Solar Powered Wireless Controlled Agriculture Spray Platform

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Abstract- *Agriculture is one of the main occupations in India. About 60-70% of Indian population is directly or indirectly involved in agriculture. With the advancement in technology sector, agriculture technology has also gained momentum. So many technology derived agricultural products and processes are coming into the market every year. Yet there is a lot of scope and need for the development of technology in the agriculture sector. From the time of seed sowing and cultivation there are many stages wherein a farmer needs to spray the crop, for protecting it from various diseases. Whereas every farmer cannot afford a tractor. Also one cannot use a tractor for all kind of crops. This robotic platform is smaller than a tractor, making it suitable to move in between two rows of crop with comparatively narrow width. Also we are employing mechanism that can be used to adjust the height of the spraying system.*

Keywords- Robotic platform, height adjustable spraying system

I. INTRODUCTION

The basic idea of the project is to design solar powered wireless controlled agriculture spray platform. Insects are largely responsible for the crop destruction. Insecticides or pesticides, a man made or natural preparation are used to kill insects or otherwise control their reproduction. These herbicides, pesticides, and fertilizers are applied to agricultural crops with the help of a special device known as a "Sprayer," sprayer provides optimum performance with minimum efforts. The invention of a sprayer, pesticides, fertilizers, bring revolution in the agriculture or horticulture sector especially by the invention of sprayers, enable farmers to obtain maximum agricultural output. Timely application of herbicides, pesticides and fungicides at peak periods plays a vital role in ensuring better yields from crop.

II. LITERATURE SURVEY

1) Chandra D and Gajendra S, (1993) developed prototype hand held sprayer using a high voltage circuit of an cut output of 15–20 KV for an input of 6 V the charging circuitry consisted of an inverter and multi meter. Droplet produced by the sprayers with nalathian kerosene was of size 10–250 micrometer. The effect of voltage and flow rate on the droplets spectrum was analyzed.

2) Manion and Kathirvel, (2002) developed a tractor operated tall tree sprayer for coconut. The unit Consisted of telescopic GI pipes which can extend from 8– high by winding a cable. The sprayer fluid from the chemical tank is guns through pressure relief and by pass valve.

3) Mourya. N.L. and Devaddattam D.S.K, (1985) reported power regarding of bullock for operating animal drawn multipurpose tool carrier for spraying. The average power required to operate the sprayer was 0.48 hp on average pair of bullock can produce about 0.8 to 1.5 hp. The pair of bullock can easily operate the tractor sprayer.

4) Muhammad et al (2010): A simple approach to Irrigation control problem using Artificial Neural Network Controller. The proposed system is compared with ON/OFF controller and it is shown that ON/OFF Controller based System fails miserably because of its limitations. On the other hand ANN based approach has resulted in possible implementation of better and more efficient control. These controllers do not require a prior knowledge of system and have inherent ability to adapt to the changing conditions unlike conventional methods. It is noteworthy that ANN based systems can save lot of resources(energy and water)and can provide optimized results to all type of agriculture areas.

5) Kalyan et al (2011): The need for systems that make agriculture easier and more sustainable has increased within the past few years. The ability to conserve two of the most important resources of a farmer, water and time, has been the latest challenge. A system that provides this ability - through the use of efficient and reliable methods such as wireless sensor networking, sprinkler irrigation, GSM, SMS technologies and readily available mobile phone devices – is certain to help the farmers get a better yield and on a larger scale, help the agricultural and economic growth of the country.

6) Chetana et al (2012) : The Automated Wireless Watering System is a user friendly system.

III. HARDWARE & SOFTWARE

HARDWARE

1 Microcontroller:

A microcontroller (sometimes abbreviated µC, uC or MCU) is a small computer on a single integrated containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, and toys. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. Some microcontrollers may use four-bit words and operate at clock rate frequencies as low as 4 kHz, for low power consumption (milliwatts or microwatts).

They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

2 H-Bridge:

An H bridge is an electronic circuit that enables a voltage to be applied across a load in either direction. These circuits are often used in robotics and other applications to allow DC motors to run forwards and backwards. H bridges are available as integrated circuits, or can be built from discrete components. The H-bridge arrangement is generally used to reverse the polarity of the motor, but can also be used to 'brake' the motor, where the motor comes to a sudden stop, as the motor's terminals are shorted, or to let the motor 'free run' to a stop, as the motor is effectively disconnected from the circuit.

3 Geared DC Motor:

Gear motor" refers to a combination of a motor plus a reduction gear train. These are often conveniently packaged together in one unit. The gear reduction (gear train) reduces the speed of the motor, with a corresponding increase in torque. Gear ratios range from just a few (e.g. 3) to huge (e.g. 500). A small ratio can be accomplished with a single gear pair, while a large ratio requires a series of gear reduction steps and thus more gears. There are a lot of different kinds of gear reduction.

