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Fault Tolerance Control in Industry of Metal Crack Detection & Segregator Using Image Processing

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ABSTRACT : This is the system for automatic crack detection. The system is capable of analysing metal parts by means of a laser excitation system and a thermographic camera. The laser creates thermal gradients inside the part under inspection, and the thermal camera observes how heat diffuses inside the part. Cracks can be automatically detected by using computer vision algorithms specifically developed for this task, which might be capable of measuring and classifying heat profiles. Different algorithms must be developed for rugged and smooth metal parts, since the reaction to laser excitation is rather different. The detection algorithms can be tested on several sequences and showed very good detection performance also with cracks of very small size, having a width.

INTRODUCTION

Quality inspection at the end of a production line is an important stage in industry, especially for high-performance components. Parts undergoing strong mechanical and thermal stress should be carefully checked, since small defects can affect performance and reliability of a component. Crack detection is one of the most common checks to be performed, because cracks are a common source of failure, and they affect a high number of different productions.

For metallic parts, crack detection is still performed exploiting a technique called “magnetic particle inspection” (MPI): the part to be analyzed is first washed, then put into a magnetic field and finally covered with magnetic particles, either in the form of a dry powder or more frequently, in a wet suspension. Cracks are easily detected because they cause leaks in the magnetic flux; such leaks are highlighted by the particles, which can be inspected by means of a UV light. The whole process is very complex and needs to be done manually; it is also extremely time-consuming, because parts need to be cleaned, magnetized, covered with particles, inspected, de-magnetized and cleaned again. Moreover, magnetic particles and their carrier are a source of pollution, and should be properly processed after use.

Given the complexity of MPI, a method for simplifying the process of crack detection and making it automatic is highly desirable: investigation on this topic is the aim of the ThermoBot project. The main idea is to exploit thermography instead of magnetic particles to detect cracks, and to apply this method to parts made of non-metallic materials, like carbon fiber. Inspection is performed by means of a laser and a far infrared (FIR) camera (also called thermal camera or thermocamera), that observes how the heat carried by the laser diffuses inside the part since cracks cause alterations on the heat flux; these can be exploited to detect cracks.

Methods based on image analysis have also been exploited in the literature, ranging from detection of welding defects in pipelines to concrete surface analysis and the protection of cultural heritage. Thermographic image analysis systems have recently been proposed for performing in-situ non-destructive inspections during thermomechanical fatigue tests; the system showed a high sensitivity, being able to detect cracks smaller than 500 μm. The system proposed is slightly different from the others discussed above as it is meant to inspect different types of materials during fatigue tests, and detect the cracks as soon as they appear.

Material Segregator:

In recent times, garbage disposal has become a huge cause for concern in the world. A voluminous amount of waste that is generated is disposed by means which have an adverse effect on the environment. The common method of disposal of the waste is by unplanned and uncontrolled open dumping at the landfill sites. This method is injurious to human health, plant and animal life. This harmful method of waste disposal can generate liquid leachate which contaminate surface and ground waters; can harbour disease vectors which spread harmful diseases; can degrade aesthetic value of the natural environment and it is an unavailing use of land resources. In India, rag pickers play an important role in the recycling of urban solid waste. Rag pickers and conservancy staff have higher morbidity due to infections of skin, respiratory, gastrointestinal tract and multisystem allergic disorders, in addition to a high prevalence of bites of rodents, dogs and other vermin. Dependency on the rag-pickers can be diminished if segregation takes place at the source of municipal waste generation. The economic value of the waste generated is not realised unless it is recycled completely. Several advancements in technology has also allowed the refuse to be processed into useful entities such as Waste to Energy, where the waste can be used to generate synthetic gas (syngas) made up of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam; Waste to Fuel, where the waste can be utilized to generate bio fuels. When the waste is segregated into basic streams such as wet, dry and metallic, the waste has a higher potential of recovery, and consequently, recycled and reused. The wet waste fraction is often converted either into compost or methane-gas or both. Compost can replace demand for chemical fertilisers, and biogas can be used as a source of energy. The metallic waste could be reused or recycled. Even though there are large scale industrial waste segregators present, it is always much better to segregate the waste at the source itself. The benefits of doing so are that a higher quality of the material is retained for recycling which means that more value could be recovered from the waste. The occupational hazard for waste workers is reduced. Also, the segregated waste could be directly sent to the recycling and processing plant instead of sending it to the segregation plant then to the recycling plant. Currently there is no system of segregation of glass, plastic and metallic wastes at an industry. The purpose of this project is the realization of a compact, low cost and user friendly segregation system for urban households and scrap shops to streamline the waste management process.

