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Innovative Multi Directional Wind Turbine

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Abstract:
The main aim of this project is to multi directional wind turbine. The direction of the wind turbines can be controlled using IR technology. Wind energy has been used since the earliest civilization to grind grain, pump water from deep wells, and power sailboats. Wind-mills in pre-industrial Europe were used for many things, including irrigation or drainage pumping, grain-grinding, saw-milling of timber, and the processing of other commodities such as spices, cocoa, paints and dyes, and tobacco. Before the U.S. installed an infrastructure of electricity wires, both water-pumping windmills and small wind electric turbines ("wind chargers") were vital to farming and developing the American Great Plains and west. In recent decades, the industry has been perfecting the wind turbine to convert the power of the wind into electricity. The wind turbine has many advantages that make it an attractive energy source, especially in parts of the world where the transmission infrastructure is not fully developed. It is modular and can be installed relatively quickly, so it is easy to match electricity supply and demand. The fuel – the wind – is free and plentiful, which eliminates or reduces the need to purchase, ship, and store expensive fuels. It is flexible – with the power generated, households use can use appliances, such as lighting and refrigeration, schools can use computers and televisions, and industries can access a reliable power source. Perhaps most importantly, the generator does not produce any harmful emissions in the process of generating the electricity, unlike many other generation sources. The controlling device of the wind is a Microcontroller. The Microcontroller is loaded with an intelligent program written in embedded 'C' language.

Keywords: Micro controller, IR Transmitter, IR Receiver, Wind

1. Introduction

HISTORICAL DEVELOPMENT

Wind has served mankind as a source of power for over 3000 years now. Before steam engine came into existence, wind power was used for sailing ships. In the later years, with the advent of wind mills, wind power was being converted to mechanical power through wind mills for grinding grains and pumping water. Wind mills have also been known to drive water through pipes for irrigation. With the development of the steam engine, the dependence on wind energy dropped drastically. This also resulted in lower interest in research into the field on wind power. Wind energy, being one of the cleanest sources of electricity, has emerged as one of the most preferred sources for electricity generation. It is also abundant and can be tapped in a cost effective way. The maximum extractable energy from the 0-100 m layer of air has been estimated to be of the order of 1012 kWh per annum, which is of the same order as hydroelectric potential. The present day sees wind power is an entirely different way. Incentives are being offered to customers who are seeking wind power instead of thermal power for their domestic requirements. This has been a welcoming change to the wind energy fraternity as the number of customers opting for wind power has been showing a rise.

POWER CONTAINED IN WIND:

The power extracted from the wind can be calculated by the given formula:

PW=0.5ρπR3Vw3CP(λ,β)

Pw = extracted power from the wind,

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ρ= air density, (approximately 1.2 kg/m3 at 20° C at sea level)
R = blade radius (in m), (it varies between 40-60 m)
Vw = wind velocity (m/s) (velocity can be controlled between 3 to 30 m/s)
Cp = the power coefficient which is a function of both tip speed ratio (λ), and blade pitch angle, (β)(deg.)
Power coefficient (Cp) is defined as the ratio of the output power produced to the power available in the wind.

This project is a design of two combination technology direction sensing robot and Multidirectional Wind Turbine. The direction of the wind turbine can be controlled using wireless IR technology.The controlling device of the Robotic vehicle is a Microcontroller. The RF device transmits different data which will be received by IR receiver. The IR receiver feeds the data to Microcontroller and Microcontroller acts on the dc motors to control the directions as well turbine directions.

