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Automated Movable Bridge Powered by Wind and Solar Energy

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Abstract-

Electrical power has become an essential part of our daily lives and when it is interrupted or not available, then the ability to do our jobs or to be able to function in a normal manner will become an imposition to our daily routine. The electricity requirement of the world is increasing at an alarming rate due to industrial growth, increased and extensive use of electrical gadgets so we can increase the usage of the best alternative source nothing but An efficiently natural source of energy from sunlight as "solar energy'. This paper presents the automation of movable bridges. Most movable bridges rely on electrical power to control and operate the mechanism that causes the bridge to move. So in this regard an automated movable bridge is designed, but the required energy for the movable bridge is not taken from the conventional source but is generated through wind and solar energy which is an innovative trend of technology for controlling the movable bridges. Usually, photovoltaic (PV) cells contained in solar panels convert the sun's energy directly into electric energy.

Key words: ***Solar panel, DC motors, 89C51 Microcontroller, IR sensors, Wind turbine***

I. INTRODUCTION:

The main idea of the proposed model is to build a movable bridge that would automatically retract to give way for the ship to pass. The bridge will have a portion of the bridge, which would be in the center of the bridge that would automatically retract once it gets signal from the ships which is wished to pass through it. The idea of retraction was to be creative and something new for a bridge design. The retractable part of the bridge would be designed through a mechanism that would support and maintain the balance and position of the retractable part (sliding mechanism). The bridge structure would require a stable and strong structure to maintain its balance and stable during retraction of the bridge. The material usage must be should not have any vibration effect which would be dangerous if the bridge would be easily affected by the vibration of the water and the air. A movable bridge is a bridge that moves to allow passage (usually) for boats or barges. An advantage of making bridges moveable is the lower cost, due to the absence of high piers and long approaches. The principal disadvantage is that the traffic on the bridge must be halted when it is opened for passages. For seldom-used railroad bridges over busy channels, the bridge may be left open and then closed for train passages. For small bridges, bridge movement may be enabled without the need for an engine. Some bridges are operated by the users, especially those with a boat, others by a bridge man (or bridge tender); a few remotely using video-cameras and loudspeakers. Generally, the bridges are powered by electric motors, whether operating winches, gearing, or hydraulic pistons. While moveable bridges in their entirety may be quite long, the length of the moveable portion is restricted by engineering and cost considerations to a few hundred feet. There are often traffic lights for the road and water traffic, and moving barriers for the road traffic.

Types of movable bridges

- Drawbridge (British English definition) – the bridge deck is hinged on one end

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- Bascule bridge – a drawbridge hinged on pins with a counterweight to facilitate raising
    - Rolling bascule bridge – an unhinged drawbridge lifted by the rolling of a large gear segment along a horizontal rack
- Folding bridge – a drawbridge with multiple sections that collapse together horizontally
- Curling bridge – a drawbridge with multiple sections that curl vertically
- Vertical-lift bridge – the bridge deck is lifted by counterweighted cables mounted on towers
- Table bridge – a lift bridge with the lifting mechanism mounted underneath it
- Retractable bridge (Thrust bridge) – the bridge deck is retracted to one side
- Submersible bridge – also called a ducking bridge, the bridge deck is lowered down into the water
- Tilt bridge – the bridge deck, which is curved and pivoted at each end, is lifted at an angle
- Swing bridge – the bridge deck rotates around a fixed point, usually at the centre, but may resemble a gate in its operation
- Transporter bridge – a structure high above carries a suspended, ferry-like structure
- Jet bridge – a passenger bridge to an airplane. One end is mobile with height, yaw, and tilt adjustments on the outboard end

Movable bridges are only necessary on navigable waters, where wooden Dutch-style draw bridges were used prior to the introduction of swing bridges (possibly c 1650). When draw bridges were open it was difficult for the bridge deck to clear the bridge's navigable passage completely, and this was probably the main reason for the development of the swing bridge. The increasing size of bridges in the early nineteenth century, to cope with both increases in road traffic and the size of ships, meant that greater force was needed for operating an opening bridge. Swing bridges were easier than draw bridges to balance, and this would also have encouraged their use. Vertical lift bridges were also built, but they were more expensive and had limited clearance so were unsuitable for docks. In the first half of the nineteenth century, cast iron was used for most large swing bridges, something of a compromise because of its brittle nature. Outside girders were often damaged by glancing blows from ships passing through the bridge passage. The width of passage was also restricted to around 40 feet, too narrow for the paddle boats which came into use in the mid-nineteenth century. From this time iron, and later steel, lattice and plate swing bridges were introduced.

