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Design and Implementation of Smart Air Pollution Control System with Low Power Generation

Mr.S.Satheesh Kumar[1], .Mr.R.Nagaraj[2], Mr.A.P.Narayanan[3], Mr.K.S.Abdul Rahman[4]

1. Asst. Professor, Dept of ECE,
Dhaanish Ahmed College Of Engineering, Padappai.
2,3,4 Student of final year, Dept of ECE,
Dhaanish Ahmed College of Engineering, Padappai.

ABSTRACT

Air pollution is a concern in many urban areas of emerging markets that rely on outdated technologies for transportation and electricity generation. This study seeks to maintain air quality index and generate power across spatial and temporal domains, with a specific focus on emerging markets and the developing world. A prototype, low-cost Smart Air Pollution Control System with Low Power Generation has been developed to support the study. The device can be replicated and deployed across regions for pollution control.

I.INTRODUCTION

Smart air pollution control system with low power generation is designed to reduce pollution and generate power efficiently. The device is placed in the divider between the roads and it absorbs the pollutants which comes from the vehicle. The solar panels are source of power supply for the sensors and control boards in the system during day time and batteries provide power at nights. The two stage air filter in the device converts the polluted smoke to fresh air that comes through the outlet. In first stage of pollutant removal process, the exhaust air is passed through a suction pipe in which water is circulated using a water pump. The particulates get dissolved in the water ensuring the air dust free.

The second stage of filtration involves the use of air filter. A particulate air filter is a device composed of fibrous materials which removes solid particulates such as dust, pollen, mould, and bacteria from the air. Filters containing absorbent or catalyst such as charcoal (carbon) may also remove odors and gaseous pollutants such as volatile organic compounds or ozone.

The air from the filter is passed through the spinning top (turbine) connected to a motor. The rotation of the motor generates electricity as in a wind turbine. This electricity generated along with the battery backup can be used to power various systems like traffic light signals, street lights etc.

The ultrasonic sensors, humidity sensors, gas sensors and LCD screens are connected to the control board for measuring and monitoring the proximity of the vehicles with that of system, the moisture content of air and type of gases present in smoke. These sensors help in improving the reliability and performance of the system.