WIND TURBINE BLADES

Wind Turbine Aerodynamics

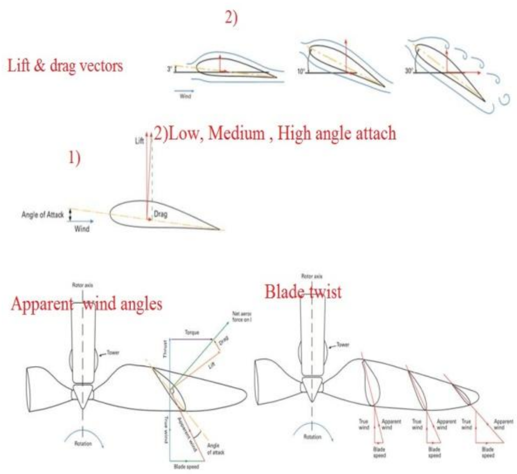
Wind turbine blades are shaped to generate the maximum power from the wind at the minimum cost. Primarily the design is driven by the aerodynamic requirements, but economics mean that the blade shape is a compromise to keep the cost of construction reasonable. In particular, the blade tends to be thicker than the aerodynamic optimum close to the root, where the stresses due to bending are greatest. The blade design process starts with a "best guess" compromise between aerodynamic and structural efficiency. The choice of materials and manufacturing process will also have an influence on how thin (hence aerodynamically ideal) the blade can be built. For instance, prepare carbon fiber is stiffer and stronger than infused glass fiber. The chosen aerodynamic shape gives rise to loads, which are fed into the structural design. Problems identified at this stage can then be used to modify the shape if necessary and recalculate the aerodynamic performance.

Number of blades

The limitation on the available power in the wind means that the more blades there are the less power each can extract. A consequence of this is that each blade must also be narrower to maintain aerodynamic efficiency. The total blade area as a fraction of the total swept disc area is called the solidity, and aerodynamically there is an optimum solidity for a given tip speed; the higher the number of blades, the narrower each one must be. In practice the optimum solidity is low (only a few percent) which means that even with only three blades, each one must be very narrow. To slip through the air easily the blades must be thin relative to their width, so the limited solidity also limits the thickness of the blades. Furthermore, it becomes difficult to build the blades strong enough if they are too thin, or the cost per blade increases significantly as more expensive materials are required.

How Blades Capture Wind Power

Just like an aeroplane wing, wind turbine blades work by generating lift due to their shape. The more curved side generates low air pressures while high pressure air pushes on the other side of the aerofoil. The net result is a lift force perpendicular to the direction of flow of the air.



The lift force increases as the blade is turned to present itself at a greater angle to the wind. This is called the angle of attack. At very large angles of attack the blade "stalls" and the lift decreases again.

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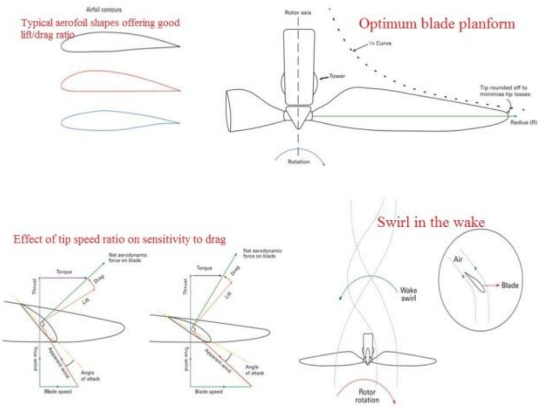
So there is an optimum angle of attack to generate the maximum lift. There is, unfortunately, also a retarding force on the blade: the drag. This is the force parallel to the wind flow, and also increases with angle of attack. If the aerofoil shape is good, the lift force is much bigger than the drag, but at very high angles of attack, especially when the blade stalls, the drag increases dramatically. So at an angle slightly less than the maximum lift angle, the blade reaches its maximum lift/drag ratio. The best operating point will be between these two angles.

Twist

The closer to the tip of the blade you get, the faster the blade is moving through the air and so the greater the apparent wind angle is. Thus the blade needs to be turned further at the tips than at the root, in other words it must be built with a twist along its length. Typically the twist is around 10-20° from root to tip. The requirement to twist the blade has implications on the ease of manufacture.



