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Interfacing PIC Microcontrollers to Peripheral Devices

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§ 2 Delivery and Acceptance of the Work

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Tilt and vibration measurement of the remote objects using ZigBee communication

***Abstract.** In the paper the investigation of the control system for the cutting endless bandsaw are presented. During the cutting process some undesired and parasites effects such as vibration occur. The clumping force during the cutting operation should be diversified along with the operation progress. As the solution I propose feedback from the accelerometer and tilt sensors. New wireless data transfer technology offers the ZigBee standard, that was adopted in presented investigation.*

***Streszczenie.** W artykule przedstawiono system sterowania piłą taśmową przy produkcji seryjnej. Procesowi cięcia towarzyszą szkodliwe oscylacje, które bezpośrednio wpływają na jakość procesu przecinania. Ponadto duże znaczenie posiada sterowanie siłą nacisku piły w zależności od ilości zębów będących aktualnie w kontakcie z przecinanym materiałem Zastosowane rozwiązanie wykorzystuje elektroniczny czujnik wibracji a także czujnik pochylenia. Stworzona została sieć sensoryczna w oparciu o technologię ZigBee do kontroli wymienionych parametrów maszyny. (**Sieć czujników w oparciu o technologię ZigBee do kontroli wymienionych parametrów maszyny**)*

Keywords: Accelerometer, tilt sensor, ZigBee, 16-bit PIC microcontroller.
Słowa kluczowe: Czujnik wibracji, czujnik pochylenia, ZigBee, 16-bitowy PIC mikrokontroler.

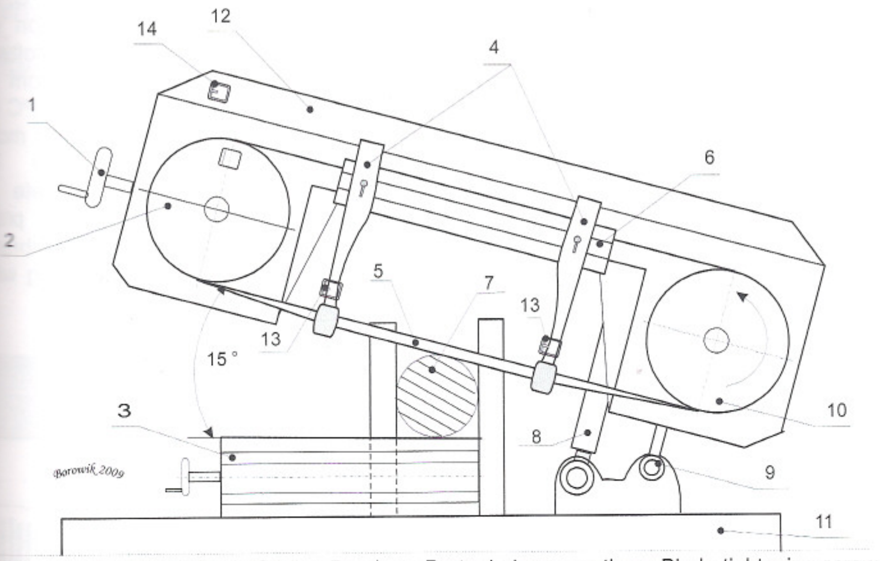

Fig. 1. Identification of Basic Cutting Bandsaw Parts during operations: Blade tightening screw (1), Stretching wheel (2), Assembling clamping block (3), Stationery blade guard (4), Blade (5), Support of blade guard (6), Material to be cut (7), Hydraulic linear motor (8), Head frame pulley (9), Active wheel (10), Frame of cutting bandsaw (11), Head of cutting bandsaw (12), Accelerometer sensors gathering the impulse burden (13), Tilt sensors gathering the head deflection data (14)