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II.BLOCK DIAGRAM

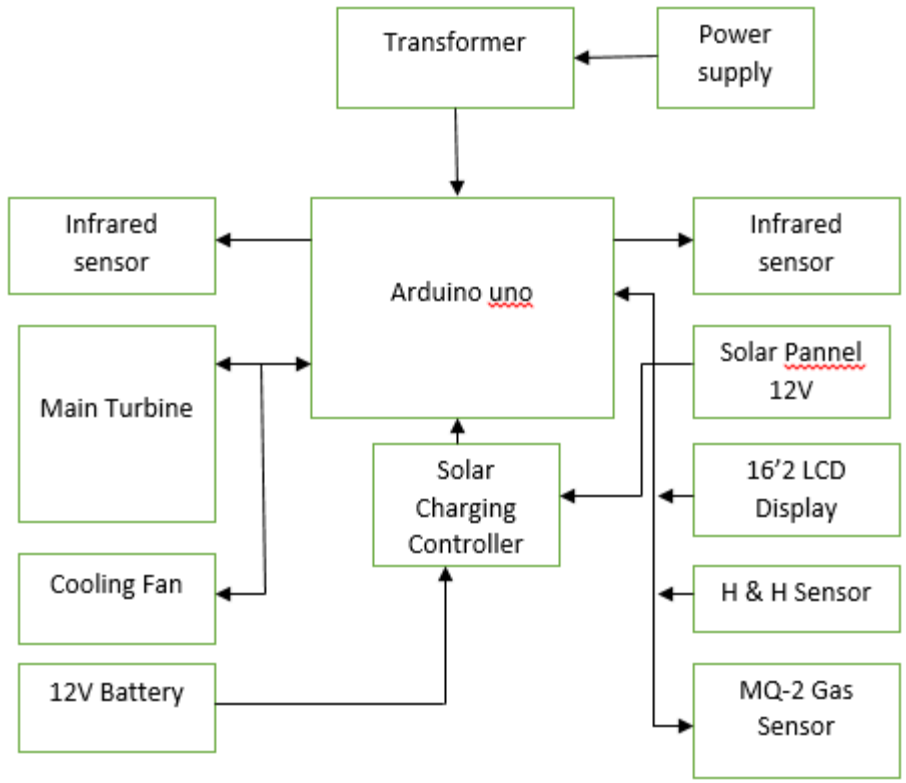

Figure 1: Block Diagram for Smart air pollution control system with low power generation

III.TRANSFORMER

A transformer is a static electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. A varying current in one coil of the transformer produces a varying magnetic field, which in turn induces a varying electromotive force (emf) or "voltage" in a second coil. Power can be transferred between the two coils through the magnetic field, without a metallic connection between the two circuits. A wide range of transformer designs is encountered in electronic and electric power applications. Transformers range in size from RF transformers less than a cubic centimetre in volume to units interconnecting the power grid weighing hundreds of tons.It transforms power from one circuit to another without changing its frequency but may be in different voltage level.

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Figure 2.1: Transformer isan apparatus for reducing or increasing the voltage of an alternating current

IV.ARDUINO

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers. A program for Arduino may be written in any programming language with compilers that produce binary machine code for the target processor. Atmel provides a development environment for their microcontrollers. Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default bootloader of the Arduino UNO is the optiboot bootloader. Boards are loaded with program code via a serial connection to another computer.

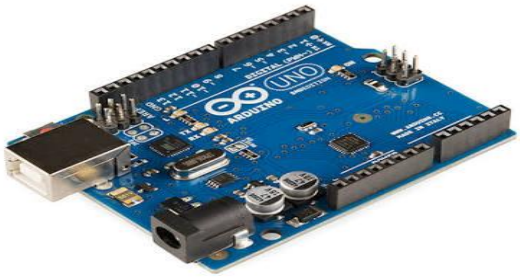

Figure 2.2: Arduino is an open-source electronics platform or board and the software used to program it.

V.INFRARED SENSOR

An infraredsensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation.Infraredsensors are also capable of measuring the heat being emitted by an object and detecting motion Infrared Radiation. IR Sensors work by using a specific light sensor to detect a select light wavelength in the Infra-Red (IR) spectrum. By using an LED which produces light at the same wavelength as what the sensor is looking for, you can look at the intensity of the received light. When an

object is close to the sensor, the light from the LED bounces off the object and into the light sensor. This results in a large jump in the intensity, which we already know can be detected using a threshold.

