VIRTUAL PARTS TRACKING USING AUGMENTED REALITY (AR) IN AN ASSEMBLY LINE

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ABSTRACT

Parts tracking is one of the crucial and time-consuming processes in the manufacturing industry for easily tracing individual parts in a production line. A proper parts tracking method promises better inventory management and increased efficiency of workers. Many times, workers are required to manually read the labels on different parts to identify them from shelves in an assembly line. This is tedious and may lead to gross errors. In this paper, a novel method to virtually identify specific parts on shelves in real-time using the latest technologies such as Augmented Reality has been proposed.

1.0 INTRODUCTION

Parts tracking, also known as traceability, is one of the most error-prone and time-consuming processes in an assembly line. Often small parts that are to be loaded into machines are queued on the racks of shelves. Workers need to read all the labels meticulously and identify the correct part based on business requirements.

Many companies in the manufacturing industry employ paper-based labeling in many of their assembly processes and it is a daunting process for the employees to check and identify all the parts by reading manually. This method is called Actual Goods Control Tag (AGCT), and this paper-based labeling may lead to mixing or swapping actual parts. This would be identified at the customer end leading to a return-to-vendor situation or scrapping of the rejected lot. Another critical issue is losing the traceability of parts in the line due to damage to paper labels or wear and tear.

Augmented Reality (AR) is a rapidly developing technology that overlays computer-generated content in the real world simulating an interactive experience for the users. A typical AR application starts with capturing the real world in the form of video which can be done by using a camera. In many cases, this video would be preprocessed on a frame-by-frame basis including noise reduction, color enhancement, and blur avoidance to ensure the best possible quality image is given as input to the next step. These preprocessed images are fed into an AR model in the next step. These are the models trained on large sets of data and objects from the real world. These models try to detect objects and find their coordinates, i.e. position in space. Having coordinates of objects and regions of interest, computer-generated content can be overlaid on each frame given to the AR model and this promises the AR experience given to the user. It is important to note that many devices such as Apple devices, involve special sensors to handle AR-related tasks more accurately and efficiently.

The AR applications can be broadly classified into two main categories. Markerless AR, where the application relies on edge detection from real-world objects, and Marker based AR where the application relies on special AR markers. AR can be further classified into location-based AR where the geographical data is considered to overlay objects. In this research, we used marker-based AR using ARUCO markers. An ARUCO marker, as shown in Figure 1, is a square-shaped visual code made up of a black border and a black-and-white inner binary matrix. Each marker has its unique identifier, and it can be easily detected in real-time by any low-power computing device.

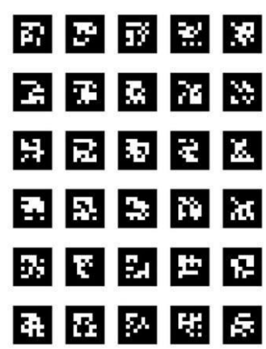

Figure 1: Sample ARUCO Markers

The rest of the paper is organized as follows. In section 2 the current practice of how companies track their parts in an assembly line and how they are using AR technology has been reviewed. In the next part, section 3, the proposed methodology is described. This is followed by section 4, results, and concluding in section 5. Finally, some options for the future are given in section 6, the recommendations.

2.0 REVIEW OF RELATED WORK

Many researchers and companies are trying to improve their traceability and tracking throughout their manufacturing process. In [1], the researchers introduced a method of automated traceability of PCBs in assembly lines by using Industrial Internet of Things (IIOT) technology. They employed various extraneous sensors such as vibration sensors, proximity sensors, and energy meters and attempted to get readings from installed sensors. The proposed method automatically handled most of the scenarios where PCBs cycle time within the assembling process but failed to handle manual interruptions.

Parts tracking and traceability can also be made possible by employing Radio Frequency IDentification (RFID) as shown in [2]. RFID tags are attached to crankshafts that go through different processes and using these RFID tags, the parts are traced and identified without much effort. RFID is the wireless use of radio-frequency electromagnetic fields to transfer data using "tags" attached to objects. These tags contain electronically stored information. This research can be made possible in automobile industries; however, in semiconductor industries, RFID tags can contaminate the nano-level diodes and other transistors in the equipment. In addition to that, fixing RFID tags to the metallic components may affect the performance of the antenna.

AR is being used in many industries such as Education where AR is being used to practically teach difficult concepts, the Textile industry where customers can trial before they buy a product, medical industry where doctors perform surgeries aided by powerful AR tools. There are many other applications for AR technology as surveyed in this research paper [3].