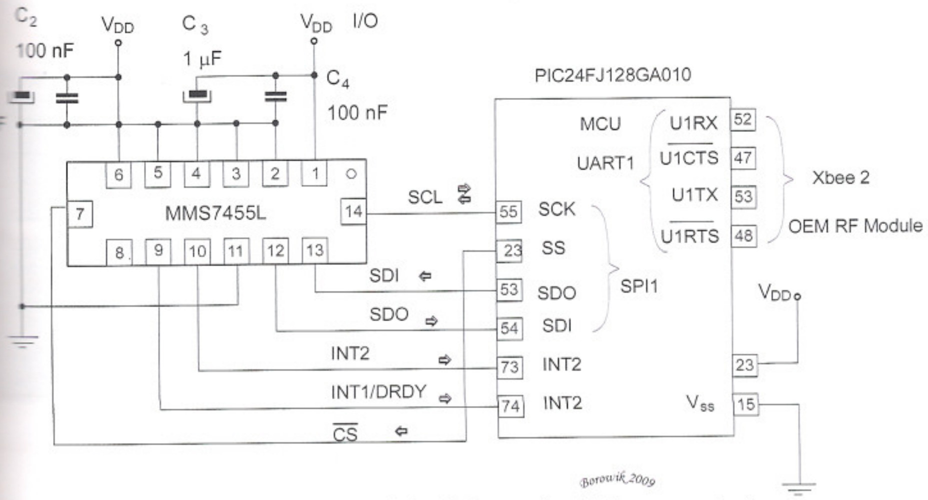

Fig. 2. Schematic diagram of the ZigBee node with the sensor device

Introduction

The paper presents a survey on the feasibility of implementing ZigBee sensor network for measuring tilt and vibration parameters of the operating object. Object of investigation was horizontal endless bandsaw for cutting metal circular profiles with diameter of 10 cm. The blade had pitch of 10 teeth/cm. Tilt and acceleration sensors are placed on the bandsaw, as shown in figure 1.

Operation Control system

Sensors are part of a system, controlling and optimizing the cutting process. Sensors through PIC24F microcontrollers are connected to the XBee sensor adapters that provide wireless network connectivity as shown in the figure 2.

Sensor description

Accelerometer used was Freescale MMA7455L. It has 2 sampling rates available at 125 Hz (using the 62.5 Hz digital filter) and 250 Hz (using the 125 Hz digital filter). It has a self test function to verify the integrity of the MEMS sensor and the ASIC signal path. There are several sensing functions that accelerometers are capable of detecting. These are motion, freefall, shock, vibration, and tilt. Measuring tilt gives information about the tilt angle between the cutting bandsaw head and frame in the range 0 – 15 degrees. Measuring vibration

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Reducing vibration and torsional oscillations in mechanical system

***Abstract**: The subject of the paper is vibration monitoring and measurements of the remote object in the pneumatic self-regulating clutch. Data from accelerometer sensor is further processed in dsPIC microcontroller targeted in minimalizing the torsional oscillations in mechanical system. Differential pneumatic flexible clutch is applied for reducing the torsional oscillation phenomena during the regular operation. Conclusions are derived and formulated.*

***Streszczenie**: Praca dotyczy nowych sposobów dostrajania układów mechanicznych drgających skrętnie za pomocą sprzęgieł pneumatycznych. Ograniczenie rezonansowych drgań skrętnych w układach mechanicznych w oparciu o układ mikroprocesorowy jest przedmiotem przedstawionych badań. Układ zawiera akcelerometr wraz z procesorem 16 bitowym ds. PIC. (**Redukcja drgań skrętnych za pomocą sprzęgła pneumatycznego**)*

Key words: dsPIC, flexible differential shaft coupling, 3-axis accelerometer, PWM duty cycle
Słowa kluczowe: dsPIC, elastyczne pneumatyczne sprzegnięcie wałów, drgania skrętne, akcelerometr, sprzęgła pneumatyczne

Torsional oscillation dumping in the mechanical system

Long time operation of mechanical system causes fatigue and changing of mechanical properties of piston machinery that are able to causes dangerous torsional oscillation in the mechanical system. This problem can be solved by means of suitable modification of dynamic properties of flexible shaft couplings. One of solution is pneumatic flexible shaft coupling that have constant characteristic features during the whole operation and thus can dump the torsional oscillations. The flexible shaft coupling is outlined in figure 1.