Blade section shape

Apart from the twist, wind turbine blades have similar requirements to aero plane wings, so their cross-sections are usually based on a similar family of shapes. In general the best lift/drag characteristics are obtained by an aerofoil that is fairly thin: it's thickness might be only 10-15% of its "chord" length (the length across the blade, in the direction of the wind flow).

Blade plan form shape

The plan form shape is chosen to give the blade an approximately constant slowing effect on the wind over the whole rotor disc (i.e. the tip slows the wind to the same degree as the centre or root of the blade). This ensures that none of the air leaves the turbine too slowly (causing turbulence), yet none is allowed to pass through too fast (which would represent wasted energy). Remembering Betz's limit discussed above, this results in the maximum power extraction. Because the tip of the blade is moving faster than the root, it passes through more volume of air, hence must generate a greater lift force to slow that air down enough. Fortunately, lift increases with the square of speed so its greater speed more than allows for that. In reality the blade can be narrower close to the tip than near the root and still generate enough lift.

Rotational speed

The speed at which the turbine rotates is a fundamental choice in the design, and is defined in terms of the speed of the blade tips relative to the "free" wind speed (i.e. before the wind is slowed down by the turbine). This is called the tip speed ratio. High tip speed ratio means the aerodynamic force on the blades (due to lift and drag) is almost parallel to the rotor axis, so relies on a good lift/drag ratio. The lift/drag ratio can be affected severely by dirt or roughness on the blades. Low tip speed ratio would seem like a better choice but unfortunately results in lower aerodynamic efficiency, due to two effects. Because the lift force on the blades generates torque, it has an equal but opposite effect on the wind, tending to push it around tangentially in the other direction. The result is that the air downwind of the turbine has "swirl", i.e. it spins in the opposite direction to the blades. That swirl represents lost power so reduces the available power that can be extracted from the wind. Lower rotational speed requires higher torque for the same power output, so lower tip speed results in higher wake swirl losses. Where high-pressure air from the upwind side of the blade escapes around the blade tip to the low-pressure side, thereby wasting energy. Since power = force x speed, at slower rotational speed the blades need to generate more lift force to achieve the same power. To generate more lift for a given length the blade has to be wider, which means that, geometrically speaking, a greater proportion of the blade's length can be considered to be close to the tip. Thus more of the air contributes to tip losses and the efficiency decreases. The higher lift force on a wider blade also translates to higher loads on the other components such as the hub and bearings, so low tip speed ratio will increase the cost of these items. On the other hand the wide blade is better able to carry the lift force, so the blade itself may be cheaper.