In the case of a small transmission ratio N, the unit may be back drivable, meaning you can turn the output shaft, perhaps by hand, at angular velocity w and cause the motor to rotate at angular velocity Nw. A larger transmission ratio N may make the unit non-back drivable. Each has advantages for different circumstances. Back drivability depends not just on N, but on many other factors. For large N, often the maximum output torque is limited by the strength of the final gears, rather than by N times the motor's torque.

4 Relay Driver:

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 low-power signal (with complete electrical isolation between control and controlled circuits), 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.

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays". A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low

reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two in the relay pictured). The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts. It is held in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function. The relay in the picture also has a wire connecting the armature to the yoke. This ensures continuity of the circuit between the moving contacts on the armature, and the circuit track on the printed circuit board (PCB) via the yoke, which is soldered to the PCB.

When an electric current is passed through the coil it generates a magnetic field that activates the armature and the consequent movement of the movable contact either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.

When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components. Such diodes were not widely used before the application of transistors as relay drivers, but soon became ubiquitous as early germanium transistors were easily destroyed by this surge. Some automotive relays include a diode inside the relay case.

If the relay is driving a large, or especially a reactive load, there may be a similar problem of surge currents around the relay output contacts. In this case a snubber circuit (a capacitor and resistor in series) across the contacts may absorb the surge. Suitably rated capacitors and the associated resistor are sold as a single packaged component for this commonplace use.

If the coil is designed to be energized with alternating current (AC), some method is used to split the flux into two out-of-phase components which add together, increasing the minimum pull on the armature during the AC cycle. Typically this is done with a small copper "shading ring" crimped around a portion of the core that creates the delayed, out-of-phase component, which holds the contacts during the zero crossings of the control voltage.

5 Solar Cell Panel:

The solar cells that we see are also called photovoltaic (PV) cells, which as the name implies (photo meaning "light" and voltaic meaning "electricity"), convert sunlight directly into electricity. A module is a group of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays.

Photovoltaic cells are made of special materials called semiconductors such as silicon, which is currently used most commonly. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely. PV cells also all have one or more electric field that acts to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off for external use, say, to power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce.

That's the basic process, but there's really much more to it. Silicon has some special chemical properties, especially in its crystalline form. An atom of silicon has 14 electrons, arranged in three different shells. The first two shells -- which hold two and eight electrons respectively -- are completely full. The outer shell, however, is only half full with just four electrons. A silicon atom will always look for ways to fill up its last shell, and to do this, it will share electrons with four nearby atoms. It's like each atom holds hands with its neighbors, except that in this case, each atom has four hands joined to four neighbors. That's what forms the crystalline structure, and that structure turns out to be important to this type of PV cell.

The only problem is that pure crystalline silicon is a poor conductor of electricity because none of its electrons are free to move about, unlike the electrons in more optimum conductors like copper. To address this issue, the silicon in a solar cell has impurities other atoms purposefully mixed in with the silicon atoms -- which changes the way things work a

bit. We usually think of impurities as something undesirable, but in this case, our cell wouldn't work without them. Consider silicon with an atom of phosphorous here and there, maybe one for every million silicon atoms. Phosphorous has five electrons in its outer shell, not four. It still bonds with its silicon neighbor atoms, but in a sense, the phosphorous has one electron that doesn't have anyone to hold hands with. It doesn't form part of a bond, but there is a positive proton in the phosphorous nucleus holding it in place.

When energy is added to pure silicon, in the form of heat for example, it can cause a few electrons to break free of their bonds and leave their atoms. A hole is left behind in each case. These electrons, called free carriers, then wander randomly around the crystalline lattice looking for another hole to fall into and carrying an electrical current. However, there are so few of them in pure silicon, that they aren't very useful.

But our impure silicon with phosphorous atoms mixed in is a different story. It takes a lot less energy to knock loose one of our "extra" phosphorous electrons because they aren't tied up in a bond with any neighboring atoms. As a result, most of these electrons do break free, and we have a lot more free carriers than we would have in pure silicon. The process of adding impurities on purpose is called doping, and when doped with phosphorous, the resulting silicon is called N-type ("n" for negative) because of the prevalence of free electrons. N-type doped silicon is a much better conductor than pure silicon. The other part of a typical solar cell is doped with the element boron, which has only three electrons in its outer shell instead of four, to become P-type silicon. Instead of having free electrons, P-type ("p" for positive) has free openings and carries the opposite (positive) charge.

6 Charge controller:

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may Or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery recharger.

7 12V DC Battery:

A 12 V DC battery is used to store the charge or power that is generated by the Solar Cell Panel. This stored energy will be further used to power the irrigation system. The same stored energy is also used to control the entire system implemented in this project. That means the same stored energy will be used to power up the Microcontroller unit that is used to control the entire system. Also the same energy is used to move the Solar Cell Panel according to the position of the sun.

