

Application of the Measurement Methods Using the Transformed Mechanical Quantities into Electrical Quantities on Farm Machinery Experiments

Zeynep Demirel Atasoy

Ankara Üniversitesi Ziraat Fakültesi Tarım Makinaları Bölümü

Aydınlıkevler-Ankara, Turkey

Abstract

Some physical quantities are used for design of the various machine prototype, improvement research and determination of the operating circumstances. These physical quantities, which are widely known, are tension-compression forces, moment, distance, velocity, vibration, flow rate, pressure and revolution per minute values. Such parameters can be measured by appropriate measurement techniques. Nowadays, every kind of mechanical quantities can be converted electrical signal, transmitted, recorded or processed by electronic components. Physical properties of materials change under mechanical effects. The inductance, capacitance, resistance, reluctance and voltage of mineral materials vary if they expose to pressure. Thus, the pressure changes influencing on the material occur and mechanical changes transform into electrical signal in the electrical circuit. These converting methods are used a lot of areas in the agricultural machinery experiments; for example predicting the draught forces of tillage equipments, determination of loads on tractor structures or soil failure caused by subsoilers, and a general purpose tractor instrumentation.

1.Introduction

In the preparing the prototypes various machines, in the development and adaptation researches and in the determining of the data that will be used in the establishment of the management conditions, some definite quantities are used. Some mechanic quantities for the farm machinery are; revolution per minute, torque, power, tractive force, specific power and specific draught resistance. By the

means of the last applications in the industry of electronics and the created possibilities; all the changes in the physical quantities can be transformed to electrical signals, conducted, stored and utilized [1].

2. The Definition of Data Production in Agricultural Process

The data flow in agricultural production process is divided into two separate parts, as

dynamic and static parts. The dynamic data show self-oriented activities in same production segment. Static data are collected data that are to be evaluated later. The information about the formation of the some dynamic data is shown in Table 1 .

In most cases, the quantities are compared with an appropriate unit. The quantity after comparison is then transformed into another physical quantity. A data measurement or a copy quantity can only be divided, transformed, given a meaning or empowered

by its own value. In this case, a measurement value transducer is present. A measurement value transducer for a measurement canal is given in Figure 1.

At the diagram in Figure 1, the value sensed by sensor is transformed into electrical value by transducer. The transducer following the sensor transforms the resistance change at a bridge circuit into the current or the voltage change. This last value is transformed by amplifier into wanted or permitted value as empowered [2].

Table 1. Some processes and information in agricultural mechanization [2]

Data flow in which the process will be held.	Seed bed preparation- Inter row cultivation	Sowing Planting Transplanting	Fertilization	Plant Protection	Green Plant Harvest	Fruit Harvest	Drying
Distance		X				X	
Time				X			X
Velocity	X	X	X	X	X		X
Revolution per minute			X	X	X	X	
Force/Moment	X		X			X	
Pressure				X			
Flow rate		X	X	X			X
Temperature				X			X
Density							X
Viscosity				X			

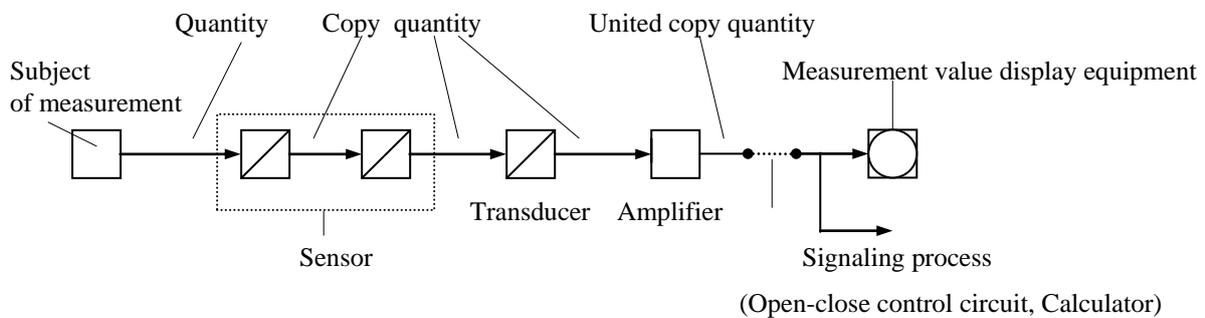


Figure 1. The flow of measurement data in a measurement canal [2]