They were still vulnerable to damage from passing ships and many were subsequently replaced by rolling bascule bridges. As the deck lifted it moved away from the edge of the passage so was unlikely to be damaged by a passing ship. Other types of movable bridge were developed, but they tended to be used in locations where there were specific problems, such as a poor foundation or restricted space. The range of movable bridges is extensive, so some limitation is necessary to make the compilation of a list manageable. For this reason, most bridges where the passage is less than 18 feet will be excluded. These tend to be canal bridges, and are probably already quite well documented. A few may be included to give an indication of their type and survival. This will also restrict the list to metal bridges, though the earliest swing bridges were built from timber, and an example could be included for completeness.

Fig-1 Image of movable bridge model

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II. RELATED WORK:

The main objective of the paper is to develop a hardware prototype and software to simulate the moving bridge system across the rivers for the road/rail traffic as well as the mariners moving. 89C51 microcontroller is used as control system of the moving bridge. The software of the system is to control the overall moving system and its algorithm by sensing the ship/boat approaching the passage (bridge) and leaving the bridge. As for the hardware prototype, it is used to simulate the bridge system with a DC motor to control the movement and motion of the bridge in horizontal direction. IR sensors on either side of the passage of the bridge act as input requests from ship/boat to open and close the bridge. Limit switches are used and they are arranged at various points of mechanical structure to identify the position of the moving bridge. It's a new method that is more predictable, more reliable, more product friendly and less maintenance prone than conventional bridges. The mechanical transmission section designed with lubricated bearing type sliding channels or gear drive mechanisms that move the bridge smoothly.

The entire system is designed to operate at 12 V DC; the required power source is derived from non conventional sources of energy i.e., wind and the solar power. The idea of using wind and solar energy is to utilize non–conventional energy resources effectively. The heart of the project work is microcontroller unit; it is designed with 89C51/52 ATMEL chip. These days there is no such electronic or electrical device that functions without microcontroller; we are living in the Embedded World surrounded with many embedded products designed with much variety of microcontroller chips produced by different companies. Our daily life largely depends on the proper functioning of these gadgets. Television, Radio, CD player, Washing Machine, Microwave Oven and many more house hold gadgets, and Card readers, Access Controllers, Palm devices of our work space enable us to do many of our tasks very effectively. Apart from all these, many controllers embedded in our car, which take care of many car operations to make it as fully automated.

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar radiation, along with secondary solar-powered resources such as wind and wave power, hydroelectricity and biomass, account for most of the available renewable energy on earth Only a minuscule fraction of the available solar energy is used. Solar powered electrical generation relies on heat engines and photovoltaic. Solar energy's uses are limited only by human ingenuity. A partial list of solar applications includes space heating and cooling through solar architecture, potable water via distillation and disinfection, day lighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes. To harvest the solar energy, the most common way is to use solar panels.

Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy.

Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. The Earth receives 174 petawatts (PW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet.

Earth's land surface, oceans and atmosphere absorb solar radiation, and this raises their temperature. Warm air containing evaporated water from the oceans rises, causing atmospheric circulation or convection. When the air reaches a high altitude, where the temperature is low, water vapor condenses into clouds, which rain

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onto the Earth's surface, completing the water cycle. The latent heat of water condensation amplifies convection, producing atmospheric phenomena such as wind, cyclones and anti-cyclones. Sunlight absorbed by the oceans and land masses keeps the surface at an average temperature of 14 °C. By photosynthesis green plants convert solar energy into chemical energy, which produces food, wood and the biomass from which fossil fuels are derived.

The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules (EJ) per year. Photosynthesis captures approximately 3,000 EJ per year in biomass. The amount of solar energy reaching the surface of the planet is so vast that in one year it is about twice as much as will ever be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined. From the table of resources it would appear that solar, wind or biomass would be sufficient to supply all of our energy needs, however, the increased use of biomass has had a negative effect on global warming and dramatically increased food prices by diverting forests and crops into biofuel production.