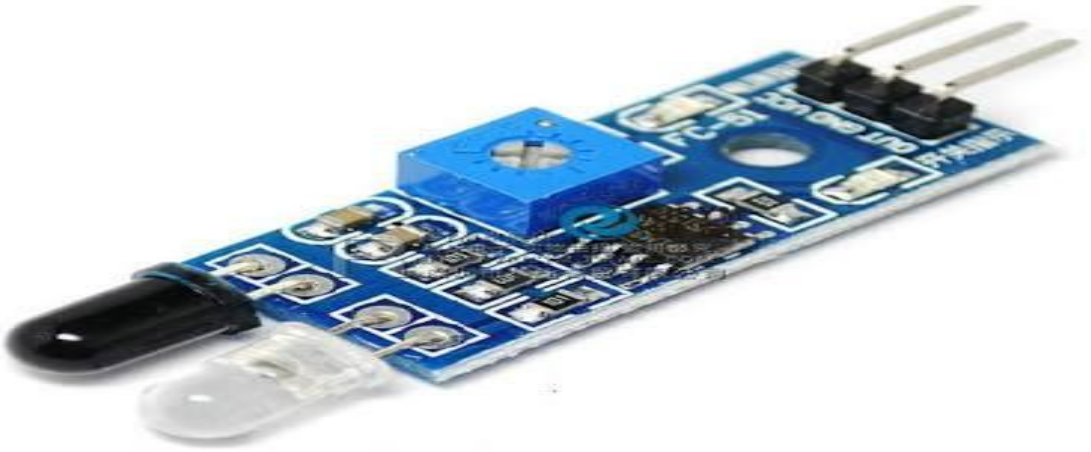

Figure 2.3: Infrared Sensora device which can detect motion by receiving infrared radiation

VI.TURBINE

A turbine is a rotary mechanical device that extracts energy from a fluid flow and converts it into useful work. The work produced by a turbine can be used for generating electrical power when combined with a generator.

Figure 2.4: Turbineis made to revolve by a fast-moving flow of air.

VII. SOLAR PANEL

Solar panels absorb sunlight as a source of energy to generate electricity or heat. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism.

Figure 2.5: Solar Panela panel designed to absorb the sun's rays as a source of energy for generating electricity or heating

VIII. MQ-2 GAS SENSOR

The Grove - Gas Sensor (MQ2) module is useful for gas leakage detection (home and industry). It is suitable for detecting H2, LPG, Smoke or Propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer.The MQ-2 is a flammable gas and smoke sensor detects the concentrations of combustible gas in the air and outputs its reading as an analog voltage. The sensor can measure concentrations of flammable gas of 300 to 10,000ppm.

Figure 2.6: MQ-X Gas Sensor module detects gas leakage

IX.BATTERY

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit.

Figure 2.7: Battery is a container consisting of one or more cells, in which chemical energy is converted into electricity and used as a source of power

X.LCD DISPLAY

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a back light or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as pre-set words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

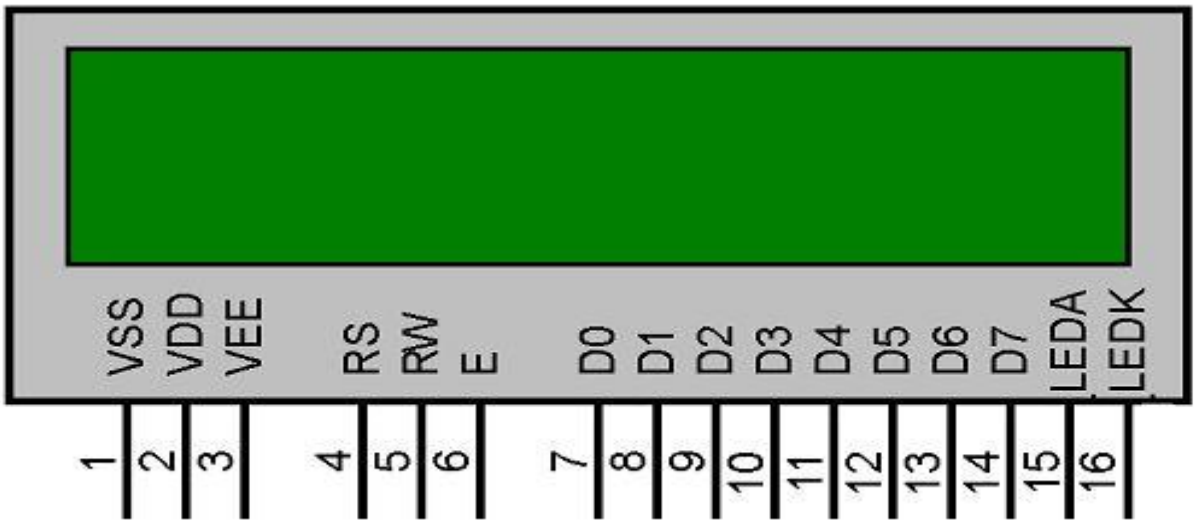

Figure 2.8: LCD Displayis the technology used for displays in notebook and other smaller computers

XI. DUST CLEANER

This device have water motor which flows the water to the water spray. Then the water flows inside this device through the water spray, reduces the dust particles in the polluted air which flows into this device. The reduced polluted air then flows to the filter for further process.

