabilities, like ability to execute elementary goal-achieving actions, reaching a given location; to react in real time to unexpected events, like the sudden appearance of an obstacle; to build, use and maintain a map of the environment; to determine the robot's position with respect to this map; to form plans that pursue specific goals or avoid undesired situations; and to adapt to changes in the environment.

2. FEASIBILITY STUDY

According to the information gathered through Internet and printed material, we found that there is many automated vehicles have been produced by the researches all around the world. Even if there are automated boats it was found that wind aided navigation of an automated boat is a new concept. Since it has not been previously used in any research, we had to study several options for supplying power to the vessel using wind.

1. To have a rechargeable battery bank which is charged by an on board wind turbine.

   Drawbacks:

   Maintaining the stability of the vessel and insufficient power of the turbine to charge the battery bank.

2. Drive the center propeller using a directly coupled wind turbine to it.

3. A fixed sail is used to drive the vessel using power while keeping a battery bank charged by a wind turbine.

3. BASIC CONCEPTS

The project aims at developing a robotic vessel, which navigates using wind energy in the sea. This is unmanned and can be controlled from a remote station, which may be another ship/boat, or a station on the land. The vessel consists of a micro-controller based embedded system which is programmed to control it according to some given requirements. There is a communication channel between the remote station and the vessel, which is a Radio Frequency Wireless communication channel.

The basic function of the vessel is to go to the location as specified by the operator in the remote station. An onboard GPS (Global Position System) is used by the embedded system to identify the present location of the robot. Latitude and longitude numbers give the location that should be reached by the robot, which is fed to the system through the communication channel. Since the micro-controller is programmed with a behavior-based algorithm the system navigates using wind power until the specified location is reached by the system. While reaching the location the operator in the station can monitor the behavior of the vessel as it sends the data about the current situation of it including the present location to the station time to time.

After reaching the specified location the vessel can be used for many application with the required modifications, which are out of the scope of our project. An example may be to use it to find the areas where the fish is and to provide information to the fishermen. Another may be to find the enemy boats in military applications.

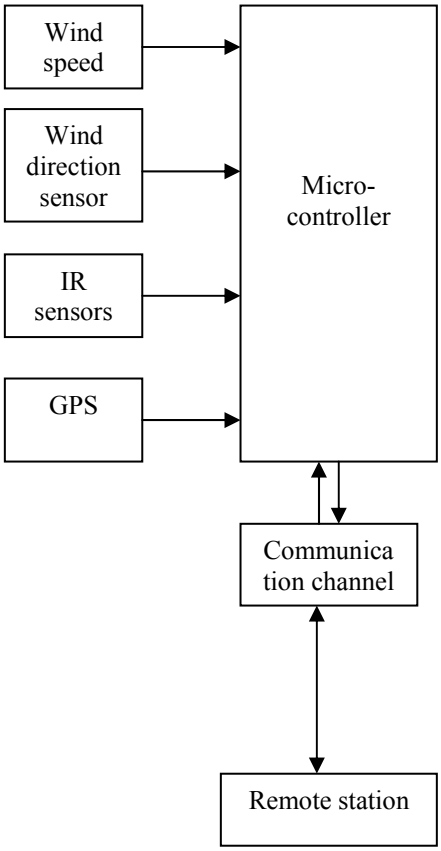

Fig.1 Basic block diagram of the robot

4. SENSORS OF THE EMBEDDED SYSTEM

4.1 Wind direction detector

The wind direction is detected relative to the vessel. The detector consists of a potentiometer attached to a wing, which aligns parallel to the wind direction and pointing towards the direction from where the wind comes. The potentiometer is a circular type, which has the range up to 300 degrees (that is the range of commercially available potentiometers). Therefore the potentiometer gives an output voltage proportional to the angle of the direction of wind, measured relative to the vessel and with respect to some fixed angle. This voltage is the output of the wind direction detector, which is fed to the micro-controller for further processing.