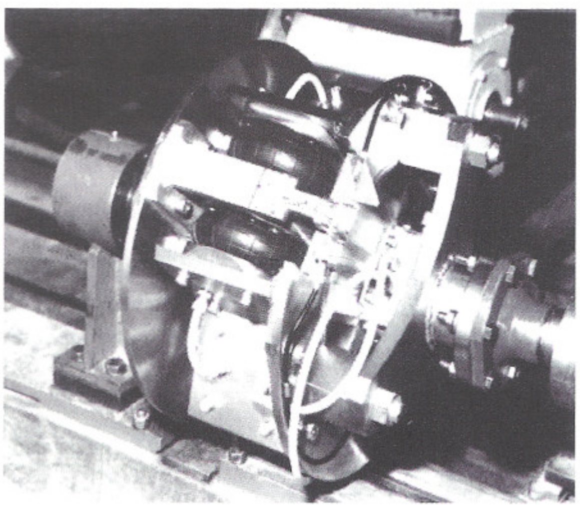

Fig. 1. Pneumatic flexible shaft coupling with auto adjustment

Pneumatic flexible shaft coupling with adjustment

Pneumatic flexible shaft coupling was used in the crushing mill driven with combustion Diesel engine. In the case of malfunction of the one of cylinders took over critical dynamic momentum.

According to J. Homisin [2] coefficient of non-linearity (torsional rigidity and damping) is dependent on the pressure of gaseous medium and the relation is described with the equation 1.

$$(1) \qquad \frac{k_{ed}}{k_{est}} = 1{,}05 + 4{,}14 * 10^{-4} * p_s$$

where: k_{ed} – equivalent dynamic torsional rigidity, k_{est} – equivalent static torsional rigidity, p_s – gaseous medium pressure.

Together with the change of gaseous medium in pneumatic coupling there are also changing values of the static and dynamic torsional rigidity and value of non-linearity $\varepsilon = a_3/a_0$ in the coupling. After pressure increase from 100 kPa to 700 kPa, coefficient of non-linearity descends in interval $\varepsilon = 15 \div 1.2$ as shown in figure 2.

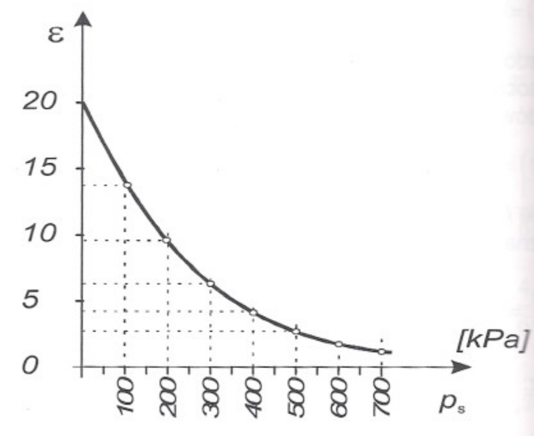

Fig. 2. Dependence between coefficient of non-linearity ε and gaseous medium pressure p_s

In the interval of gaseous medium pressure p_s = 200 – 700 kPa the pneumatic coupling behaves like a quasi-linear coupling.

Application of microcontroller dsPIC33 for coupling adjustment

The dsPIC device family employs a powerful 16-bit architecture that integrates the control features of a Microcontroller (MCU) with the computational capabilities of a Digital Signal Processor (DSP). The resulting functionality allows for applications that rely on high-speed, repetitive computations, as well as control. Applications for the dsPIC33 motor control family include among others electronically assisted power steering.