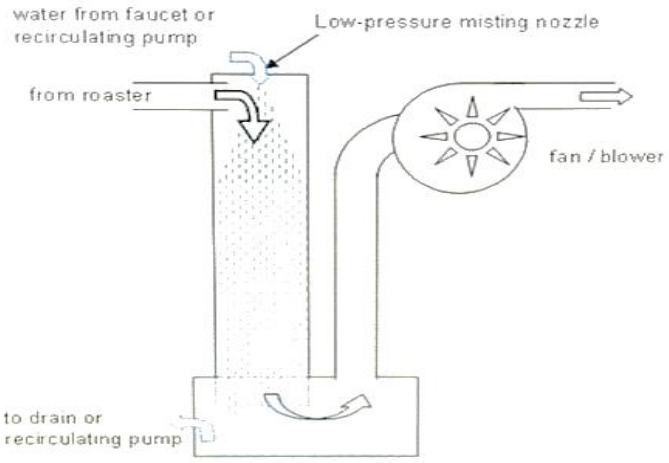

Figure 2.9: Dust Cleaner cleans the dust particles in the polluted air

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XII. EXPERIMENTAL SETUP

The device will be placed on the divider near traffic signals. The main device will be placed approximately one kilometer from the traffic signal and the pipes from the main device will flow out for some distances to absorb the polluted air at different places.