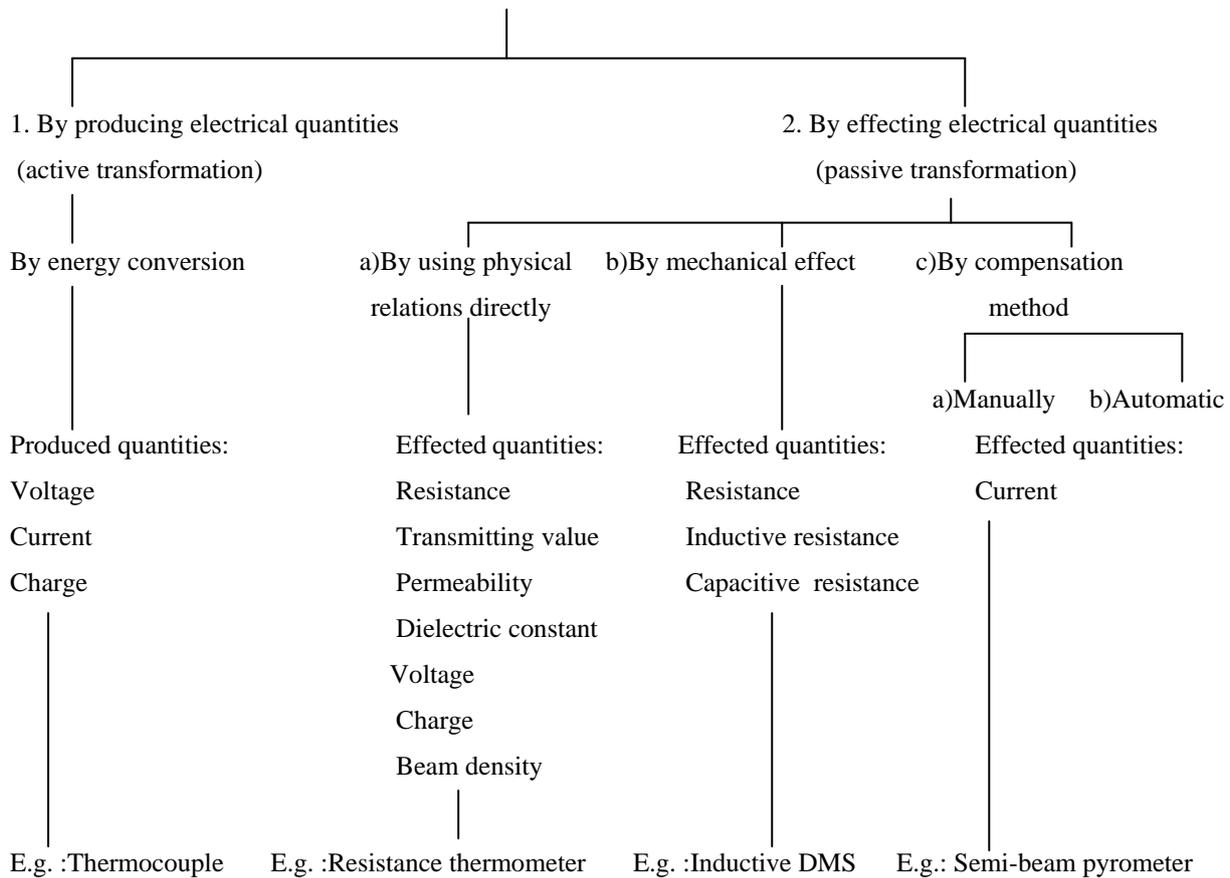
3. The Transformation of Mechanical Quantities into Electrical Quantities and the Measurement

In the process of transforming non-electrical quantities into electrical quantities, active and passive transformation methods are used. In the process of active transformation, the electrical quantities are produced and in the process of passive transformation, the electrical quantities are effected. The examples

related to the two methods are shown in Table.2.

The inductance, resistance, reluctance, capacitance and the voltage of the metallic materials under pressure show slight changes even the values are insignificant. As a result, in an electrical circuit containing elements responding pressure changes, the mechanical changes are converted into electrical signals. Transducers are named appropriately according to these facts.