Depending on a geographical location the closer to the equator the more "potential" solar energy is available. Solar plate is a light sensitized steel backed polymer material used by artists as an alternative to hazardous printing techniques. It is a simple, safer, and faster approach than traditional etching and relief printing. It does not use grounds, acids or solvents. it is exposed with u.v. light (the sun) and developed with ordinary tap water.

Highly interaction in human machine in daily lives has made user interaction progressively very important. The hunger for automation brought many revolutions in the existing technologies. These had greater importance than any other technologies due its user-friendly nature.

Fig-2 Figure of solar and wind powered movable bridge

The vehicles moving with some speed over bridge exert some force which is used to rotate the blades of the fan present over the bridge that is constructed like a dynamo to generate energy. The fan mechanism is designed to generate electric energy through wind force. The structure/construction that contains four blades mechanical system is considered as the motion converter. The mechanical motion created by the wind when a vehicle moves with some speed is converted into the electrical energy; thereby it is called as motion converter. In general any motion converter that generates electricity by applying some force is constructed by implementing electro-mechanical techniques. In this regard here a simple electro mechanical fan is coupled to the DC motor shaft. Whenever some force is applied (due to wind), the fan rotates which in turn rotates the DC motor as well, as the fan is coupled to the motor and thus the electric energy is generated. It works on the principle that when a vehicle moves with some speed, due to the wind force exerted on the fan, makes to rotate it which in turn rotates the motor. The kinetic energy of the wind will cause the fan to rotate, which will further rotate the transmission shaft and hence the generator armature (i.e. acting as prime mover to run generator). The electrical device used to generate electricity in this technique is a simple DC motor; this motor shaft is coupled with the fan mechanism. The fan mechanism mechanical structure is constructed with four iron blades. When the blades rotate due the wind exerted by

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the vehicle movement with some speed, this in turn rotates a geared shaft of the DC motor. The output of this shaft is coupled to a dynamo to convert kinetic energy into electricity. This is the basic principle involved in this mechanism.

The advantage of selecting reduction gear mechanism motor is, though the external shaft rotates at low speed, depending up on the gear ratio, the internal shaft will be rotated at high speed. This is essential here; otherwise if the shaft speed is low, the armature may not produce any energy. Rotary motion can be transferred from one shaft to another by a pair of rolling gears. Depending up on the ratio of final shaft speed, number gears are arranged in group and are called as gear trains. These gear trains are mechanisms which are widely used either to increase or to decrease the final shaft speed. When the speed is increased torque will be reduced, where as if the speed is decreased torque will be increased, this is the general phenomena for normal DC motor. In general these teethed gear wheels are coupled in between two parallel shafts. When two gears are in mesh, the larger gear wheel is often called as crown wheel and the smaller one is called as pinion.

III. PROPOSED METHODOLOGY:

In this proposed model, the main aim is to fabricate an automated movable bridge powered by using non conventional energy sources like wind and solar energy.

The ATMEL 89C51 is an 8 bit controller, the internal Architecture is similar to the 8031 core. The most popular and used architecture is Intel's 8031. Market acceptance of this particular family has driven many semiconductor manufacturers to develop something new based on this particular architecture. The 8031 contains variety of configurations; even after 25 years of existence, semiconductor manufacturers still come out with some kind of device using this 8031 core.

The microcontroller unit is playing major role in this project work. Nowadays with the advancement of technology particularly in the field of micro-controllers, all the activities in our day-to-day living have become part of information technology and we find controllers in each and every application. Thus, the trend is directing towards micro-controller based project works. A micro-controller contains a CPU, clock circuitry, ROM, Ram and I/O circuitry on a single integrated circuit package. The Micro-controller is therefore, a self-contained device, which does not require a host of associated support chips for its operation as conventional microprocessors do. It offers several advantages over conventional multi-chip systems. There is a cost and space advantage as extra chip costs and printed circuit board and connectors required to support multi-chip systems are eliminated. The other advantages include cheaper maintenance, decreased hardware design effort and decreased board density, which is relevant in portable control equipment.