PROPOSED METHOD

The block diagram shown in Figure 1 represents the automated waste material segregator where three types of materials are segregated, namely, Metal, Glass and Plastic. The controller used is Arduino UNO. An object is placed on the conveyor which runs on a motor of 12v, 1A which is connected through the motor driver and is programmed to run in clockwise direction by the Arduino.

The object is placed on the conveyor, depending on the output of inductive sensor and capacitive sensor the motor driver drives the motor.

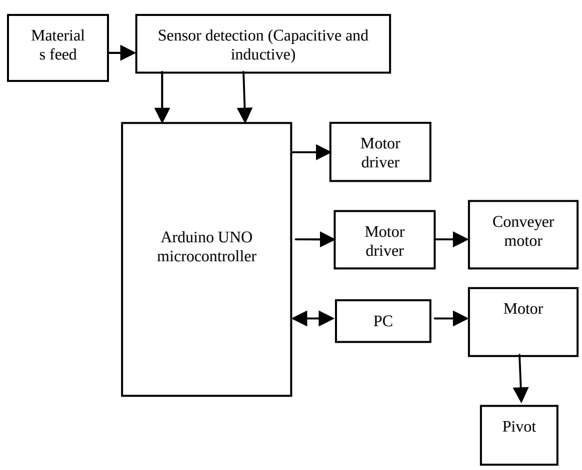

Figure 1: Block diagram of proposed system

Arduino Uno Act as a microcontroller, Arduino Uno is based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button. The board can be programmed with Arduino Software (IDE). The board can operate on an external supply from 6 to 20 volts. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The ATmega328 has 32 KB flash memory. It also has 2 KB of SRAM and 1 KB of EEPROM. Inductive proximity sensor Inductive proximity sensors operate under the electrical principle of inductance. Inductance is the phenomenon where a fluctuating current, which by definition has a magnetic component, induces an electromotive force (emf) in a target object. To amplify a device's inductance effect, a sensor manufacturer twists wire into a tight coil and runs a current through it. An inductive proximity sensor has four components; the coil, oscillator, detection circuit and output circuit. The oscillator generates a fluctuating magnetic field the shape of a doughnut around the winding of the coil that locates in the device's sensing face. Inductive Proximity Sensors being contactless sensors can be used for position sensing, speed measurement, counting, etc. They can be used in extreme conditions, such as oily, dusty, corrosive environment. Their application ranges from Automobile Industries to Steel Industries, from CNC/NC machines to material handling equipment, process automation, conveyor systems, and packaging machines.

Capacitive proximity sensor: Capacitive proximity sensors use the face or surface of the sensor as one plate of a capacitor, and the surface of a conductive or dielectric target object as the other. The capacitance varies inversely with the distance between capacitor plates in this arrangement, and a certain value can be set to trigger target detection. The sensing surface of a capacitive sensor is formed by two concentrically shaped metal electrodes of an unwound capacitor. When an object nears the sensing surface it enters the electrostatic field of the electrodes and changes the capacitance in an oscillator circuit. As a result, the oscillator begins oscillating. The trigger circuit reads the oscillators amplitude and when it reaches a specific level the output state of the sensor changes. As the target moves away from the sensor the oscillator's amplitude decreases, switching the sensor output back to its original state.

RESULT

1. Identifies metal and non-metal products
2. Identifies cracks on the metal products
3. Edges and curves can be identified using camera
4. Separator will separate cracked and non cracked metal products
5. Automatic counter to count the number of cracked and non cracked metal products

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