Table 2. The transformation of non-electrical quantities into electrical quantities [3]



3.1. Transducers

The transducer types are stated below:

Resistance transducers: The most common types of the resistance transducers are extendable measurement bands named Strain Gauge or DMS. Measurement bands known forms can be illustrated as a strain wire attached to a carrier made up of paper or metal.

The variation of a resistance at all conditions can be measured by Wheatstone Bridge. The basic concept is to attach extendable measurement bands in appropriate places where the measurement will take place and transform the physical dimension changes into electrical resistance changes [3]. The location and connection figures of the measurement bands (DMS) on the tensile beam shown as an example in Figure 2.

Transducers, apart from resistance transducers, 1. Piezoelectric transducers, 2. Inductive transducers, 3. Capacitive

transducers, 4. Magnetoelastic transducers and 5. Photoelectric transducers are used extensively in agricultural machinery.

3.2. Amplifiers

The tiny signals which are transformed into electrical quantities can be noticed, read and amplified by the amplifiers in the registered limits. Moreover, amplifiers could be used as microprocessors. These types of amplifiers are also known as operation amplifiers (OPAMP) [3].

4. Application Examples of Agricultural Machinery

At this section, some application examples found in the articles will be explained from the point of transformation methods related to converting non-electrical quantities into electrical quantities. The examples are taken from the measurement sets used experiments of researchers.

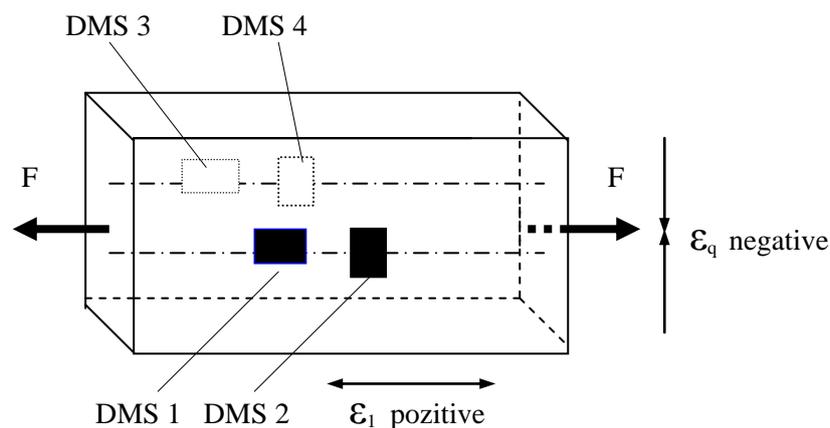


Figure 2. The locations of measurement bands (DMS) at tensile beams [4]

4.1. Experiment Set with Vibration Simulator

Generally, the system consists of a hydraulic unit, an electronic control panel and a mechanism containing a swing and a balance on which the trailer will be placed upon.

The tension-compression dynamometer is attached to the balance mechanism and the torsion moment values of the chassis can be measured. There is an inductive type transducer in the structure of the tension-compression dynamometer. At this point, the distance between dynamometer axis and the balance axis was taken exactly 1m. Thus, as ($M = P.l$) equation states, by taking $l=1m$, the direct torsion moment by calibration can be found and seen from amplifier [5].

4.2. Determination of the Grain Losses

During Harvest with a Combine-Harvester

At the harvest with a combine-harvester, the grain losses can be monitored via the help of the sensors which send impulses to a monitoring screen. If wanted, by placing sensors on one or two shaker, the grain losses through all shakers can be determined. This system uses piezoelectric and magnetic sensors and helps to the operator in determining the shaker cleaning losses, the choice of movement velocity and other adjustments [6].

4.3. A Field Method for Predicting the Draught Forces of Tillage Implements

Three-point linkage dynamometer system was developed to measure the draught of implements under different soil conditions.

There is only one Wheatstone Bridge circuit with Strain Gauge (DMS) (extendable measurement band) to sense the force on the top link in this system. This measurement and processing system also contain a data logger [7].

4.4. The Determination of the Loads on Tractor Axles

Loads imposed on the axles were measured and transducers with extendable measurement bands were used in this system. The transducers were placed on front and rear axles of tractor in order to sense loads in specific directions. The loads to be determined were the vertical, lateral, and longitudinal loads at the center of the front wheel, the vertical and horizontal forces on the rear wheel, bending moment at the middle of the tractor body, and the torque on the rear axle [8].