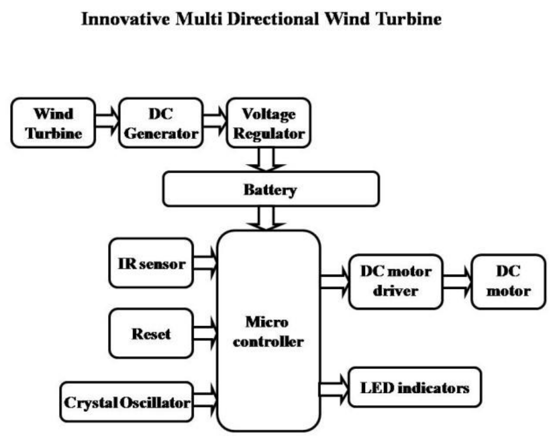
2. LITERATURE SURVEY

Technologies and resources

Wind power has been used as long as humans have put sails into the wind. For more than two millennia wind-powered machines have ground grain and pumped water. Wind power was widely available and not confined to the banks of fast-flowing streams, or later, requiring sources of fuel. Wind-powered pumps drained the polders of the Netherlands, and in arid regions such as the American mid-west or the Australian outback, wind pumps provided water for livestock and steam engines. The first windmill used for the production of electricity was built in Scotland in July 1887 by Prof James Blyth of Anderson's College, Glasgow. Blyth's 10 m high, cloth-sailed wind turbine was installed in the garden of his holiday cottage at Mary Kirk in Kincardineshire and was used to charge accumulators developed by the Frenchman Camille Alphonse Faure, to power the lighting in the cottage, thus making it the first house in the world to have its electricity supplied by wind power. Blyth offered the surplus electricity to the people of Mary Kirk for lighting the main street, however, they turned down the offer as they thought electricity was "the work of the devil". Although he later built a wind turbine to supply emergency power to the local Lunatic Asylum, Infirmary and Dispensary of Montrose the invention never really caught on as the technology was not considered to be economically viable. Across the Atlantic, in Cleveland, Ohio a larger and heavily engineered machine was designed and constructed in the winter of 1887-1888 by Charles F. Brush, this was built by his engineering company at his home and operated from 1886 until 1900.

The Brush wind turbine had a rotor 17 m (56 foot) in diameter and was mounted on an 18 m (60 foot) tower. Although large by today's standards, the machine was only rated at 12 kW. The connected dynamo was used either to charge a bank of batteries or to operate up to 100 incandescent light bulbs, three arc lamps, and various motors in Brush's laboratory. Professor Giovanni Francia (1911–1980) designed and built the first concentrated-solar plant, which entered into operation in Sant'Ilario, near Genoa, Italy in 1968.

3. IMPLEMENTATION:

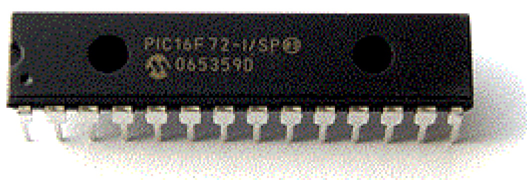


This project consists of the direction of the wind turbines can be controlled using IR technology

4. RELATED WORK:

This system consists of brief introduction of different modules used in this project is discussed below:

Micro controller



These devices feature a 14-bit wide code memory, and an improved 8 level deep call stack. The instruction set differs very little from the baseline devices, but the 2 additional opcode bits allow 128 registers and 2048

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words of code to be directly addressed. There are a few additional miscellaneous instructions, and two additional 8-bit literal instructions, add and subtract. The mid-range core is available in the majority of devices labeled PIC12 and PIC16. The first 32 bytes of the register space are allocated to special-purpose registers; the remaining 96 bytes are used for general-purpose RAM. If banked RAM is used, the high 16 registers (0x70–0x7F) are global, as are a few of the most important special-purpose registers, including the STATUS register which holds the RAM bank select bits. (The other global registers are FSR and INDF, the low 8 bits of the program counter PCL, the PC high preload register PCLATH, and the master interrupt control register INTCON.) The PCLATH register supplies high-order instruction address bits when the 8 bits supplied by a write to the PCL register, or the 11 bits supplied by a GOTO or CALL instruction, is not sufficient to address the available ROM space.

