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Refurbishment of Under-utilized Scientific Equipment for Modern Teaching and Research: Case of a Bio-reactor Upgrade

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We have found that large number of expensive scientific equipment purchased, received under foreign aids, national grants or any other public monetary funds are highly under-utilized in state universities especially those received before ten to thirty-five years. The apparent reasons found were; support and spares are not available to be replaced, venders or the manufacturer no longer available, lack of operational guides available, replacement for damaged parts cannot be found and due to their complexities refurbishments were failed etc. Therefore, we realize the value of saving billions of money to the nation if we could properly regain the operations of those equipment and enabling them with modern requirements for teaching and research in the universities and institutes. Hence we propose the refurbishment of a Bio-reactor (Fermenter); is the machine with enclosed and sterilized environment for making microorganism-controlled products. In the fermentation, fermenter controls critical functions of fermenting process such as temperature, pH, dissolved oxygen (DO) and mixing speed or agitation. The reengineered legacy fermenter was manufactured in 1985 by B.E. Marubishi, Japan and it was out of operation since 25 years. The machine was built entirely with analog controls including signal conditioner. The EPROM in the machine has been exposed to ultraviolet light sources and programs would be erased. The pH and dissolved oxygen sensors are galvanic type. MSU control unit and signal conditioner have been connected with each other via legacy data buses. Refurbishment of the MSU unit and signal conditioner has been bypassed and sensors are connected with newly built electronic circuit with the in house developed software modules. The sensor signals are processed by two micro-controllers and send it to the central raspberry processor. The raspberry-Pi processes the inputs and sends back the signals to control the fermenter. The control signals are again processed by micro-controller and thus it changes the fermenter parameters according to received control signals. The proposed control interface is web-based and it can be accessed anywhere in the world. The IoT conversion could help the students to do their research and practical work in bioengineering conveniently. Scientific Fermenter is an expensive equipment and not easy to afford for a new one. By the proposed research and development project we were able to save around 30 million LKR of public money and also started the teaching of new courses and research projects. Trials and experiments were carried out under well-controlled standard calibrations and setup was aligned with original operational characteristics. Refurbished setup was verified with the set of results obtained compared with that of original electronics and control algorithm given in published data.

Keywords: Fermenter, IoT, Micro-controller, Bio-reactor, Raspberry-Pi

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