4.5. The Determination of Soil Failure Caused by Subsoilers

The subsoiler test in the laboratory conditions was conducted in a movable soil bin. The horizontal draught force, vertical suction force and moments on the tine could be measured by a T beam and the draught was verified by a traction dynamometer between the soil bin and the variable speed motor. Output signals from the T beam and the traction dynamometer were recorded on an electromagnetic oscillograph through an amplifier [9].

4.6. The Determination of the Volumetric Moisture Level at the Capacitive Sensors

The volumetric moisture level of the soil can be measured by the evaluation of the effects of the capacitance between two or more electrodes placed inside the soil. At the sensors based capacitance, the capacitance of the capacitors (probes or plates in the soil) imposing to a frequency are varied by the present water volumes in the soil [10].

4.7. General Purpose Tractor Measurement and Control System and Data Logging System

A tractor with 97 kW power was equipped with transducer set to measure fuel consumption; engine, wheel, and ground

speed; front and rear axle torque and weight, and forces in the 3-point hitch. Transducer signals were isolated, amplified, filtered and recorded by a microcomputer-based data logger. The block diagram regarding the system is shown in Figure 3 [11].

5. Conclusion

By the adaptation of the electric and electronic systems into agricultural machinery experiments, the machine system functions are improved and their productivity is increased. By this manner, the various variables effecting the performance of the machinery are measured more efficiently and reliable, and taken under control.

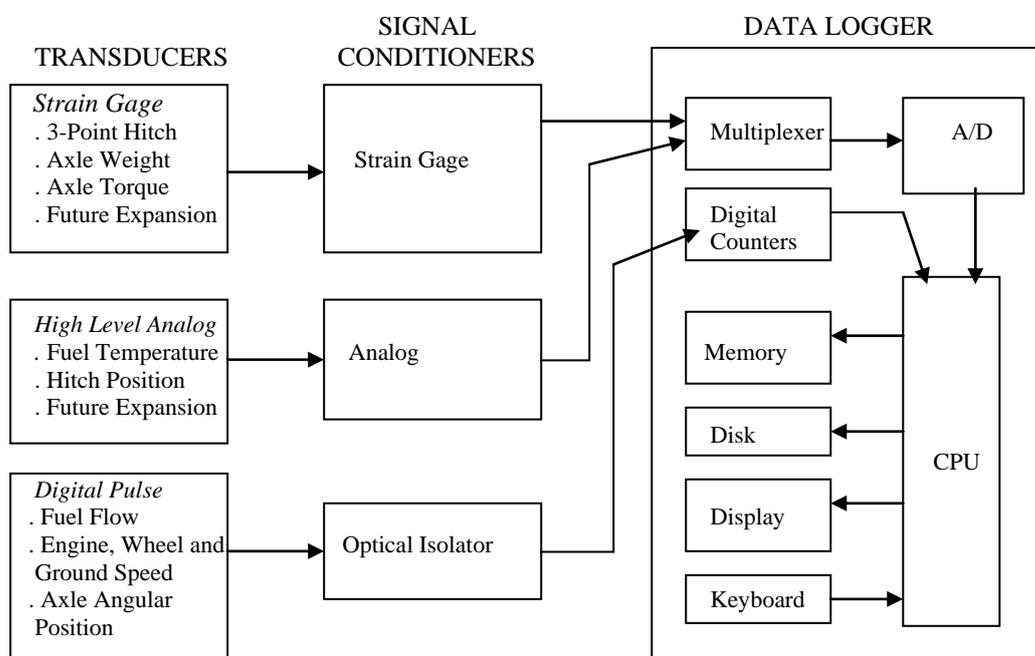


Figure 3. Simplified block diagram of tractor instrumentation and data logging system [11]

The methods of transforming the mechanical quantities into electrical quantities are specifically used by agricultural machinery researchers. By these methods, the basic performance and the characteristics of the agricultural machinery are revealed.

6. References

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Contact Person for Paper:

Res. Assist. Zeynep Demirel Atasoy
Adress: Ankara Üniversitesi Ziraat Fakültesi
Tarım Makinaları Bölümü
06130 Aydınlıkevler-Ankara,TURKEY
Fax: +90 312 318 38 88
E-Mail:zdemirela@ttnet.net.tr