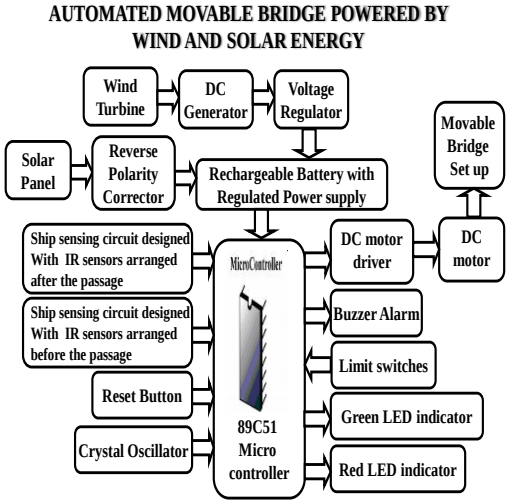

Fig-3 Block Diagram of the Proposed Model

The proposed model Solar and wind Powered movable bridge is a combination of both hardware and software using 89C51 microcontroller as intermediate between input and output devices like DC motor to control the movement and motion of the bridge in horizontal direction, IR sensors on either side of the passage of the bridge act as input requests from ship/boat to open and close the bridge. Limit switches are used and they are arranged at various points of mechanical structure to identify the position of the moving bridge. It is

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embedded as part of a complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today. Embedded systems are controlled by one or more main processing cores that are typically either microcontrollers or digital signal processors (DSP). The key characteristic, however, is being dedicated to handle a particular task, which may require very powerful processors. Since the embedded system is dedicated to specific tasks, design engineers can optimize it to reduce the size and cost of the product and increase the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. The reset logic is used to protect the internal program of the micro controller when the power spikes are present in the line current. And the oscillator is used to generate the clock for the micro controller to run the internal programs and clock of the micro controller.

When a mariner is traveling in one of the waterways that contain a movable bridge and the bridge needs to be moved in order for the journey to continue, then the bridge needs to be moved at that time, not later when the electrical service is restored. The same would exist for the motoring public or for a railroad shipping the nation's goods across the rail network from manufacturer to consumer. The mariner wants the bridge raised so he can continue his journey and the railroad or motoring public wants the bridge lowered so they can get to their final destination in a timely manner. So in this regard an automated movable bridge is designed, but the required energy for the movable bridge is not taken from the conventional source but is generated through wind and solar energy which is an innovative trend of technology for controlling the movable bridges. On the high way bridges as the vehicles will be moving with some speed, at the top of the bridge a fan is placed whose blades are parallel to the road way. The fan is coupled to the DC motor shaft and by the movement of the vehicles with some speed, the fan will be rotated which in turn rotates the DC motor. The main aim is to generate electric energy from the fan rotation, store it in a battery and utilize the stored energy when required i.e., operate the movable bridge when the mariner approach. To prove this concept practically, a prototype module is constructed with a fan that has two blades, which is aimed to generate energy whenever some force (wind energy) is applied to the fan by the movement of the vehicles. Also the solar energy trapped from the panels is also used for the application. Therefore here an automated sliding (movable) bridge is designed, which will be opened automatically by sensing the approaching mariner. Approaching mariners from both directions are sensed, an alarm and its corresponding red indicators remains ON for alerting the road traffic in either directions. These devices remain in ON condition until the movable bridge is closed again. The moving bridge mechanism is coupled with smooth sliding channels and is driven through reduction gear mechanism type DC motor.

The entire system is designed as automatic, human involvement is not required for operating the movable bridge. Fan blades are designed using electro-mechanical technology and to generate electricity one small DC motor is used that is connected to the fan. This motor functions like a dynamo and its shaft is coupled with blades mechanism of the DC motor. Whenever the vehicles move, motor shaft will be rotated automatically and the motor generates some voltage. The external shaft of the motor will be rotated at very low speed; at this speed any type of armature or dynamo cannot generate required voltage. There by the motor used in this project work is built in with reduction gear mechanism, hence inner shaft of the motor rotates at high speed. In this concept when this shaft is coupled to a dynamo, the kinetic energy will be converted into electric energy. The voltage generated by the motor is regulated and is used to charge the battery.