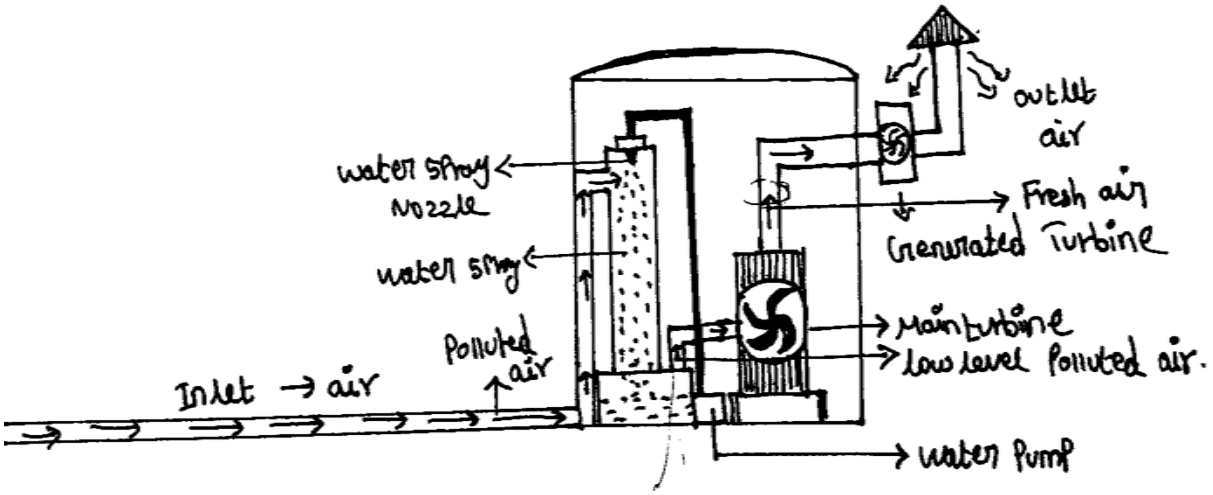

Figure 3.1: Main Device Outlet Diagram

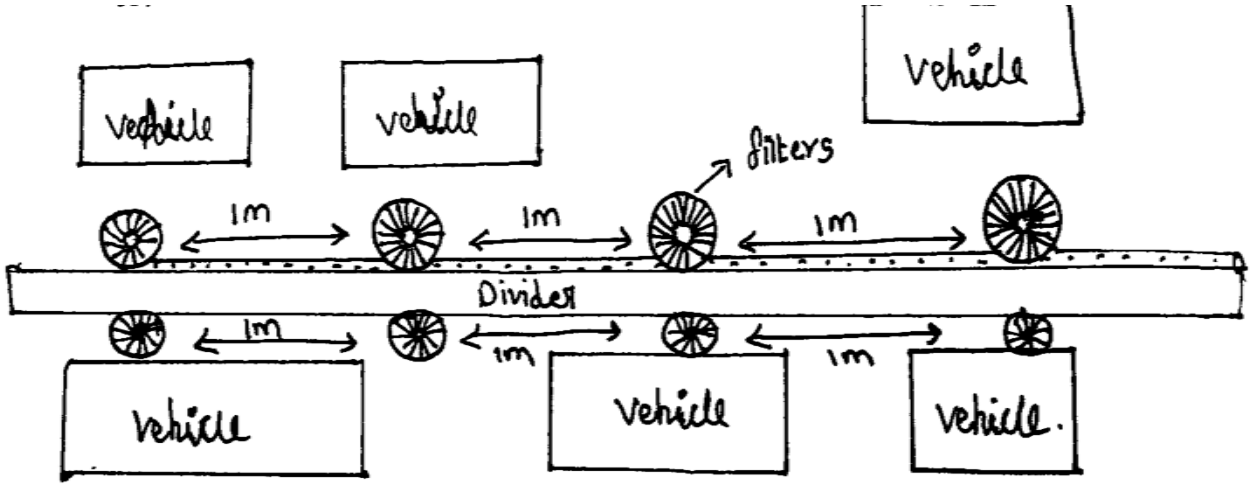

Figure 3.2: Experimental Setup Diagram

XIII.FUTURE ENHANCEMENT

The smart air pollution control system with low power generation device will solve the problems for air pollution in the future. The pollution will be reduced in the traffic signal areas. But the drawback of this device is that the device cannot absorb polluted air efficiently in vehicle moving areas.

XIV. RESULT

The device absorbs polluted air with the dust particles and smoke efficiently. The dust particles, smoke will be filtered through the dust controller with water spraying method. The filtered air comes out from the filter, then enters into the turbine and the turbine generates low power.

CO_2 Parameter Measurement:

S.No	Pollution Values in PPM	Air Temperature	Humidity Value	Results
1.	350 PPM Pollution Level - [Good]	Temp - 8-85^{o} C	61.3 %	Good
2.	350-660 PPM Pollution Level - [Polluted]	Temp – 9-10^{o} C	59.2 %	Moderate
3.	660-800 PPM Pollution Level - [Heavy Polluted]	Temp – 12-13^{o} C	57.1 %	High
4.	800-1131 PPM Pollution Level – [Poor]	Temp – 15-16.8^{o} C	52.1 %	Not Be Used

Table 1: CO_2 Parameter Measurement

Figure 4: PPM Measurement Meter

XV.CONCLUSION

The implementation of Smart Air Pollution Control System with Low Power Generation in real time will solve the air pollution in the traffic signals areas which emits more amount of polluted air from the vehicles.

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{v.shum, s.hailes}@ucl.ac.uk
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{manik.gupta, eliane.bodanese} @eecs.qmul.ac.uk
[3] Pachamuthu Rajalakshmi, Uday B. Dasai, Indian Institute of Technology, Hyderabad, India
{raji, ubdesai}@iith.ac.in
[4] Hui Wang,Yuhan Dong, Kai Zhang, Shenzhen Key Laboratory of Advanced Sensor and Integrated System, Graduate School at Shenzhen, Tsinghua University, China.
Email: { h-wang14@mails.,dongyuhan@sz., zhangkai@sz.}tsinghua.edu.cn
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