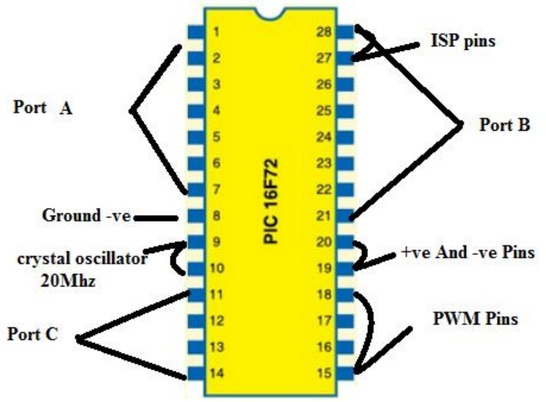


Fig PIC 16F72 Micro Controller

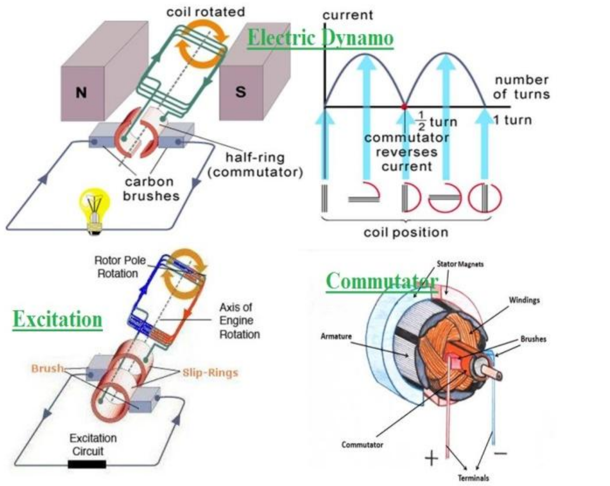
Port A: $A_0$to A_5 is belongs to port A. In which A4 is the 8 bit timer and remain are the ADC pins

Port B: B0 to B7 is the port B. In which B7 and B8 are the ISP pins which is used to dump the program into the microcontroller.(Ex. LCD, Voice module and Key pad). 8th pin is the ground pin this is the negative terminal, 9th and 10th pins which are connected to the crystal oscillator. 19th and 20th pins are used for power supply. 15th to 18th pins are used as PWM pins(These pins are used for communication like Gps and Gsm).

Port C: Co to the C3 are belong to port C. In which Co and C1 are timers and C2 and C3 are used for capture and computing.

ELECTRIC DYNAMOS

Dynamo is an electrical generator that produces direct current with the use of a commutator. The operating principle of electromagnetic generators was discovered in the years 1831–1832 by Michael Faraday. The principle, later called Faraday's law, is that an electromotive force is generated in an electrical conductor which encircles a varying magnetic flux. The electric dynamo uses rotating coils of wire and magnetic fields to convert mechanical rotation into a pulsing direct electric current. A dynamo machine consists of a stationary structure, called the stator, which provides a constant magnetic field, and a set of rotating windings called the armature which turn within that field. The motion of the wire within the magnetic field causes the field to push on the electrons in the metal, creating an electric current in the wire. On small machines the constant magnetic field may be provided by one or more permanent magnets; larger machines have the constant magnetic field provided by one or more electromagnets, which are usually called field coils.



GEARS

A gear or cogwheel is a rotating machine part having cut teeth, or cogs, which mesh with another toothed part to transmit torque. Geared devices can change the speed, torque, and direction of a power source.

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Gears almost always produce a change in torque, creating a mechanical advantage, through their gear ratio, and thus may be considered a simple machine. The teeth on the two meshing gears all have the same shape. Two or more meshing gears, working in a sequence, are called a gear train or a transmission.

DC MOTOR

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

Motor Mode of Operation

A DC magnetic field is generated in the air gap by either the permanent magnet or the DC current passing through the field windings (coils). Another DC current is forced to flow through the armature windings (coils) from an external DC source passing through the commutators and brushes.

A magnetic force is therefore, generated as a result of the interaction between the field circuit magnetic field and the armature current. This force acts on the side conductors of the same loop in an opposite direction to create a torque that starts to rotate the DC motor's armature (in this case in clockwise direction).

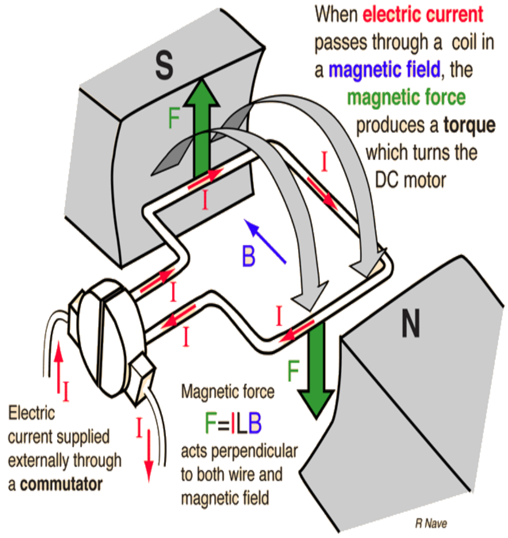

Fig Principle of operation of DC motors.