IV. HARDWARE DESIGN OF PORTABLE DEVICE

In today's world, in almost all sectors, most of the work is done by self powered controls systems like

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controlling of movable platforms at railway station, movable bridges at water ways for ships, etc as per the requirement. The entire proposed system has been divided into two sections: Automation for movable platform and power generation using solar and wind sources section.

The idea of the proposed model is to fabricate an innovative movable bridge that would automatically retract to give way for the ship to pass that would automatically retract once it gets signal from the ships which wishes to pass through it. The mechanical transmission section designed with lubricated bearing type sliding channels or gear drive mechanisms that move the bridge smoothly. The mechanical system is considered as motion converter, this can be created by implementing electro-mechanical techniques. The concept is to transform the motion from one form to some other required form by using suitable mechanical and electrical devices. In this project work the technique of transform the rotational motion into linear motion is implemented. For this purpose a DC motor is used to create the motion for the bridge in the horizontal direction over the water passage. The motor is constructed with reduction gear mechanism and it is built in with the motor internally. As the machine is designed as prototype module, lowest rating motor is used to drive the mechanism.

The advantage of selecting reduction gear mechanism motor is that a small motor can drive heavy loads. As the motor is purchased from local market, ratings' regarding torque is not mentioned. Only speed (RPM) and the operating voltage are specified. As per this data the motor is designed to operate at 12V DC and the motor speed is 30 RPM. The motor driving capacity is tested practically and in our test we came to know that the motor can drive an independent load of maximum 3 Kg. There by according to this driving capacity, one small mechanical structure of this project is designed for the demo purpose. Rotary motion can be transferred from one shaft to another by a pair of rolling gears. Depending up on the ratio of final shaft speed, number gears are arranged in group and are called as gear trains. These gear trains are the mechanisms, which are widely used either to increase or to decrease the final shaft speed. When the speed is increased torque will be reduced, where as if the speed is decreased torque will be increased i.e., speed (RPM) and torque are inversely related to each other. In general these teethed gear wheels are coupled in between two parallel shafts. When two gears are in mesh, the larger gear wheel is often called as crown wheel and the smaller one is called as pinion. The operation will be controlled by the controller depending on the inputs from the sensing circuits. The movement of the DC motor for this operation is restricted through the limit switches in either of the directions.

To drive the moving bridge mechanism, a high torque, high precise movement DC motor is used such that the clock wise rotation of the DC motor moves the bridge in one direction and anti clockwise rotation of DC motor will move in the other direction, i.e., back to home position. The DC motor driving is done with a drive circuit using H - Bridge. The limit switches are used as input signals for the DC motor driving circuits i.e., H - Bridge that controls the movement or the direction of the motor. The motion is created by rack-and-pinion method by coupling a pinion/toothed pulley directly to the motor shaft. Here with the help of the DC motor the platform moves between two reference points in horizontal direction. The entire mechanism is arranged over a single structure and horizontal movement is intended to move the bridge in a straight line. The reference points are identified through limit switches. Detailed description about gear drive mechanisms and rack and pinion mechanism is provided in the further chapters.

The entire system is designed to operate at 12 V DC; the required power source is derived from non conventional sources of energy i.e., wind and the solar power. The idea of using wind and solar energy is to utilize non–conventional energy resources effectively.

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V CONCLUSION

The existed paper presents Fabrication of an "Automated Movable Bridge Powered By Wind And Solar Energy" has been successfully designed and implemented. Integrating features of all the hardware components been used and developed in it. The Presence of each and every module has been reasoned out and placed very carefully. Hence the contributing to the best working unit for a building a newly designed bridge that would automatically retract to give way for the ship to pass by controlling using DC motor interfaced with H-bridge has been designed perfectly. For demo purpose a retractable moving bridge is designed that slides to the other side of the river/water passage to pass through the road traffic. The same mechanism can be implemented for all the other platforms with little modifications. Secondly, usage of non conventional energy sources like wind energy and solar power along with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested. The microcontroller which acts as the mediator between the input module and output module has been successfully programmed using Keil u vision compiler software using Embedded C language.

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