8 Zigbee:

Zigbee is a wireless standard for personal area network, sensor monitoring and control that is designed for low power, short-range communications between wireless devices. The standard is classified as IEEE 802.15.4 wireless PAN WiPAN. The ZigBee standard has seen increasing interest from both commercial and scientific markets for applications such as wireless sensor networks, home automation and industrial control. One interesting facet of the ZigBee standard is that is designed so that devices can make a self-forming and self-healing networks as needed. In this scenario, a central PAN coordinator

SOFTWARE

9 Keil IDE

Keil MDK is the complete software development environment for a wide range of Arm Cortex-M based microcontroller devices. MDK includes the µVision IDE and debugger, Arm C/C++ compiler, and essential middleware components.

10 Embedded C

Embedded C is a set of language extensions for the C programming language by the C Standards Committee to address commonality issues that exist between C extensions for different embedded systems.

11 Willars Programmer.

This is programmer for 89 series microcontroller devices in 20 & 40 pin packages and supports various 8 pin serial EEPROM IC.ZIF socket enables easy insertion and removal of devices for programming. Programming is very fast since it is USB based. No external power required since it is powered from USB port itself.

IV. WORKING PRINCIPLE

The aim of this project is to design a robotic platform that can be used for agriculture spraying purpose. Here we are

designing a robotic platform that is suitable to hover and move in an agriculture field. This includes all terrain capabilities. So here we are designing an all-wheel robotic platform with independent suspension system. This will help the robot to move in almost any kind of terrain. Also we are using high torque geared DC motors that are fitted at all the wheels, which will make the robot to produce enough torque in order to move along with the weight of spray liquid easily. The control system discussed over here is a wireless one. So to carry this job we are using the Zigbee technology. Combined all together we will be able to make the robot to work as our desired purpose.

The project will be consisting of two parts. The first is the control part or the control end. The second is the robot end. The control end will be equipped with a microcontroller, and push buttons along with a Zigbee. The push buttons will be used for moving the robot in various directions. The push buttons are fed to the microcontroller and the microcontroller is programmed such that it will be waiting to receive commands from the push buttons. Whenever a push button is pushed the microcontroller will read it and convert this signal as a command to move the robot in that particular direction. This signal is then fed to the Zigbee device that is also connected to the microcontroller via Serial Port. Now this Zigbee will convert this signal into a wireless signal and send it.

Now we have another Zigbee device connected to the robot end. This Zigbee device is connected to the Microcontroller. This Zigbee device will receive the signal sent from the control end and feed this signal to the microcontroller. The microcontroller will receive the signal and compare the command with some pre-programmed commands. Thus the microcontroller will generate an appropriate signal to operate the robot with respect to the received signal/command.

The control end is also equipped with some more button/switches in order to make the spray ON/OFF and also to adjust the height of the spray nozzle. H-Bridge or Relay driver will be used for switching the motors and the spray pump.

V. APPLICATIONS

1 Agriculture spraying
2 Lawn spraying
3 Gardening

VI. ADVANTAGES & LIMITATIONS

ADVANTAGES

1. Remote Operation.
2. Real-time control.
3. Easy to operate.
4. Clean and free Energy.
5. No Pollution Levels.
6. Low Cost.
7. Consumes Less Space.
8. Low Operational Cost.
9. Easy maintenance.
10. Complete Automated System.

LIMITATIONS

1 Battery has to be charged for effective use.
2 Solar Power is available only at Day Time.

VII. CONCLUSION

In this project we are designing a robotic platform that is powered by solar energy, and can be used for agriculture spraying purpose. This robotic platform is smaller than a tractor, making it suitable to move in between two rows of crop with comparatively narrow width. Also we are employing mechanism that can be used to adjust the height of the spraying system. This will help in using this platform for plants of various heights. Implementing solar means the operating cost of this platform is very less in comparison with a tractor or other vehicle. Also it does not release any harmful gases in the atmosphere.

REFERENCES

[1] Solar Operated Multiple Granulated Pesticide Duster WCE 2011, July 6-8, 2011, London, U.K, Vo l. III.ISBN: 978-988-19251-5-2.

[2] Degarmo, E. Paul; Blac k, J T.; Kohser, Ronald A. (2003), Materials and Processes in Manufacturing (9th ed.),Wiley, ISBN 0-471-65653-4

[3] Groover, M ikell P. (2007), "Theory of Metal Machining",Fundamentals of Modern Manufacturing (3rd ed.), John Wiley & Sons, Inc., pp. 491–504, ISBN 0-471-74485-9

[4] Oberg, Erik; Jones, Franklin D.; McCauley, Christopher J Heald, Ricardo M. (2004), Machinery's Handbook (27th ed.), Industrial Press, ISBN 978-0-8311-2700-8.

[5] Isabelle Bald i, Pierre Lebailly, "Pesticide contamination of workers in vineyards in France", Journal of Exposure Science and Environ mental Ep ide mio logy (2006) 16, 115– 124.