As the armature starts to rotate a counter (back) emf is induced in the armature windings that opposes the armature voltage and, therefore, reduces the armature current. During the motor's rotation, each coil (turn) reaches a point in-between the field poles (neutral point) where the conductors are no longer cutting the field's magnetic field. Therefore, the force acting on the conductors at this point is zero. Due to the machine's inertia and because there are other armature coils being cut by the field at the same instant, the rotor continuous its clockwise rotation. Moreover, the commutators and brushes sets are designed in such a way to reverse the current in the armature coils after passing this neutral point to maintain the clockwise rotation direction.

IR (INFRARED) TRANSMITTER AND RECIVER

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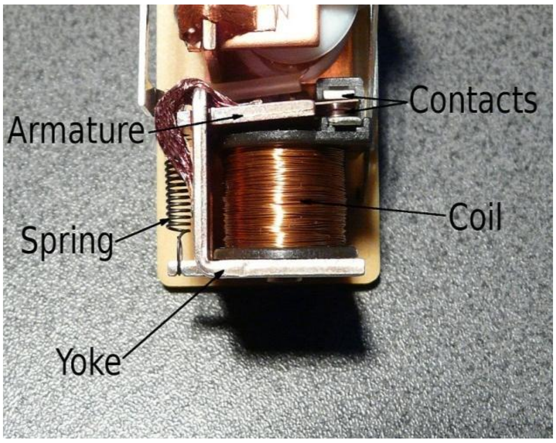
Infrared radiation is the region of the electromagnetic spectrum that lies between microwaves and visible light. Infrared radiation has two ranges: near infrared light is closest in wavelength to visible light, while far infrared is closer to the microwave region of the electromagnetic spectrum. The shorter waves are the ones used by remote controls. Information is transmitted and received using electromagnetic energy, without using wires. Infrared technology offers important advantages as a form of wireless communication. Nowadays, almost all audio and video equipment can be controlled using an infrared remote control. At the receiving end, a receiver detects the light pulses, which are processed to retrieve/decode the information they contain. The infrared transmitter & receiver are designed to sense the presence or absence of partitions such that lighting functions change to accommodate the appropriate size

RELAY SWITCHES



A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays.

Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Efficiency

The efficiency in wind Power extraction is a function of Power Coefficient Cp, where Cp is the ratio of power Extracted by the Windmill to the total contained in the wind resource.

$$Cp = \frac{P_T}{P_w}$$

Where power Excepted by the wind turbine $P_T = c_p * P_W$

$$= ½\,\rho A v3 \ \times Cp\ (watts)$$

The Betz Limit is the maximum possible value for Cp 16/27 which is equal to but the optimum possible for a multi -blade windmill is 30%.

Torque Extracted

In the windmill used for pumping water, Torque output is key. Torque is given by the ratio power extracted to rotor speed.

T = P_T/w

Rotor speed $\omega = \lambda v/R$

Where v = Wind speed (m/s)

λ= Teep speed ratio

$R = length\ of\ the\ blade\ (m)$

$$Thus : T = \frac{P_T}{\lambda v/R}$$

But $P_T = \frac{1}{2}\rho\pi R2\ v^3 \ \times Cp\ Watts$

Therefore : $\frac{\frac{1}{2}\rho\pi R\,2\ v^3 \times Cp}{\lambda v/R}$

T=$\frac{\frac{1}{2}\rho\pi R\,3}{\lambda} v^2 Cp$ (Nm)

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