Live and historical data can also be seen using AR technology as proposed in this paper [4]. The researchers used Microsoft PowerBI software and the Unity game engine to prepare a dashboard that shows the sensor data in real time. They have used Microsoft HoloLens and iPad Pro 12.9 inch to exhibit the potential of AR technology in hand-carrying mobile devices. This research is more of a descriptive statistic that analyses the historical data and shows the results in the form of a dashboard.

In this research, we propose a novel method to identify specific parts on shelves virtually in real time using AR technology.

3.0 METHODOLOGY

A mobile device is given to workers that uses its camera to detect the ARUCO markers that are attached to the four corners of a shelf, acting like a grid localization map like what is shown in Figure 2.

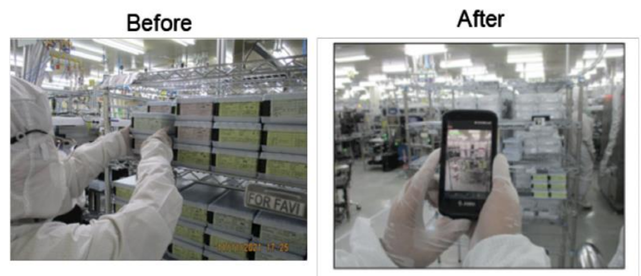

Figure 2: Demo of AR application on a phone

Our proposed methodology is as follows:

1. The live video stream from the camera is fed into the application.
2. Each frame will be preprocessed to remove noise and enhance the contrast.
3. The preprocessed frame is fed into the AR model that runs on the low-power computing mobile device.
4. The AR model tries to detect the ARUCO marker attached to the four corners of the shelf where the equipment is queued.
5. If all 4 ARUCO markers are visible, the model will overlay a grid map that shows outlines of all the equipment on the shelf.
6. Once the grid map is generated, the model will highlight the part that must be prioritized next. This data should come from existing inventory management software.
7. The coordinates of the part that should be highlighted would come from a database that sequentially stores all the part's coordinates.

By using this application, the workers don't need to go through the labor-intensive process of reading all the labels and picking the prioritized one. All they need to do is point the mobile device in front of the 4 ARUCO markers.

4.0 RESULTS AND DISCUSSION

With this AR approach, we were able to replace our manual tracing and improve the accuracy of our parts tracking method. We achieved a significant amount of savings by cutting down AGCT paper usage and also reduced the probability of ink contamination to 0.01%.

One limitation of this approach is that the camera should point to all 4 ARUCO markers. The parts cannot be tracked even if one of the ARUCO markers is not visible. In the future, we are planning to experiment with grid-localization techniques that eliminate the dependence on all 4 ARUCO markers. In addition to the above limitation, we also try to explore different ways to eliminate the manual entry of coordinates in the database.

5.0 CONCLUSION

In conclusion, a novel method of parts tracking using Augmented Reality technology has been developed and tested. Our manufacturing site's use of Fourth Industrial Revolution (4IR) technologies is a revolutionary step toward increasing production, yield, and efficiency. Using 4IR technology gives us a stronger competitive advantage and puts us in a successful and long-term growth position in the quickly changing manufacturing sector. This approach can greatly improve worker efficiency and save a lot of time.

6.0 RECOMMENDATIONS

Though this method can help workers save time and energy, the application heavily relies on the visibility of all 4 ARUCO markers which can become a problem as the worker has to stand at a particular distance to the shelf. Moving closer to the shelf makes the ARUCO marker invisible and the whole grid localization map would be compromised. The researchers are working on an intelligent solution where the grid localization map could be visible even with one ARUCO marker.

7.0 ACKNOWLEDGMENT

We would like to express our sincere gratitude to Dr. Warapon Chinsatit, for his invaluable contribution in forming this framework, providing critical feedback on the methodology, sharing essential data, and offering helpful discussions throughout the research process.

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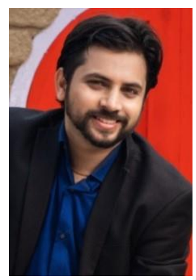
9.0 ABOUT THE AUTHOR



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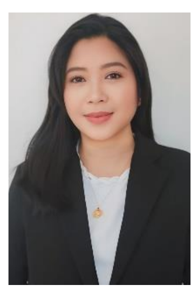

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