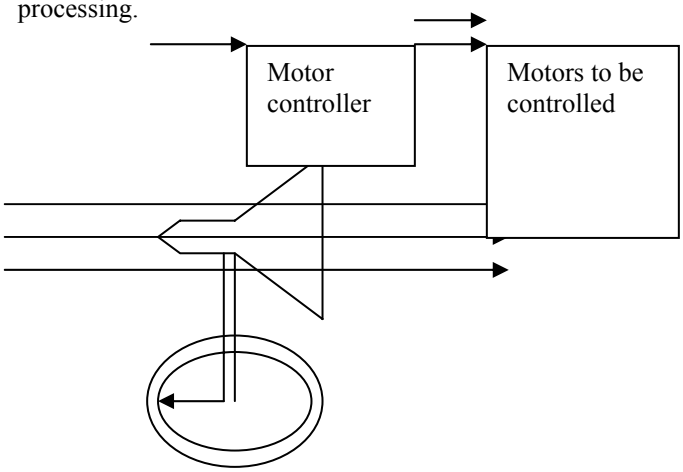

Fig. 2 Potentiometer

4.2 Wind speed sensor.

This consists of a tachometer connected to an anemometer. The anemometer rotates at a speed proportional to the wind speed relative to the vessel which rotates the tachometer which is a small dc generator that produces a dc voltage proportional to the speed of tachometer and hence the speed of wind. The output of the wind speed sensor is a dc voltage and this voltage is fed to the micro-controller for further processing.

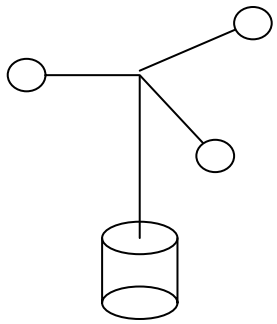

Fig. 3 Anemometer

4.3 IR sensors

IR sensors are used to detect the obstacles in front of the vessel in order to avoid them. The signals from IR sensors are fed to the micro-controller to be processed. Two IR sensors are mounted in front of the vessel at two ends.

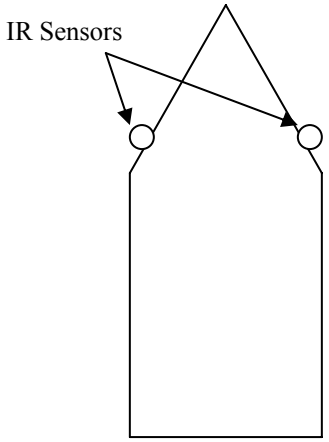

Fig. 4 IR sensors

4.4 GPS

A GPS with a serial port has to be used in order to identify the current location of the vessel. The GPS data is fed to the micro-controller directly. This data is sent to the remote station and also used for further processing.

5. POWER SUPPLY TO THE EMBEDDED SYSTEM

There are two main power sources that can be used to drive vessel in the sea.

- Wind energy
- Solar energy

There is a fixed sail on the vessel. This sail uses wind power directly to drive the vessel forward. Wind supports the vessel to move in forward direction only if there is component of wind speed along that direction. By measuring the wind speed direction (relative to the vessel) it can be determined whether the vessel can move using wind power or not. This information is sent to the station as well.

There is an onboard battery bank as well which is charged by a solar panel. This battery bank supplies the power to the circuit and two motors, which drive the two propellers used to turn the vessel. If sufficient energy is obtained by the solar panel the two propellers also can be used to drive the vessel.

Therefore the vessel uses

- Wind power directly to drive the vessel
- Solar power drive the vessel using two propellers

The above two options are used by the system appropriately according to the situation.

The actual implementation of the vessel is a complex and expensive process. This type of projects should be handled step by step. Our aim was to propose a design and implement a simulation, which demonstrates the behavior of the actual implementation and could be used to develop it.

As it is difficult to find the required equipments we had to replace some of the parts of the vessel appropriately.

- Since it is difficult to find a GPS for our project, as they are very much expensive a programmed computer replaced the GPS, which allow us to input the GPS data in a suitable manner to demonstrate the behavior of the vessel as it navigates.
- Another computer is used as the remote location and the communication path is the RS 232.
- The output signals of the wind sensors were created using dc power sources.
- The behavior of vessel was demonstrated with different conditions.

6. CONCLUSION

A major problem that we came across during the project was lack of efficiency of the wind power. We were unable to draw appreciable wind power to drive our prototype vessel. As a remedial action we employed battery power. But in actual case, by observing the wind pattern we can employ wind energy as well.

7. ACKNOWLEDGEMENT

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8. REFERENCES

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